BEFORE THE PUBLIC UTILITIES COMMISSION

OF THE STATE OF HAWAIʻI

In the Matter of the Application of HAWAIIAN ELECTRIC COMPANY, INC. HAWAIʻI ELECTRIC LIGHT COMPANY, INC. MAUI ELECTRIC COMPANY, LIMITED For Approval to Commit Funds in Excess of $2,500,000 for Climate Adaptation Transmission and Distribution Resilience Program and to Recover Costs through the Exceptional Project Recovery Mechanism.	DOCKET NO.

APPLICATION OF
HAWAIIAN ELECTRIC COMPANY, INC.
HAWAIʻI ELECTRIC LIGHT COMPANY, INC.
MAUI ELECTRIC COMPANY, LIMITED

EXHIBITS A THROUGH L

VERIFICATION

AND

CERTIFICATE OF SERVICE

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APPLICATION

TO THE HONORABLE PUBLIC UTILITIES COMMISSION
OF THE STATE OF HAWAI‘I:

Hawaiian Electric Company, Inc. (“Hawaiian Electric”), Hawai‘i Electric Light Company, Inc. (“Hawai‘i Electric Light”), and Maui Electric Company, Limited (“Maui Electric”) (collectively the “Hawaiian Electric Companies” or “Companies”) request approval from the Public Utilities Commission of the State of Hawai‘i to commit funds in excess of $2,500,000 (currently estimated at $189,727,000 from 2022-2027) for a Climate Adaptation Transmission and Distribution (“T&D”) Resilience Program (“Project”) and to recover the Project costs through the Exceptional Project Recovery Mechanism (“EPRM”).

I. EXECUTIVE SUMMARY

The Companies serve approximately 95% of Hawai‘i’s population and operate approximately 9,400 miles of transmission and distribution lines across five islands that are foundational to the state’s economy and the wellbeing and health of the people of Hawai‘i.

Ensuring that the Companies' electric system can withstand and recover from severe disruptions and adapt to the changing climate is vital to the resilience of our entire community.

There are multiple aspects of power system resilience, including generation, cybersecurity, transmission, and distribution. Each plays a crucial role in safeguarding the delivery of electric power in the face of threats to this critical resource. The scope of this Application is focused on transmission and distribution system resilience. More specifically, this Application seeks Commission approval for investments over a five-year period to adapt the Companies' transmission and distribution system to our state's changing climate and growing resilience threats through the implementation of high-value, no-regrets actions. The investments include: (1) hardening critical transmission lines, (2) hardening and mitigating risks to critical overhead poles, (3) hardening circuits serving critical customers, (4) flood monitoring of substations, (5) upgrading distribution circuits to provide redundant transformer capacity (Maui only), (6) undergrounding select overhead distribution lines (Oʻahu only), (7) hazard tree removal, (8) state-of-the-art resilience modeling, and (9) wildfire prevention and mitigation. The Companies estimate that the average monthly bill impact of this Project for a typical residential customer will be $0.33 for Hawaiian Electric, $0.86 for Hawaiʻi Electric Light, and $0.71 for Maui Electric.

Having a more resilient power system means that less damage will occur when severe events happen and electric service to customers will be restored more quickly. The benefits of a more resilient electric grid include:

- Critical customer facilities and community lifelines are less likely to have electric service interrupted;
- Critical customer facilities and community lifelines that do lose power can be restored much more quickly;

- The total length of restoration ("TLR") can be dramatically reduced, resulting in fewer customers being out of power for extended periods of time;
- The local economy returns to normal more quickly, minimizing business losses;
- Storm restoration costs are dramatically reduced;
- Storm inventory levels can be reduced, which lessens storm preparation costs that are passed on to customers; and
- Day-to-day reliability is typically improved.

The Project is consistent with state policy and Commission priorities and reflects industry best practices and significant stakeholder input.

In 2021, Hawaiʻi was the first state to declare a climate emergency. Specifically, Senate Concurrent Resolution 44 states in part that "based upon the scientific information and expertise available, Hawaiʻi is in danger of disaster occurrences as a result of the effects of global warming, thereby endangering the health, safety, and welfare of the people, warranting preemptive and protective action[,]" and resolved that "climate mitigation and adaptation efforts [should] mobilize at the necessary scale and speed." Other state laws similarly recognize the urgent need for climate adaptation efforts in Hawaiʻi. For example, Hawaiʻi Revised Statutes ("HRS") Section 225P-1 reflects the need to "address the effects of climate change to protect the state's economy, environment, health, and way of life" and "adapt to the inevitable impacts of global warming and climate change…." Likewise, HRS §226-109 sets climate change adaptation priority guidelines to address climate change, including impacts to the energy sector, among others.

These concerns are justified by real events, including recent extreme weather events both in Hawaiʻi and nationally, which are increasing in both frequency and intensity due to climate change. Since 2015, Governor Ige issued at least 15 weather-related emergency proclamations[1] for events including, hurricanes, tropical storms, flooding, landslides, wildfire, and lava eruptions, among others. Hurricane Iniki in Hawaiʻi, Hurricane Ida in Louisiana, Hurricane Maria in Puerto Rico and Hurricane Sandy in New York all illustrated the extreme damage to the electric system that can occur, and the corresponding difficulty in response and recovery, when a significant hurricane hits unhardened infrastructure. Florida provides an example of a state that suffered damage to its electrical system from hurricanes, but also illustrates how hardening investments can both reduce the level of damage to the system and improve recovery and restoration times. And Hurricane Lane in Hawaiʻi provides an example of an all too real and recent "close-call" that demonstrates the threats are not a distant future issue and why critical resilience investments should not be delayed.

The Commission has also recognized resilience as a top priority outcome in Docket No. 2018-0088 (Performance-Based Regulation Investigation) and in its support of and participation in the Resilience Working Group ("RWG") to support the Companies' Integrated Grid Planning ("IGP") process.[2] The goal of the RWG is to support the development of resilience planning inputs for Hawaiʻi's power system including resource, transmission, and distribution assets, in relation to potential societal and economic impacts of potential severe events.

The Project incorporates significant work, recommendations, and input from the RWG. The RWG's members represent a broad range of state and national agencies, commercial and industrial customers, and not-for-profit interest groups.[3] While not encompassing the totality of

[1] https://governor.hawaii.gov/emergency-proclamations/
[2] *See*, e.g. Order No. 36388 Convening Phase 2 and Establishing a Procedural Schedule, issued June 26, 2019 at 5-7.
[3] The RWG included representatives of the Commission, Division of Consumer Advocacy,

the RWG's recommendations, nor the whole of the resilience work that will be needed over time, Project components were selected as immediate, cost-effective, no-regrets[4] resilience solutions that can be undertaken now to improve the ability of the system to withstand and recover from major storms, hurricanes, and storm-related flooding.

The Project strategies were also developed based on industry best practice and lessons learned from other utilities which have made significant investments in resilience. The initiatives are targeted to prioritize high value projects that will address the greatest vulnerabilities in a cost-effective manner, including critical circuits, structures, poles, and loads. Moreover, based on the Companies' analysis, the benefits of the proposed investments could exceed their estimated costs after just one severe storm hitting the islands.

The investments are also designed to enable and facilitate the delivery of grid services from distributed energy resources ("DER"), including microgrids. Investments in a robust distribution system and hardened transmission backbone will help enable delivery of services and value from these resources to the extent they are available during and after a significant storm event. In other words, the proposed climate adaptation resilience program enables and is necessary to the operation of DER and microgrid resilience solutions. This is similarly true for grid-scale renewables. Investments in key transmission line hardening can enhance the value of grid-scale renewables by helping to ensure and safeguard their availability in resilience scenarios.

City & County of Honolulu Emergency Management, City & County of Honolulu Office of Climate Change, Sustainability and Resiliency, Federal Emergency Management Agency, Hawaiʻi Emergency Management Agency, Hawaiʻi National Guard, Hawaiʻi State Energy Office, Hawaiʻi Department of Transportation, United States Army, United States Coast Guard, United States Department of Energy, United States Marine Corps, and United States Navy, among others. See, Exhibit B (*Resilience Working Group Report for Integrated Grid Planning*).

[4] As discussed further below, no-regrets resilience enhancements are 1) based on industry best-practice, 2) do not compete with customer and third-party solutions, and 3) can be implemented in such a way as to produce optimal results for expenditure by targeting assets that are most critical and/or vulnerable and using the most cost-effective means to meet hardening standards

The need to adapt to climate change is undeniable and urgent. The Companies submit that the Project is a critical step to addressing this need for the electric transmission and distribution system that is critical to the wellbeing of the state and its inhabitants and at a relatively modest bill impact. While the Companies are seeking approval of these important investments, which need to be made as soon as possible, they are in parallel preparing to pursue federal funding sources that could greatly offset costs to customers – that is, matching funding that may be available under the Bipartisan Infrastructure Investment and Jobs Act, passed by Congress on November 6, 2021 and signed into law by President Biden on November 15, 2021, which includes significant funding for both grid reliability and resiliency as well as flood and wildfire mitigation and coastal resiliency. The Companies will update the Commission as that effort proceeds.

II. APPLICANTS

Hawaiian Electric Company, Inc., whose principal place of business and whose executive offices are located at 1001 Bishop Street, Suite 2500, Honolulu, Hawaiʻi, is a corporation duly organized under the laws of the Kingdom of Hawaiʻi on or about October 13, 1891, and now exists under and by virtue of the laws of the State of Hawaiʻi. Hawaiian Electric Company, Inc. is an operating public utility engaged in the production, purchase, transmission, distribution and sale of electricity on the island of Oʻahu.

Hawaiʻi Electric Light Company, Inc., whose principal place of business and whose executive offices are located at 1200 Kilauea Avenue, Hilo, Hawaiʻi, is a corporation duly organized under the Republic of Hawaiʻi on or about December 5, 1894, and is now existing under and by virtue of the laws of the State of Hawaiʻi. Hawaiʻi Electric Light Company, Inc. is an operating public utility engaged in the production, purchase, transmission, distribution, and sale of electricity on the island of Hawaiʻi.

Maui Electric Company, Limited, whose principal place of business and whose executive offices are located at 210 West Kamehameha Avenue, Kahului, Maui, Hawaiʻi, is a corporation duly organized under the Territory of Hawaiʻi on or about April 28, 1921 and now exists under and by virtue of the laws of the State of Hawaiʻi. Maui Electric Company, Limited is an operating public utility engaged in the production, purchase, transmission, distribution, and sale of electricity on the islands of Maui, Molokaʻi and Lānaʻi.

III. CORRESPONDENCE

Correspondence and communications regarding this Application should be addressed to:

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IV. EXHIBITS

The following Exhibits are provided in support of this Application:

Exhibit A – Project Cost Estimate

Exhibit B – Resilience Working Group Report for Integrated Grid Planning

Exhibit C – Project Business Case

Exhibit D – Revenue Requirements and Bill Impact Calculation

Exhibit E – Exceptional Project Recovery

Exhibit F – Non-Wires Opportunity Evaluation

Exhibit G – Green House Gas Emissions Analysis

Exhibit H – Critical Customer Circuit Example

Exhibit I – April 2022 Blue Chip Economic Indicators Report

Exhibit J – Letters of Support for Resilience Investments

Exhibit K – Importance of a Resilient Grid

Exhibit L – Accounting Treatment Details

V. REQUESTED APPROVALS

The Companies respectfully requests that the Commission issue two decisions and orders as follows (see discussion of Critical Transmission Line Hardening in Section XII.A):

A. First Decision and Order Request: Approval of the Project

The Hawaiian Electric Companies request Commission approval of the following:

1. The commitment of funds in excess of $2,500,000, excluding customer contributions, for the purchase, installation and construction of the Project. The Project has a total estimated cost of $189.7 million[5] ($156.6 million in capital expenditures and $33.1 million in operations and maintenance expenses ("O&M")); this request is made in accordance with the provisions of Paragraph 2.3(g)(2) of G.O. 7, as modified by Decision and Order ("D&O") No. 21002, issued May 27, 2004 in Docket No. 03-0257;[6]
2. The proposed accounting and ratemaking treatment for the Project, including the recovery of the Project costs through the EPRM established in D&O No. 37507, filed

[5] In accordance with Order No. 38279 in Docket No. 2020-0167 (Maui Electric Switchyard/Synchronous Condenser Project), issued on March 17, 2022, the Companies have excluded certain overhead and on-costs from the requested commitment of funds and EPRM recovery amount in this Application, as those overhead costs will not be incurred as a direct result of implementation of the Project. The Companies confirm the overhead costs that are included in this Application are for: 84100004: OH - Payroll Tax, 84100005: OH - Non-Productive Time, and 84100006: OH – Benefits.

[6] Pursuant to D&O No. 21002, the G.O. 7 capital expenditures threshold was increased from $500,000 to $2.5 million, excluding customer contributions. The capital cost of the subject Project is greater than $2.5 million (excluding customer contributions), therefore, Commission approval of the capital expenditures is required.

December 23, 2020 in Docket No. 2018-0088,[7] until new rates become effective that provide cost recovery for the Project;

3. A proposed inflationary adjustment true-up mechanism to be applied to the Commission approved amount of EPRM recovery for this Project (as further discussed in this Application); and

4. Recovery of Project's recorded capital and incremental O&M expenditures that are placed into service during the current Multi-year Rate Period ("MRP") be included in base rates when such rates are reset for the next MRP. After the current MRP expires, recovery of costs for the Project's remaining years through the EPRM until new rates that provide recovery of the Project's remaining costs become effective for the MRP thereafter.

B. Second Decision and Order Request: Approval of Above-Ground 69 kV Line Extension(s)

Upon completion of the necessary analysis and studies and filing of any corresponding request(s) as may be necessary for approval of above-ground 69 kV line extensions, the Companies respectfully request the Commission issue a Decision and Order that:

1. If necessary, determines that a 69 kV line extension in connection with relocation of specified sections of a) the 6200 69kV transmission line on Hawaiʻi Island, and/or b) the Maʻalaea-Puʻunēnē 69kV transmission line on Maui, may be constructed above the surface of the ground, pursuant to HRS § 269-27.6;[8]

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[7] *See* D&O No. 37507 at 226, Ordering Paragraph #5, indicating that the "Major Project Interim Recovery ("MPIR") Guidelines are terminated as of the date of this D&O and immediately replaced with the EPRM Guidelines...".

[8] Bifurcating the approvals in this way will enable the Companies to begin work sooner on the portions of these lines that are planned to be hardened in place, thus expediting the hardening of the 6200 line and Maʻalaea-Puʻunēnē line and accelerating resilience improvement. See discussion in Section XII.A.

2. If necessary, conducts a public hearing pursuant to HRS § 269-27.5; and

3. Grants such other relief as may be just and reasonable under the circumstances.

VI. STATUTORY PROVISION OR AUTHORITY

The approvals in this Application are requested pursuant to Hawaiʻi Revised Statutes §§ 269-6, 269-16, 269-27.5, and 269-27.6, § 16-601-74 of the *Rules of Practice and Procedure Before the Public Utilities Commission*, and Title 16, Chapter 601 of the Hawaiʻi Administrative Rules, G.O. 7 Paragraph 2.3(g)(2), as modified by D&O 21002 and D&O 37507, and the Commission's EPRM Guidelines as set forth in Appendix A to D&O 37507.

VII. CONTEXT AND GUIDEPOSTS FOR THIS APPLICATION

This Application requests approval of the Hawaiian Electric Companies' first significant direct investment specifically to support the enhanced resilience of the Companies' distribution and transmission infrastructure against the increasing and more severe natural disasters resulting from global climate change. It builds upon the foundation already established by the Companies to provide reliable and secure electrical service to customers but is supplemental to normal "business-as-usual" reliability investments.

The resilience investments proposed in this Application are aligned with the recommendations of the RWG. Key members of the RWG have expressed support for electric grid resilience.[9]

Major General Kenneth S. Hara, Adjutant General for the State of Hawaiʻi and director of both the Hawaiʻi Emergency Management Agency and Hawaiʻi Office of Homeland Security, stated the following in his December 28, 2021 letter to the Commission:

> Investments to improve resilience in the electric utilities' generation, transmission and distribution systems against the effects of more extreme weather events caused by climate change … will support the reliable provision of electric service to the State of Hawaii,

[9] See Exhibit J to this Application.

critical infrastructure providers, and the first responders who will be a key part of any rescue and recovery response resulting from a major disaster in Hawaii.

> Based on my experience, loss of reliable electricity in critical sectors (hospitals, first responders, emergency management, telecommunications, water and food supplies), results in significant impacts. These impacts include severe disruption to mission critical services, impacts to life and health of the public, damage to infrastructure and property, environmental impacts, and immense cost and economic implications. Several critical infrastructure and key resources providers possess backup power capabilities; however, backup generator power is not sufficient to sustain "normal" operations and are reliant on fuel resupply.
>
> My recommendation is to support investment efforts of the state's electric utilities that align to Emergency Management/Homeland Security priorities of Prevention, Protection, Mitigation, Response and Recovery. Aligning to these goals will allow Hawaii's electric utilities the ability to maintain electric service or restore that service as quickly as possible once disruptions occur. One key contribution to that ability will be the sensible hardening of generation, transmission, and distribution facilities critical to the provision of electric service such that essential services can survive during and after severe events.
>
> Time is of the essence for investments to build a more resilient grid. I truly believe that if investments are not made now, future costs will be exponentially higher following a major disaster.

Similarly, Corey B. Shaffer, Senior Manager Network Operations for Verizon Hawaii stated in his letter of support for the Companies' T&D investments of June 10, 2022:

> As the Senior Manager for Network Assurance in Hawaii, I can state unequivocally that a functioning communications infrastructure (wired and cellular communications and internet service) is crucial to support mission critical functions as well as enable communication within communities both during and after a disaster. Verizon has hundreds of cell sites in Hawaii that require power to operate and virtually all are powered by the Hawaiian Electric Companies. Moreover, fiberoptic cables run along Hawaiian Electric's pole lines, and these fibers provide connectivity to over 95% of Verizon's wireless network. Many people do not realize that this wired communication infrastructure is required to support our modern wireless communications networks.
>
> As discussed in the Resilience Working Group ("RWG") of the Integrated Grid Planning ("IGP") proceeding, of which I am a member, Verizon's main concern is ensuring that poles serving our critical infrastructure and poles carrying our fiberoptic lines are resilient. Hardening of transmission and distribution poles serving critical cell sites as well as lines carrying critical fiberoptic lines would greatly enhance the resilience of the communications system and overall community resilience.

And as the Consumer Advocate recently stated in the PBR Proceeding:

> The Commission has established that resilience is one of the key regulatory outcomes that it is seeking to advance through PBR and PIMs.[10]
>
> The Consumer Advocate believes that additional measures should be taken to encourage the Companies to improve the resilience of their systems. With each passing year it becomes increasingly obvious that Hawaii needs to prepare for extreme weather events that are hard to predict or to plan for.[11]

Consistent with the recommendations of the RWG and key stakeholders such as the Adjutant General and Verizon Hawai'i, this Application incorporates the following guideposts as a fundamental part of its design:

1. Pragmatism. In 2021, Hawai'i was the first state to declare a climate emergency through the passage of Senate Concurrent Resolution 44 that among other things, stated that "based upon the scientific information and expertise available, Hawaii is in danger of disaster occurrences as a result of the effects of global warming, thereby endangering the health, safety, and welfare of the people, warranting preemptive and protective action[,]" and resolved that "climate mitigation and adaptation efforts mobilize at the necessary scale and speed." [Emphasis supplied]

As RWG members have noted in their correspondence in support, "the next major natural disaster could hit Hawaii at any time, and we must all work to make sure we are as prepared as we can be when it does." "Time is of the essence for investments to build a more resilient grid … if investments are not made now, future costs will be exponentially higher following a major disaster." This Application therefore seeks to balance the need to avoid unnecessary delay in making critical resilience investments, with the need to ensure that the investments are targeted,

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[10] Hawaii Public Utilities Commission, Docket No. 2018-088, Phase 1 Decision and Order, No. 36326, page 7.
[11] See, Consumer Advocate Statement of Position in Docket No. 2018-0088 at 51-52.

necessary and support the provision of resilient service to customers. The Application does that by requesting approval for identified "no-regrets" "low-hanging fruit" investments that can be commenced upon approval so that resilience improvements can begin immediately, while also evaluating in more detail the further resilience investments that will be required in the longer term including developing greater certainty regarding the scope and unit costs associated with certain projects. In this way, common sense investments in resilience which can be made now will not be delayed by the need to further study and define other more complex investments.

2. Flexibility. In addition to a time of rapid technological and scientific developments which could impact the types of investments made, this Application also comes during a unique convergence of uncertainty for many issues which are beyond the control of the utilities, the Commission or any of the key stakeholders and partners necessary to improve infrastructure resilience for the State. This includes but is not limited to the global pandemic which has impacted both the reliable availability of an experienced technical workforce and supply chain issues for the parts and supplies required for projects; global inflation which reached the highest levels in over 40 years including for fuel supplies; and war which has exacerbated both the inflation and supply chain issues as well as uncertainty. All these issues tend to impact the Hawaiʻi utility grids, which often require additional transportation time and costs for project inputs, even more severely than in other jurisdictions. The impacts of an unpredictable future are compounded for a project like this that will span over five years. Thus, innovative approaches and reasonable flexibility are essential to successful implementation. A reasonable level of flexibility will allow the Companies to adapt to evolving circumstances, new information and data, and new opportunities to best accomplish the desired resilience goals in the most expedient and cost-effective manner for customers. Examples of areas of cost uncertainty and variability include the following:

Inherent Scope Variability. The initiatives proposed in this Application are programmatic in nature and subject to significant inherent variability. For example, Critical Transmission Line Hardening, Critical Pole Hardening, and Critical Customer Circuit Hardening primarily involve hardening of existing transmission, sub-transmission, and distribution poles and structures. Each initiative will encompass a wide variety of pole/structure types, configurations, and hardening approaches. Therefore, individual poles and structures within a given program can vary widely from one another in terms of scope and cost. Critical Pole Hardening, for example, is expected to include hardening of transmission (for outer islands), sub-transmission, or distribution structures/poles of varying configurations. In addition, hardening approaches may vary depending on the individual pole, from installing additional guys, to trussing, to pole upgrade, to installing intermediate poles to reduce span lengths. Given the magnitude and programmatic nature of this initiative, the Companies have not identified every pole or structure that will be hardened over the course of the Project, so unit cost assumptions are based on reasonable best estimates but are expected to vary considerably from pole to pole. As another example, Critical Circuit Hardening will involve hardening sub-transmission and distribution lines serving critical customers. The Companies have not identified and scoped every individual circuit to be hardened, so cost estimates contain reasonable best assumptions about pole types and the number of poles per circuit requiring hardening. Of course, circuits can vary greatly in terms of the number of poles and their characteristics, so the cost per circuit is expected to have wide variation.

Materials. Prices for wood and steel poles have increased significantly over the past year, greatly outpacing the current already high inflation rate, due both to global demand and the pandemic's impact on global supply chains. Further price increases are anticipated but extremely difficult to predict.

Outside Services. Worker shortages in the industry (due to the pandemic, voluntary and involuntary retirement and the "great resignation" and reorientation of the workforce) as well as the fact that many mainland utilities are undertaking large capital programs – including for resilience – raises the risk of increased outside contractor pricing. General inflation has been high and unpredictable. This uncertainty has now been compounded by the continuing conflict in Ukraine, new lockdowns in China impacting supply chains, and an uncertain labor market outlook overall.

Inflation. As a practical matter, significant inflation volitivity has not been experienced for decades. However, in light of the current ongoing levels of inflation and the corresponding uncertainty regarding future cost stability, the Companies are requesting approval of an inflation adjustment mechanism together with a true-up at the end of the 5-year program. In designing this mechanism, the Companies utilized the 2022-2023 forecasted GDPPI from the April 2022 Blue Chip Economic Indicator's report (2.9%) as the annual escalation factor for non-labor costs (all costs excluding internal Hawaiian Electric Companies Labor) for each year of the program from 2023 to the end of the program (compounded year over year). Consistent with the guidepost of Accountability discussed below, the Companies have also proposed a provisional cost cap for each company based on the estimates detailed in this Application. The final cost cap for each company is proposed to be derived by a retroactive adjustment after the last year of the program based on actual historical GDPPI. The Companies' final EPRM filing will include a true-up to the extent that total costs may exceed the final cost cap.

3. Transparency and Accountability. To balance the need to move forward with resilience investments before every project and initiative can be scoped and costed in detail, and to allow for some reasonable amount of flexibility to address uncertainty with regard to project scope, timing and cost, the Companies commit to transparency with regard to (1) the initiation, conduct and progress of projects and initiatives, and (2) accountability for spending. This transparency and accountability will begin with a continuation of the Companies' partnership with the RWG. Prior to the first year of execution, the Companies will provide the RWG the opportunity to provide input and feedback into planning and criteria development. This will include re-engagement with the RWG to continue efforts to categorize and identify critical customers as well as prioritizing critical customer circuits for hardening. The Companies will utilize this feedback to develop a methodology for selecting critical customer circuits for hardening. The Companies will provide regular updates to the RWG on progress, as well as on an ad-hoc basis for any topics or changes requiring RWG input. The Companies will also provide regular updates to the Commission which will include written updates regarding the status and expenditures to date by initiative.

Additionally, because it is expected that unit costs for the various initiatives could vary from the estimates provided as discussed above, the Companies commit to staying within the total approved Project amount per Company (subject to an inflation mechanism as described below), while working to maximize resilience value for each expenditure. The Companies will do this by prioritizing work based on a combination of vulnerability, criticality, and execution efficiency. And as stated above, the Companies will keep the RWG and Commission abreast of Project developments and seek feedback from the RWG.

4. Community Partnership. Achieving infrastructure resilience for the State, including of the electrical sector will require more than just the utilities' efforts and the investments described in this Application. It will also require a partnership with the Commission, Consumer Advocate and key stakeholders including our RWG, governmental and community partners, as these investments will require the input of and collaboration with many different interests to help assure that the Companies' investments are as targeted, sensible, and efficient as possible.

5. Utility Financial Integrity. Among other important elements, the Commission recognized Utility Financial Integrity as "essential to [the utilities] basic obligation to provide safe and reliable electric service for its customers".[12] Thus, the "PBR framework is intended to preserve the utility's opportunity to earn a fair return on its business and investments, while maintaining attractive utility features, such as access to low-cost capital"[13] and "[s]afeguards have been built into the PBR Framework to protect the Companies from substantial, persistent financial harm and provide them with the support necessary to move forward with this necessary transformation despite the economic challenges brought on by the COVID-19 pandemic."[14] As the Companies move forward with the significant expenditures necessary to buttress utility infrastructure against extreme climate change events, it will be important to continue to maintain the Companies' financial integrity so that they may continue to make these types of investments at reasonable costs.

[12] D&O 37507 at 10-11.
[13] D&O 37507 at 11.
[14] D&O 37507 at 19-20.

VIII. GOVERNMENT AND CUSTOMER STAKEHOLDERS RECOGNIZE THE IMPORTANCE OF STARTING INVESTMENTS IN A RESILIENT ELECTRIC GRID AS SOON AS POSSIBLE

As discussed and detailed more fully in Exhibit K, the Commission as well as Federal, State, and County governments, Hawai‘i's communities, and IGP and RWG stakeholders have all identified the resilience of the electric system and the ability of the utility to continue to provide reliable power during emergencies as a critical matter for attention. Climate change has only exacerbated concerns and intensified focus on the issue of a resilient power system and its ability to recover from natural disasters and other emergencies.

This Application requests recovery for key resilience project investments which the IGP RWG and the Companies have identified as the immediate no-regrets projects and programs that are necessary to begin the critical process of hardening the electrical system against severe events such as major storms, hurricanes, flood events, and wildfires on O‘ahu, Maui County, and Hawai‘i Island.

These types of investments were recently addressed by the Commission. In the April 26, 2022 PBR Panel Hearing, Commission Chair Jay Griffin referenced the December 6, 2021 Kona Low event, which brought high winds and heavy rainfall and caused long-duration customer interruptions on O‘ahu, Hawai‘i Island, and Maui, as an event that attests to the need for greater focus and accountability for system resilience:

> When we talk about . . . increasing frequency and intensity of these storms in the future, I think the public expects us to be creating a system that will be more resilient to [extreme weather] . . . This was an extreme event and we're expecting more of those . . . We've got to do better . . . We need to have answers we can take back to the public [regarding] how we're responding to these events.[15]

[15] PBR Hearing Day 1, April 26, 2022, at 02:29:10 - 02:36:52. See https://youtu.be/4ysLdVLJjr4.

The Companies agree. A focused effort on resilience improvement is imperative to meet the challenges of a changing climate and increasingly volatile threats to the Companies' isolated power system. These investments are supplemental to routine asset sustainment efforts which are inadequate to safeguard the grid against severe resilience threats. As the Consumer Advocate noted in its Comments on the Commission Staff Proposal in Docket No. 2018-0088:

> Resilience investments are not adequately addressed through the ARA, existing PIMs, or proposed PIMs. Further, the economic pressure created by the ARA might encourage utilities to downplay resilience-related investments. The Consumer Advocate believes that the utilities should be making more progress to prepare for the increasing frequency and magnitude of storms that can wreak havoc on the electric utility system and the Hawaii economy.[16]

As discussed in Exhibit K, a catastrophic hurricane will lead to major disruptions in the production, transmission, and distribution of electricity in Hawai'i, however, targeted resilience investments can serve to mitigate the level of damage. These resilience-focused investments, founded upon industry best practice and stakeholder input, will serve to strategically strengthen the grid and address vulnerabilities to severe events to limit outages to critical community lifelines,[17] lessen damage to the grid, and reduce restoration times.

IX. THE PROPOSED INVESTMENTS ARE FOUNDATIONAL AND COMPLEMENTARY TO DER AND MICROGRIDS

Resilience solutions encompass a range of interventions, including risk prevention and risk mitigation. Preventive solutions prevent risks from being realized, while mitigation solutions lessen the impacts of risks that are realized.

Event risk prevention generally entails solutions to either withstand (e.g., system hardening) or avoid risk. For example, the Companies' proposed Critical Pole Hardening &

[16] Division of Consumer Advocacy's Comments on Staff Proposal for Development of Priority Performance Mechanisms dated September 17, 2021, filed September 30, 2021, at 10.
[17] *See,* FEMA Community Lifelines, https://www.fema.gov/emergency-managers/practitioners/lifelines

Mitigation initiative aims to perform targeted hardening of poles that would be most critical to withstand failure in a severe event in order to reduce the total length of restoration.[18] Other solutions, such as implementing non-grid-connected microgrids in remote areas or undergrounding conductor are examples of preventive solutions geared toward risk avoidance.

Mitigation solutions, on the other hand, can either reduce the impact of a failure event or facilitate recovery after the failure to reduce the consequences of an event. Mitigation measures can generally be thought of as addressing residual risks, filling any holes where preventive measures fail, or to address short-term needs until longer-term preventive measures are implemented. These can entail a combination of utility, third-party, and customer actions. For example, installing flood monitors improves situational awareness by alerting System Operators to substation flooding, allowing them to remotely de-energize the substation to reduce equipment damage. Likewise, incorporating switches with automation (e.g., SCADA and ADMS) for segmentation of the transmission and distribution system can reduce the outage exposure for a set of customers, reduce outage durations, and facilitate post-event restoration. Grid-connected customer and community microgrids,[19] along with customer DER/battery solutions are considered mitigation solutions in the event the larger grid fails.

A holistic approach to resilience improvement will require a combination of both preventive and mitigation solutions to create an effective resilience enhancement portfolio. The scope of this Application includes both preventive and mitigation solutions, but is largely focused on foundational hardening of the transmission and distribution system to benefit the largest number of customers and connected energy supply resources. Mitigation solutions with

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[18] *See,* Section XII.C.

[19] Community microgrids include multi-customer microgrids operating on utility-owned distribution or sub-transmission infrastructure. This would include hybrid microgrids of the type defined in the Microgrid Services Docket No. 2018-0163

potential customer and third-party solutions are currently enabled by the Companies' microgrid services tariff and opportunities identified in the IGP grid needs assessment and solution sourcing process. As explained in further detail in this Application and in Section 2 of Exhibit C (*Project Business Case*), the preventive solutions proposed in this application are complementary to, synergistic with, and often necessary to enable the resilience value of mitigation solutions involving DER, microgrids, and grid automation. By hardening distribution infrastructure, including hardening critical customer circuits as described in Section XII.B, the Companies' efforts will complement microgrids as a resilience solution by strengthening the distribution backbone, including the distribution lines serving groups of critical customers that may benefit from microgrid implementations in the future. Hardening the transmission and distribution system will also facilitate the resilience value of DER by enabling the output from multiple distributed resources to be combined and delivered within the system. Collectively, these synergistic and complementary interventions will help to address Hawai'i's resilience needs in an environment of increasing electricity reliance and growing resilience threats.

X. THE PROPOSED INVESTMENTS ARE ALIGNED WITH INDUSTRY BEST-PRACTICE

The proposed initiatives are in accordance with industry best practice to target high value projects that address the largest vulnerabilities in a cost-effective manner. A brief discussion of each of the proposed initiatives is provided below:

1. **Critical Transmission Line Hardening.** The Critical Transmission Line Hardening initiative focuses on strengthening transmission lines that are most critical for delivering electricity from generation locations to load centers. Improving transmission system resilience benefits virtually all customers by safeguarding the delivery of bulk power. Furthermore, if a critical transmission

line is damaged, it must be given high priority for repair, which can limit the ability to maximize restoration efficiency.[20]

2. **Critical Pole Hardening & Mitigation.** The Critical Pole Hardening & Mitigation initiative targets poles for strengthening or mitigation that are the most difficult to restore and/or cause the most impact if they fail. As a result, critical pole hardening has become almost synonymous with "targeted hardening" in the industry. Critical pole hardening was used extensively in both Florida and in Texas.[21]

3. **Critical Customer Circuit Hardening.** The Critical Customer Circuit Hardening initiative focuses on strengthening circuits that serve critical loads. If a critical circuit is damaged, not only does the critical load experience an interruption, but the circuit must be given high priority for repair, which can limit the ability to maximize restoration efficiency. Critical customer circuit hardening was used extensively in Florida.[22]

4. **Substation Flood Monitoring.** The Substation Flood Monitoring initiative will enable substations to be proactively de-energized before floodwaters rise to a level where control equipment becomes inundated. This action greatly reduces the likelihood of substation equipment damage and facilitates getting substations back online faster after a major event, which is necessary before distribution

[20] *A More Resilient Grid*, Dan T. Ton, W-T. Paul Wang, IEEE Power & Energy Magazine, May/June 2015 at 26-27.
[21] *Distribution Hardening: Benchmark Survey and Best Practices*, Public Utility Commission of Texas Project No. 36375, August 2009
[22] *See,* https://www.tdworld.com/grid-innovations/distribution/article/20966585/fpl-hardens-system-against-storm-outages

restoration begins. Substation flood monitoring is used extensively in both Florida and the Northeast.[23]

5. **Wildfire Prevention & Mitigation.** The Wildfire Prevention & Mitigation initiative includes targeted system hardening and situational awareness investments in wildfire risk areas to prevent wildfire ignition and enable quicker response to any ignitions that do occur. The risk of a utility system causing a wildfire ignition is significant. For example, the PG&E ignition of the Camp Fire resulted in a $15 billion settlement.[24] As such, wildfire ignition mitigation has become a regulatory requirement in California and in Australia.[25-26]

6. **Distribution Feeder Ties (Maui Only).** The Distribution Feeder Ties initiative will create backup ties for substation transformers on Maui that currently lack ties to other transformers. Feeder ties are one of the most cost-effective ways to increase reliability and resilience and are practiced widely by utilities around the world. Feeder ties will allow isolated substation transformers to be backed up by other substations/transformers and damaged feeders to be back-fed from undamaged or repaired feeders, reducing restoration time. This can be especially helpful during multi-day restoration events, when certain customers can be restored many days earlier than if no feeder ties are available.[27]

7. **Lateral Undergrounding (O‘ahu only).** The Lateral Undergrounding initiative involves carefully targeted undergrounding of distribution laterals in highly

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[23] *Storm & Flood Hardening of Electrical Substations*, IEEE 2014 T&D Conference, 14TD0564
[24] *PG&E Announces $13.5 Billion Settlement Of Claims Linked To California Wildfires*, NPR, Dec. 7, 2019
[25] *Office of Energy Infrastructure Safety Approves 2021 Wildfire Mitigation Plan for Southern California Edison*, https://energysafety.ca.gov;
[26] *The Australian Bushfire Mitigation Strategy*, T&D World, Jan. 2018
[27] R.E. Brown, *Electric Power Distribution Reliability*, 2nd Ed., CRC Press, 2009

vulnerable areas to reduce total length of restoration. Lateral undergrounding can be a cost-effective way to nearly eliminate the possibility of storm damage in certain areas. In addition, the undergrounded areas no longer require vegetation management. Undergrounding is being aggressively pursued in both Florida and Virginia for storm hardening, and in California for wildfire mitigation.[28,29,30]

8. **Hazard Tree Removal.** The Hazard Tree Removal initiative involves the removal of off-right-of-way trees that are weak, dead, diseased, or structurally compromised and pose a risk to power lines. Most storm damage tends to be due to trees that are outside of the right-of-way. Utility best practice is to identify and proactively remove these trees, with the removal being paid for by the utility. A robust hazard tree program can greatly reduce the amount of damage that occurs during a major storm. Hazard tree removal programs are in place at virtually all large mainland U.S. utilities.[31]

9. **Resilience Modeling.** The Resilience Modeling initiative is focused on developing performance-based modeling capabilities to evaluate system resilience and support investment options analysis in terms of expected system performance under severe event scenarios. Resilience modeling is an emerging area of research that will allow utilities to incorporate resilience strategies into the long-term planning process. Resilience models will allow resilience requirements to be set and then determine whether system plans are able to achieve these resilience

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[28] *See,* https://www.dominionenergy.com/projects-and-facilities/electric-projects/strategic-underground-program
[29] *See,* https://www.fpl.com/reliability/storm-secure-underground-program.html
[30] *PG&E Will Bury 10,000 Miles of Power Lines So They Don't Spark Wildfires*, CPR News, July 21, 2021
[31] *Hazard Trees: Benchmark Survey and Best Practices*, Public Utility Commission of Texas
Project No. 36375, August 2009

requirements. Resilience modeling was first investigated by a consortium of Florida utilities at the direction of the Florida PUC.[32]

XI. THE PROPOSED INVESTMENTS ARE TARGETED TO OPTIMIZE BENEFITS FOR EXPENDITURE

In addition to being aligned with industry best practice, the Companies are focusing their efforts on the assets that are the most critical and/or vulnerable. By targeting hardening and improvements to assets that are most critical and/or vulnerable, the Companies will ensure that resilience enhancements are carried out in a cost-effective way. That is, investments will be targeted to produce optimal results for the level of expenditure.

For example, hardening distribution and sub-transmission circuits that serve critical customers such as major hospitals, military facilities, and first responders increases the probability that these customers will stay online during and following a severe event and can be more quickly restored following interruptions. Focusing the Companies' efforts on these critical circuits to ensure these services are available during restoration is a "no-regrets" action.

As another example, the Critical Pole Hardening & Mitigation initiative will harden poles that would be a high priority to replace during restoration, are difficult to replace, would impede restoration if downed, and/or are especially vulnerable to severe events. Identifying "critical poles" in the context of this initiative essentially entails identifying the poles that would be most cost-effective to proactively harden to reduce restoration time, costs, and impacts. Critical poles are, by definition, the poles that are most cost-effective to harden.

Preventing damage to assets that would be most likely to fail under a given threat is a straightforward way to cost-effectively reduce the impacts of that threat. For example, the

[32] Florida Public Service Commission Order No. PSC-06-0351-PAA-EI

Companies' Substation Flood Monitoring initiative will deploy flood monitors to substations that are most at risk of flooding. Similarly, Wildfire Prevention & Mitigation activities are identified and prioritized based on inspections and assessments of identified wildfire risk areas to determine appropriate solutions to prevent or mitigate ignitions.

By prioritizing assets that are most critical, vulnerable, or a combination thereof, the proposed activities will proceed in a way that produces the greatest benefits for expenditure.

XII. PROPOSED PROJECT COMPONENTS AND SCOPE

The Companies are proposing an initial phase of "no-regrets" resilience enhancements based on the industry best practices discussed. These no-regrets resilience enhancements 1) do not compete with customer and third-party solutions, and 2) can be implemented in such a way as to produce optimal results for expenditure by targeting assets that are most critical and/or vulnerable and using the most cost-effective means to meet hardening standards.

The level of investment proposed and decision to focus on no-regrets actions is sensitive to the reality that power system resilience enhancement is still relatively new in the industry. Given the high degree of uncertainty with predicting severe events and the intrinsic challenges to evaluating power system resilience, more data and capabilities are needed before the benefits of individual investments can be clearly quantified and an optimal level of resilience spending can be ascertained. Such challenges are well-known across the industry, and there is significant interest in advancing capabilities in this area. However, it is the Companies' position that we cannot afford to wait for the state of the art to advance before taking action. As detailed previously, the cost of inaction can be catastrophic.

The proposed investments do not represent the totality of what the Companies believe must be done to achieve a resilient electric grid. Rather, these initial investments are proposed based on the Companies' position that there are common-sense, well-established, foundational, no-regrets resilience enhancements that can begin in parallel with the remaining steps in the IGP process. These types of investments, including those put forward by the RWG, will continue to be evaluated and implemented over time as a part of the Companies' ongoing and overall investments in projects to improve the resilience of the grid and ability to recover from severe events. This process will include incorporation of lessons learned from this initial set of investments, identification of additional and complementary resilience investments which may be necessary, and the consideration of modeling outputs to better inform subsequent investments.

As the various components of the Project are prioritized and implemented, the Companies will identify synergies between other transmission and distribution needs that are identified to ensure efficient investment. For example, there may be synergies with upgrades needed for renewable energy zones or to increase DER hosting capacity.

Further discussion of the Project schedule, risks, and operational impacts are provided in Exhibit C (*Project Business Case*).

A. <u>Critical Transmission Line Hardening</u>

Strongly integrated and robust transmission networks are crucial for system resilience due to the flexibility they afford under severe event scenarios. Since resilience is inherently concerned with extreme, high-impact events, resilience planning must consider severe and uncommon operating scenarios, such as the sudden loss of multiple system resources simultaneously due to extreme weather. Under such scenarios, robust transmission networks enable the system to compensate for unplanned coincident outages of generation, ancillary equipment, and/or lines.

Without a resilient transmission system, the grid is more vulnerable to wide-spread outages or system-wide blackout. In late August 2021, Hurricane Ida made landfall in Louisiana as a Category 4 storm. High winds knocked out all eight transmission lines delivering power to New Orleans, causing a city-wide blackout.[33]

After Winter Storm Uri, which struck Texas in February 2021, a report commissioned by the American Council of Renewable Energy (ACORE) found that "each additional 1 GigaWatt (GW) of transmission ties between the Texas power grid (ERCOT) and the Southeastern U.S. could have saved nearly $1 billion, while keeping the heat on for hundreds of thousands of Texans." The full report analyzed five recent severe events across the U.S. and concluded that "all generation sources are vulnerable to severe weather, making increased transmission to broaden the pool of available resources one of the best options for increasing resilience."[34]

For isolated island grids such as those in Hawai'i, the lack of transmission interties to other neighboring grids is already a constraining factor. This makes the need for a robust, hardened, island-wide transmission system even more crucial for system resilience. Given that each island is unable to leverage interties to other neighboring grids, system resilience is heavily influenced by the extent to which critical transmission lines connecting disparate regions and resources on the grid are able to withstand extreme weather events and be quickly restored when failures occur.

Hardening the transmission system is critical to ensuring that grid-scale solar, wind, and battery resources, community based renewable energy, along with customer distributed resources continue to operate or are quickly restored following a severe event. While many of the

[33] *See,* https://www.utilitydive.com/news/ida-knocks-out-all-transmission-lines-into-new-orleans-leaves-1m-without/605754/
[34] *See,* July 2021 report by ACORE: *Transmission Makes the Power System Resilient to Extreme Weather*. https://acore.org/wp-content/uploads/2021/07/GS_Resilient-Transmission_proof.pdf

customer battery energy storage systems made today can operate during a grid outage to self-power a portion or all of a home's load, the majority of solar systems need the presence of the grid to operate. In order for these grid-connected systems to operate, the transmission system must be intact to signal to the inverters that the grid is present and operating. Following an event, grid connected, customer distributed generation and batteries can continue to provide energy within the system if it becomes segmented. In this case, the grid infrastructure is needed to combine the output from multiple distributed resources and transmit this energy to where it is needed. Without a robust transmission and distribution system, the delivery of energy from distributed resources and grid-scale resources to other customers will be hampered, limiting the realization of their resilience value. Microgrids, while an important point solution for critical facilities and smaller groups of customers, do not alone address the larger community needs for reliable clean energy in an increasingly electrified Hawai'i.

The Companies' proposed Critical Transmission Line Hardening initiative focuses on hardening existing transmission lines that are critical for system operation and/or restoration following a severe resilience event. The Companies' approach is to incrementally harden critical transmission lines such that the minimum strength of the line would meet or exceed National Electrical Safety Code ("NESC") Extreme Wind Loading criteria. All structures or spans that do not meet or exceed the NESC Extreme Wind Loading criteria will be designed to the stronger of the Companies' design policy or 100-year extreme wind loading criteria, which exceed NESC Extreme Wind Loading criteria.

On O'ahu, the focus is on ensuring that at least one of the possible paths through the transmission system is hardened to avoid or limit system damage from extreme wind events and support faster restoration following a widespread outage or island-wide blackout. O'ahu's transmission restoration guidelines divide the transmission system into three “target systems.” Target System 1 represents the "backbone" of the transmission system used to black start and parallel generation resources needed to restore large load centers. After Target System 1 is energized after a blackout, Target System 2 is energized next. Target System 2 is the first buildout from Target System 1 to nearby transmission substations and allows the Companies to restore the first major load centers and other critical infrastructure such as the Honolulu International Airport, Honolulu Harbor, and Department of Defense facilities. After Target Systems 1 and 2 are energized, Target System 3 can be energized, which allows the Companies to restore the remaining load centers on the island, including Windward O‘ahu and East Honolulu. By hardening at least one of the possible transmission restoration paths through Target Systems 1, 2, and 3, the Companies will have a better chance of avoiding wide-spread outages and enabling quicker restoration of service following severe events such as major storms and hurricanes.

The high priority transmission restoration paths may also have synergies with renewable energy zones (“REZ”) contemplated in the IGP process. The transmission REZ Study has identified potential transmission system network upgrades that may be needed to increase the capacity of the transmission system to harness electrical power from identified REZs.[35] The Companies will seek to optimize REZ plans as they develop, with the implementation of individual transmission lines as part of this initiative.

The goal of this initiative is to harden one of the possible transmission restoration paths such that the minimum wind speed rating of any component of this path would meet or exceed

[35] *See, Hawaiian Electric Transmission Renewable Energy Zone (REZ) Study*, filed as Exhibit 2 of the Hawaiian Electric Companies’ Grid Needs Assessment Methodology Review Point in Docket No. 2018-0165 on November 5, 2021

NESC Extreme Wind Loadings. Any structure or span that is replaced would be designed to the stronger of the Companies' design policy or 100-year extreme wind loading criteria. Based on an analysis of the hardening requirements for the various possible transmission restoration paths, the Companies estimate that the least-cost path to harden would involve upgrading roughly 400 structures across 16 critical transmission lines. For the initial five-year plan proposed in this Application, the Companies intend to harden approximately 81 structures on O'ahu for a total of approximately $54,194,000, as shown in Exhibit A to this Application.

On Hawai'i Island, the major load centers include North Kona and South Kohala on the west side and Hilo and Puna in the east. The east and west sides of the island are connected by four critical cross-island transmission ties. The four cross-island ties are critical for maintaining power transfer capability between the west and east, enabling economic dispatch of resources, independent of their location. Given that the resource mix on the grid is subject to change, these cross-island ties also enable built-in flexibility for future scenarios, including flexibility for where new renewable generation can be sited (as is contemplated in the REZ study).

More importantly from a resilience planning perspective, the power transfer capability afforded by these lines is especially critical during severe operating scenarios, such as those caused by storms and hurricanes, where generation resources and power lines can be suddenly taken offline. The cross-island ties provide critical flexibility to shift generation based on available resources under these types of scenarios by enabling power transfer from one side of the island to the other. Without the cross-island ties enabling the system to flexibly compensate for these types of sudden changes in system resources, the grid is more vulnerable to wide-spread outages or system-wide blackout. The geographically dispersed utility-scale generation facilities and cross-island ties have been key in facilitating a reliable system with high variable production as well as enabling the system to survive major storms, earthquakes, and lava events.

There have been multiple storms affecting Hawaiʻi Island in the past that caused outages of multiple of the cross-island ties at the same time, resulting in precarious operating scenarios where the grid was saved by the ties that remained energized. For example, during Hurricane Iselle, power was provided to customers in East Hawaiʻi/Hilo from Keahole facilities via the 6200 line (one of the cross-island ties running along Saddle Road) as most of the East Hawaiʻi generation was lost along with the other three cross-island ties. The cross-island ties were also essential for reliable continuity of service during the extended outage of the geothermal plant following the 2018 eruption. Ensuring that there are hardened transmission ties connecting the east and west sides of Hawaiʻi Island is essential for system resilience for the present and future mix of generation resources.

Of the four cross-island ties, the Companies have selected the 6200 line, which runs from Keʻāmuku Switching Station to Kaumana Switching Station along Saddle Road as the most beneficial to harden first. This line is one of the shorter cross-island ties, which results in more resilience benefit per dollar spent on hardening. In addition, a portion of the 6200 line in the upper Kaumana area is located in a critical habitat area. When the line in this area is damaged, gaining access to the line is very challenging for troubleshooting, repairs, and restoration. Poor visibility due to rainy, cloudy, and foggy weather conditions further complicate the already difficult access for troubleshooting and repairs. Hardening and relocating this section of line to the road will greatly improve restoration times if required after a severe event. Furthermore, previous planning studies have indicated that when there is significant generation coming from one side of the island and one of the cross-island ties is lost, there can be potential voltage and overload issues that can be addressed by reconductoring 6200. This type of contingency situation is relevant for both blue-sky reliability (depending on the resource mix on the grid at the time), and for resilience considering severe event scenarios where the loss of generation resources can cause an imbalance of generation between the opposite sides of the island (even if generation were balanced across the island during normal conditions). The 6200 line is also one of the transmission lines that was identified for reconductoring to support the future Renewable Energy Zones needed to interconnect grid-scale renewable energy beyond Stage 1 and 2 procurements. Hardening the 6200 line and upgrading to the standard conductor size will safeguard and improve the resilience value of this critical line for the present and future grid, while also providing synergies with other planning goals (e.g., 100% renewables/decarbonization).

The Companies plan to harden the 6200 line such that the minimum wind speed rating will meet or exceed NESC Extreme Wind Loading criteria. Any structure or span that is replaced would be designed to the stronger of the Companies' design policy or 100-year extreme wind loading criteria. While upgrading the line, the conductor will also be upgraded to current standard (556 kcmil AAC).

The 6200 line is about 50 miles long. The Companies plan to harden and reconductor to current conductor standards approximately 10 miles of line in this initial five-year program, with roughly 178 structures to be upgraded or installed. This includes the relocation of approximately 7 miles of line out of a critical habitat area, which the Companies consider the highest priority segment of this line to address to maximize resilience benefit. The total cost for this initial phase of work is estimated at approximately $12,386,000.

In order to expedite the 6200 line hardening initiative, the Companies are requesting approval for 1) the commitment of funds associated with the Project, and 2) the proposed accounting and ratemaking treatment for the Project, prior to approval of the above-ground 69kV line extension for the sub-section of the 6200 line that is planned to be relocated. Upon completion of any necessary analysis and studies regarding location and construction of the high-voltage electric transmission lines, the Companies will address the elements of HRS § 269-27.6 and will request that the Commission conduct a public hearing under HRS § 269-27.5, as necessary, as part of a subsequent request to be filed with the Commission. Bifurcating the approvals in this way will enable the Companies to begin work sooner on other parts of the 6200 line that will not require relocation, thus expediting the hardening of the 6200 line and accelerating resilience improvement.

For Maui County, the Companies identified the following three transmission paths as most critical to harden:

- Maʻalaea-Puʻunēnē which connects Maʻalaea Power Plant to the major load centers in Central Maui.
- Maʻalaea-Waiinu which also connects Maʻalaea Power Plant to the major load centers in Central Maui.
- Maʻalaea-Kīhei which is the shortest path from Maʻalaea Power Plant to the major load center of Kīhei.

Of these three, the Companies' selected the Maʻalaea-Puʻunēnē line to harden first. In addition to connecting the Maʻalaea Power Plant to loads in Central Maui, the Kuihelani Solar project is interconnecting to Maʻalaea-Puʻunēnē near Kuihelani Switching Station, which increases criticality of the Maʻalaea-Puʻunēnē tie. Furthermore, Maʻalaea-Puʻunēnē was one of the lines identified for reconductoring in the REZ study. While the Companies do not intend to reconductor Maʻalaea-Puʻunēnē as part of this five-year plan, the Companies intend to harden this line (i.e., upgrade/strengthen poles and structures) such that it will meet or exceed NESC Extreme Wind Loading criteria with the larger conductor size contemplated by the REZ study. Any structure or span that is replaced will be designed to the stronger of the Companies' design policy or 100-year extreme wind loading criteria.

For the majority of the Maʻalaea-Puʻunēnē line, the Companies plan to upgrade poles in-place. However, there are two areas where the Companies are considering alternative options. The portion of the Maʻalaea-Puʻunēnē line heading from Maʻalaea Power Plant to Honoapiʻilani Highway shares structures with the Maʻalaea-Kaheawa 1 line for approximately 1.5 miles. Splitting this double circuit line section into two separate lines may be optimal to improve resilience by reducing the probability of coincident outages of both transmission lines by a single failure event. The Companies are also considering relocating a 2-mile section of the Maʻalaea-Puʻunēnē line near Kuihelani Switching Station where the Companies currently have limited access. Relocating this section of 69kV line to Kuihelani Hwy may be optimal to enable quicker restoration in the event of damage to this line. The Companies will analyze options to address these line sections in 2022 and 2023. To the extent that it is determined that these overhead line projects should move forward and to the extent necessary, the Companies will address the elements of HRS § 269-27.6 and will request that the Commission conduct a public hearing under HRS § 269-27.5 as part of a subsequent request to be filed with the Commission. Bifurcating the approvals in this way will enable the Companies to begin work sooner on the remainder of the Maʻalaea-Puʻunēnē line that will be upgraded in-place, thus expediting the hardening of this critical transmission line and accelerating resilience improvement.

The Companies estimate that about 144 transmission structures will need to be upgraded or installed to harden the Ma‘alaea-Pu‘unēnē line. This includes approximately 2 miles of line to be relocated near Kuihelani Switching Station, along with splitting 1.5 miles of double-circuit line running from Ma‘alaea Power Plant to Honoapi‘ilani Highway into two separate lines. The Companies intend to harden the entire line in this five-year program at an estimated cost of $8,433,000.

In order to meet the aggressive hardening timeline proposed and enable the Companies to commence with detailed engineering design upon Commission approval, the Companies will continue scoping and analysis in 2022 prior to Commission approval. This will include efforts to further refine the scope of work and prioritization of the hardening activities described above.

B. Critical Customer Circuit Hardening

Critical customers include those that provide services essential to human health and safety and enable the rest of society to function. Since all critical customer sectors depend on electricity to function, ensuring reliable and resilient power to these customers is crucial to the resilience of the community writ large. The RWG developed a framework for prioritizing customers and infrastructure sectors from the perspective of importance to supporting (1) national security and/or public safety and health and (2) power system recovery. The RWG's critical customer sectors have general alignment and overlap with other national constructs such as FEMA's Community Lifelines[36] construct and the Department of Homeland Security's ("DHS") Critical Infrastructure Sectors.[37]

Like the energy sector, some other critical customer sectors also function as infrastructure networks, where interrelated resources and facilities of varying criticality are located across the

[36] *See,* https://www.fema.gov/emergency-managers/practitioners/lifelines
[37] *See,* https://www.cisa.gov/critical-infrastructure-sectors

community. When critical sites in these networks are disrupted, this increases reliance on the other system components to ensure service continuity. Recently, the Honolulu Board of Water Supply ("BWS") shut down its Hālawa shaft, Hālawa well, and ʻAiea well after water contamination was detected at the Navy's Red Hill shaft. Normally, the Hālawa Shaft supplies 20% of the Honolulu region's drinking water.[38] As of this writing, it is not yet known when the Hālawa Shaft will be brought back in service.[39] The loss of this critical resource in the island's water system further increases the importance of reliable and resilient power to the other wells and pumps on Oʻahu to continue to meet demand. This is especially true if a severe event occurs while BWS is operating without the Hālawa shaft. It is therefore of increased importance to minimize energy disruptions to the remaining critical sites and ensure that utility power can be quickly restored when disruptions occur.

Critical Customer Circuit Hardening aims to harden distribution and sub-transmission circuits to benefit communities by strengthening service to critical customers (such as major hospitals, water infrastructure, military facilities, first responders, and other Tier 1 and 2 critical customers in alignment with the framework established by the RWG) by implementing cost-effective solutions (e.g., pole upgrades, storm guying, etc.) that address potential weak points and vulnerabilities along the circuit to increase the overall resilience of the circuit to meet or exceed NESC Extreme Wind Loading criteria.

Critical Customer Circuit Hardening is a complementary or necessary solution to on-site backup generation/battery storage or non-wires alternatives for risk mitigation, such as microgrids, but is not duplicative of them. For example, many critical customers have on-site

[38] *See,* https://www.hawaiinewsnow.com/2021/12/13/bws-latest-test-results-Halawa-shaft-show-no-sign-fuel-contamination/

[39] *See,* https://www.staradvertiser.com/2021/12/10/breaking-news/Halawa-shaft-could-be-shut-down-for-years-even-permanently-amid-water-contamination-crisis/

backup generation. The RWG Report summarizes the existing backup power capabilities in key customer sectors, with some sectors tending to have greater backup power capabilities than others. In any case, on-site backup generation is a stop-gap solution until grid power is restored to the site. In the case of backup diesel generators, critical infrastructure sectors are typically only able to operate at reduced capacity until grid power is restored, prioritizing their most critical facilities and functions. Power supply for backup generators is also limited by on-site fuel stores and the ability to resupply fuel. Backup generator reliability is also an issue, as there are many examples of backup diesel generators for critical facilities failing after being called on following a severe event due to infrequent use or exercising of equipment. On-site renewable DER solutions can also be used to provide backup power to critical facilities, but are themselves vulnerable to severe weather, and are also stop-gap solutions until grid power restoration is achieved. As described in Section 2 of Exhibit C (*Project Business Case*), a holistic, multi-pronged approach involving both prevention (e.g., system hardening) and mitigation (e.g., microgrid) solutions is needed to improve resilience. Hardening critical customer circuits will help to prevent outages to critical customer facilities and enable quicker restoration after outages occur.

The Critical Customer Circuit Hardening initiative will also help to provide the necessary backbone for future mini-grid[40] and community microgrid solutions. Community microgrids could also be the hybrid microgrid type being discussed in the Microgrid Services Docket No. 2018-0163. Many critical customer circuits may be good candidates for community microgrids or CCHs in the future.[41] In order to implement a community microgrid, hybrid microgrid or CCH

[40] For the purpose of this Application, mini-grids are largely self-sufficient electric islands that generally operate over larger areas than microgrids, including at the transmission level.
[41] Critical Customer Hubs are a variant of the microgrid concept that includes mobile generation and/or distribution equipment. This concept came out of the Companies-led Ko‘olaupoko Community Resilience Initiative.

for resilience purposes, the component distribution infrastructure (i.e., wires, poles, switches, etc.) upon which the microgrid operates must remain intact and be hardened to withstand the type of resilience threat the microgrid is intended to mitigate. Therefore, hardening critical customer circuits will complement any future microgrid or CCH implementations in these areas.

Exhibit H (*Critical Customer Circuit Example*) to this Application depicts an area in Kailua, Oʻahu that would likely be considered "no-regrets" for Critical Customer Circuit Hardening. In this area, identified critical customers such as Adventist Health Castle and Fire Station 39 Olomana, as well as other community lifeline[42] facilities, such as an emergency shelter (Kailua High School), correctional centers (Hawaiʻi Youth Correctional Facility and Women's Community Correctional Center), and schools (Kailua High School, Olomana School, and Maunawili Elementary), are all fed by two circuits coming from the nearby Pōhākupu Substation. These circuit areas are densely populated with critical customers and community lifeline infrastructure and are located a short distance from the substation, which is implicative of favorable cost-benefit characteristics for hardening.

In addition, this area may be an ideal candidate for a future community microgrid or CCH. In fact, the Companies have been actively pursuing the development of a CCH in this area. Exhibit H shows a high-level overview of the upgrades that would need to be made on the distribution circuitry in order to implement a CCH, including the installation of switches and fuse cutouts to isolate the CCH from the main grid. In 2021 and 2022, the Companies, in partnership with the Hawaiʻi State Energy Office (HSEO) and Hawaiʻi Emergency Management Agency (HI-EMA), applied through FEMA's Building Resilient Infrastructure & Communities (BRIC) grant program to seek federal cost share for this and two other CCH projects in the

[42] *See,* FEMA Community Lifelines, https://www.fema.gov/emergency-managers/practitioners/lifelines

Ko‘olaupoko region. Although the Companies’ application and no other energy project applications nationwide were funded through the BRIC grant program in 2021, the Companies re-applied to the 2022 BRIC grant program, which has expanded funding. Awardees for this year are slated to be notified in summer 2022.

Developing this CCH for resilience purposes requires the component infrastructure to be hardened. As shown in Exhibit H, the Companies plan to upgrade approximately 28 46/12kV poles, 23 12kV poles, and install anchors for an additional 34 poles, to harden the component distribution circuitry of the CCH to meet or exceed NESC Extreme Wind Loadings as part of the CCH’s development.

By identifying and hardening no-regrets critical customer circuits such as the ones shown in Exhibit H, critical customers, including community lifeline facilities, will be less likely to lose power in a severe event and quicker to restore if utility power is lost (minimizing the amount of time these facilities would need to rely on backup generators and fuel, while also reducing total length of restoration and restoration costs). In addition, hardening these circuits complements and facilities potential future mitigation solutions such as microgrids and CCHs to further enhance resilience.

Upon submitting this Application, the Companies plan to further engage the RWG to resume the work of refining critical customer sector definitions and classifications and identifying critical facilities and community lifelines that provide broader societal benefits. The Companies also plan to seek RWG feedback and input as they develop methods to prioritize critical customer circuits under this Project, as well as methods to evaluate whether a given critical circuit is: 1) “no regrets” to proceed with hardening from substation to identified loads, or 2) requires further evaluation of solution alternatives. For example, some circuits may have characteristics that favor a more mitigation-focused approach, where a microgrid solution combined with hardening within the future microgrid boundary may be more cost effective than hardening from the substation to the critical loads. Hardening would then be executed under the Project, while companion microgrid solutions could be evaluated and sourced through the IGP solution sourcing process. In discussions with the IGP stakeholder council, there was consensus that resilience planning, solution identification, and implementation does not need to happen in a serial sequence with the resource planning and grid needs assessment. Rather, that resilience planning and implementation can occur in parallel to the other parts of the IGP process. Accordingly, the Companies plan on proceeding as such to address the collective agreement that making incremental progress to address resilience and climate adaptation is urgent. In order to meet the aggressive hardening timelines proposed, the Companies will identify, prioritize, and scope specific critical customer circuit hardening projects informed by further RWG discussions and other community and stakeholder input based on the budgeted amounts described below.

On Oʻahu, the Companies plan to harden distribution feeders and laterals directly serving critical customers, as well as select critical sub-transmission lines. The Companies plan to harden approximately 13 circuits over the five-year program for a total of $15,444,000, as shown in Exhibit A.

On Hawaiʻi Island, the Companies plan to harden distribution feeders and laterals directly serving critical customers as well as select critical sub-transmission lines. The Companies plan to harden four circuits over the five-year program for a total of $4,502,000.

Similarly, the Companies plan to harden distribution feeders and laterals directly serving critical customers in Maui County as well as select critical sub-transmission lines. The Companies plan to harden four circuits over the five-year program for a total of $4,768,000.

C. Critical Pole Hardening & Mitigation

This initiative aims to perform targeted hardening of poles for which failure would have a disproportionate impact on restoration following a severe event, including critical poles at increased risk due to sea level rise. While Critical Transmission Line Hardening is focused on preventing damage to transmission lines that are most critical for system operation in a resilience scenario, and Critical Customer Circuit Hardening is focused on preventing damage to circuits serving critical community lifeline functions and infrastructure, the Critical Pole Hardening & Mitigation initiative views criticality primarily through the lens of reducing the total length of restoration, reducing restoration costs, and minimizing societal impacts of downed poles. Viewed through this lens, "critical" poles are generally poles that would be a high priority to replace, difficult to replace, impede restoration if downed, and/or are especially vulnerable to resilience threats. Some examples of critical poles are:

- Poles adjacent to interstate/major highway crossings
- Poles carrying multiple circuits
- Pole-mounted substations
- Substation getaway poles
- Poles with multiple primary risers

To illustrate with an example, if poles adjacent to major highway overhead crossings were to fail in a storm or hurricane, causing the pole or conductor to fall into a major highway or freeway, this would impede traffic, potentially including emergency vehicles, and would take significant resources, time, and coordination with other emergency response efforts to make the repairs.

Some types of critical pole features are more critical than others, and some poles may have multiple critical features, increasing the criticality rating of the pole.

Any poles targeted for hardening through this initiative will be designed to meet or exceed NESC Extreme Wind Loading requirements. Hardening these poles may include one measure or a combination of measures such as replacing a critical pole with a stronger pole, reducing span length by installing intermediate poles, installing additional guying, or strengthening a critical pole with steel trussing.

The Companies are already beginning to see some of the effects of sea level rise on transmission and distribution infrastructure in certain areas across the Companies' service territories. Coastal erosion and flood water can cause erosion and scour around the base of poles and pole anchors; exposure to salt water can also corrode equipment. The Critical Pole Hardening & Mitigation initiative will also perform upgrades and/or relocations of poles that are either currently being impacted or are imminently at risk of impact due to sea level rise.

As shown in Exhibit A, the Companies propose to harden 170 critical poles for a total of $16,103,000 on O'ahu, 130 poles for a total of $11,809,000 on Hawai'i Island, and 80 poles for a total of $7,708,000 in Maui County. These plans are based on the first five years of a longer-term plan to harden the most critical poles in the Companies' service territories.

In order to meet the aggressive hardening timeline proposed and enable the Companies to commence with detailed engineering design upon Commission approval, the Companies will proceed with additional scoping activities beginning in 2022 prior to Commission approval. This will include the identification and prioritization of critical poles for hardening and refining the scope of work for poles to be hardened in the first year of the program.

D. Substation Flood Monitoring

Substation flooding can cause significant equipment damage if water reaches control equipment while the substation is still energized. For this initiative, the Companies plan to install flood monitors in substations identified to be at-risk of flooding. Flood monitors improve situational awareness by alerting system operators to substation flooding, allowing them to remotely de-energize a substation to reduce equipment damage. The Companies have begun identifying substations potentially at-risk of flooding using the Companies' GIS asset data in combination with FEMA Flood Insurance Rate Maps, State of Hawai‘i Sea Level Rise Exposure Area maps, and private climate analytics flood risk models.

The Companies plan to install flood monitors in four substations per Company for a total of roughly $650,000 per Company, as shown in Exhibit A.

In order to meet the aggressive timelines proposed, the Companies will proceed with scoping activities beginning in 2022 prior to Commission approval. This will include identification, prioritization, and scope of work refinement for substation flood monitor installations.

E. Distribution Feeder Ties (Maui Only)

Compared to Hawai‘i Island and O‘ahu, many substation transformers on Maui currently have no circuit ties at the distribution level. When there is an outage at these substations, either for scheduled maintenance or an unplanned outage, the Companies' current practice is to utilize a mobile substation to serve the load, when feasible. However, using a mobile substation is not always feasible (for example, if there is inadequate space at the substation). In situations where a mobile substation can be used, implementing the mobile substation is a time-consuming process that results in customer interruptions, especially in the case of unplanned substation outages, where customers may be out of power for an extended period.

By installing backup ties for isolated substations, customer interruptions can be reduced in the case of planned or unplanned outages of the substation. In addition, distribution feeder ties can often also reduce outage durations caused by faults on the circuit (such as outages caused by vegetation or equipment damage by a storm) by enabling customers to be fed via another circuit. Constructing distribution feeder ties between circuits will greatly reduce outage durations and provide operational and restoration flexibility, which will improve both reliability and resilience.

The goal of this initiative is to construct distribution ties for substation transformer units with no existing ties where it is cost effective and feasible.

The Companies propose to create backup distribution feeder ties for the following circuits:

- Hana 1 & Hana 2 (tie together)
- Ke‘anae
- Kula

The total cost for this initiative is $1,033,000. See Exhibit A for further details.

The Companies plan to proceed with refining the scope of work for these projects in 2022 prior to Commission approval so that detailed design can begin once approval is received.

F. Lateral Undergrounding (O‘ahu Only)

During severe events, many damage locations typically occur on overhead laterals in forested locations. Converting these overhead laterals from overhead to underground can therefore be a cost-effective way to reduce the amount of damage that needs to be repaired, significantly reducing the total length of restoration. Stakeholders have also repeatedly requested that the Companies consider undergrounding as a solution for resilience, particularly in areas with a high density of vegetation.

Although undergrounding laterals is generally much less costly than undergrounding three-phase mains, costs can still vary widely based on soil condition, customer density, third-party attachments, whether directional boring can be used, and so forth. This initiative will identify four miles of overhead laterals for underground conversion to validate cost assumptions before more aggressively pursuing this resilience strategy.

The four miles of circuit will be identified by ranking all single-phase laterals on O‘ahu based on vegetation-related failures on a failures-per-circuit-mile basis (using five to ten years of historical data). This will identify the overhead laterals that would be likely to have the most damage in a severe event. O‘ahu is initially chosen as it already has the required resources available to perform this work.

The identified laterals will be further prioritized based on cost factors such as customer density, the presence of third-party attachments, and accessibility. The prioritization process will result in the selection of four circuit miles of distribution laterals on O‘ahu for undergrounding to improve storm resilience. Based on lateral undergrounding costs experienced by other utilities, the total cost for this initiative is set at $4,179,000, as shown in Exhibit A to this Application.

In order to meet the aggressive hardening timeline proposed, the Companies will proceed with scoping activities beginning in 2022 prior to Commission approval. This will include analysis and assessments to identify overhead distribution lines for targeted undergrounding along with refining the scope of work for the initial year of implementation.

G. Hazard Tree Removal

Hazard trees are trees that are not in the right-of-way that are dead, diseased, or structurally compromised, and are tall enough to fall into power lines. It is common for hazard trees to cause significant damage during severe events. As such, a hazard tree removal program can be very effective at reducing this type of damage. The Companies' current vegetation management programs do not include the removal of trees that are outside of the right-of-way, so this initiative represents an incremental increase in O&M that is not currently embedded in the target revenues approved for the Maui Electric 2018 test year rate case (Docket No. 2017-0150), Hawai'i Electric Light 2019 test year rate case (Docket No. 2018-0368), or Hawaiian Electric 2020 test year rate case (Docket No. 2019-0085), nor recovered through any recovery mechanism that is currently in effect.

The Companies plan to complete surveys for each Company to identify and prioritize hazard trees for removal. This will also include the identification of invasive tree species that have weak root systems and/or are prone to failure during high winds. In order to begin removing hazard trees as soon as possible following Commission approval, the Companies will proceed with this survey work prior to approval of the Application.

Without the benefit of the survey, the Companies estimate that they will remove 800 hazard trees per Company over the five-year program for approximately $11,000,000 per Company, as shown in Exhibit A. Actual expenses will depend on the survey results as well as various factors such as location, size, and height as well as the method of removing the debris.

H. Resilience Modeling

The industry recognizes that grid resilience is an exceptionally difficult concept to measure and evaluate. While there are well-defined and established metrics for grid reliability, there are currently no formal metrics or methods to evaluate resilience in the power industry that have received universal acceptance and adoption. As a result, calculating cost-benefit characteristics and performing options analysis of resilience enhancements is exceedingly difficult to do with precision. Metric development, consequence-based approaches for investment, and cost-benefit analysis applied to resilience are active areas of early-stage research and implementation in the industry. While the Companies believe there are no-regrets preventive actions that can and must be taken now to improve resilience, the Companies also intend to contribute to the development and implementation of cutting-edge methods to better evaluate resilience and assist with options analysis going forward.

The Companies plan to pursue the development of a performance-based model and method through partnership with national labs and/or universities that will support the Companies' efforts to 1) evaluate system resilience, and 2) compare investment options for resilience enhancements in terms of their expected benefits vis-à-vis system damage and recovery under severe event scenarios. Development and implementation of the resilience model will proceed in stages, from requirements gathering and data assessment, to proof-of-concept development, to implementation at scale. The Companies estimate that this initiative will cost approximately $700,000 total across all three Companies, as shown in Exhibit A. Due to the importance of this work, the Companies plan to begin work on scoping and developing the resilience model in 2022 prior to Commission approval of the Project, with full implementation to be completed in two years. The Companies intend to use this model to inform work prioritization both within as well as beyond this initial five-year program.

I. Wildfire Prevention & Mitigation

Considering the devastating California wildfires of 2018 and the Companies' own experiences in 2019, the Companies have taken proactive action to address wildfire risks. To this end, the Companies reviewed the San Diego Gas & Electric, Southern California Edison, and Pacific Gas & Electric mandated wildfire mitigation plans to identify best practices that would be appropriate for Hawaiʻi's environment and weather conditions. In addition, the Companies performed assessments of potential wildfire areas on Oʻahu, Maui, Lānaʻi, Molokaʻi, and Hawaiʻi Island. The Companies' Wildfire Prevention & Mitigation initiative has the following objectives:

1. Minimize the probability of the Companies' facilities becoming the origin or contributing source of ignition for a wildfire
2. Prevent the Companies' facilities from contributing to the severity or breadth of wildfires
3. Identify and implement operational procedures to ensure the Companies can respond effectively to a wildfire without compromising customer and employee safety, while remaining sensitive to customers' need for reliable electricity

Recognizing the importance of addressing wildfire risks, the Companies began wildfire prevention and mitigation activities in 2019. The Companies' ongoing wildfire prevention and mitigation efforts were described in Docket No. 2019-0327 in the Companies' responses to PUC-HECO-IR-105, filed on July 13, 2021. However, these efforts are not routine, business-as-usual, or common historical practice.

The Companies' wildfire prevention and mitigation efforts incorporate a multi-pronged approach including system hardening and situational awareness investments. Some of the system hardening efforts, such as including identified wildfire risk zones in prioritization of pole and shield-wire replacements, will be addressed through the Companies' ongoing asset sustainment programs. Some of the Companies' wildfire prevention and mitigation investments were planned to be implemented under Grid Modernization Project Phase 2 ("GMS Phase 2").[43] This included the deployment of field devices, such as smart reclosers and smart fuses, to minimize the intensity of sparks caused by line contact.

The Companies plan to implement certain system hardening and situational awareness interventions under this Project. Examples of system hardening activities planned under the Project include:

- Proactive pole and hardware upgrades to prevent failures and address clearance issues with overhead conductors in wildfire risk areas. Examples may include pole hardening or changing horizontal conductor configurations to vertical or delta to reduce the probability of swing shorts.
- Proactive replacement of copper conductors with aluminum in wildfire risk areas. Copper conductors tend to become brittle and pose a higher risk of failure compared to aluminum.

Examples of situational awareness investments planned under the Project include:

- Installing weather stations in strategic locations to monitor wind speed and relative humidity. Detection of high-risk conditions will be used to trigger alternative operational procedures to minimize the risk of wildfires and enable expedient response.

[43] *See* Companies' response PUC-HECO-IR-105, filed in Docket No. 2019-0327 on July 13, 2021

- Installing video cameras in strategic locations to help dispatchers respond to fires and provide fire responding authorities with critical information about wildfire situations.

The Companies used a combination of ignition density maps developed by the Pacific Fire Exchange along with historical experience to identify initial wildfire risk areas.[44] The Companies then conducted Unmanned Aerial System ("UAS" or "drone") and field inspections of the Companies' facilities and surrounding vegetation in these identified areas to evaluate risk and identify potential interventions. The following qualitative criteria were then used to prioritize areas for which to develop prevention and mitigation plans:

- Type of vegetation
- Proximity to residents
- Accessibility issues for fire response
- Other lessons learned from California experiences

The Companies have identified initial wildfire priority areas on O'ahu, Maui, Moloka'i, Lāna'i, and Hawai'i Island. These priority areas are considered a starting point and other areas may be added as circumstances warrant.

The current wildfire priority areas for O'ahu include: West O'ahu (Wai'anae to Kahe Valley), East Honolulu ('Āina Haina to Hawai'i Kai), Kapolei (along railroad track), 'Aikahi/Mōkapu, Central O'ahu (Kunia to Waikele), and Waialua. As shown in Exhibit A, the total estimated program cost for O'ahu is $5,341,000.

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[44] The Pacific Fire Exchange is a fire science and information communication program co-led by the Hawai'i Wildfire Management Organization (HWMO) and the University of Hawai'i at Mānoa. https://www.pacificfireexchange.org

In Maui County, the current wildfire priority areas include: West Maui (Lahaina to Kapalua), Maʻalaea, Olowalu, Molokaʻi (from west Molokaʻi to Kawela), and Lānaʻi. The total estimated program cost for Maui County is $6,243,000.

On Hawaiʻi Island, the current wildfire priority areas include: Waikoloa Village, Naʻalehu, Kohala, and Pōhakuloa. The total estimated program cost for Hawaiʻi Island is $2,517,000.

Due to the urgency of addressing wildfire risk, the Companies plan to continue engineering assessments and scoping for Wildfire Prevention & Mitigation work prior to Commission approval of the Project.

XIII. COST ESTIMATE

The subject Project has a total estimated cost of $189.7 million from 2022-2027, excluding customer contributions. The Project's estimated total cost is broken down by Company as follows:

a. Hawaiian Electric: $95.9 million capital expenditure and $10.8 million O&M;
b. Hawaiʻi Electric Light: $31.8 million capital expenditure and $10.9 million O&M;
c. Maui Electric: $28.8 million capital expenditure and $11.4 million O&M;

The Project's component initiatives are shown below and are discussed in further detail in this Application. Please see Exhibit A (*Project Cost Estimate*) for further cost details.[45]

[45] Estimated costs per component may change over the course of the Project, with the expectation that the total Project cost will not. In other words, the Companies will need flexibility with respect to allocation of total Project costs to the component parts.

	Capital	O&M	Grand Total
HE.005575: Resiliency Program - Hawaii Island	**$ 31,846,018**	**$ 10,882,051**	**$ 42,728,069**
1: Critical T-Line Hardening	$ 12,385,563		$ 12,385,563
2: Critical Customer Circuit Hardening	$ 4,501,817		$ 4,501,817
3: Critical Pole Hardening	$ 11,808,563		$ 11,808,563
4: Wildfire Prevention & Mitigation	$ 2,517,215		$ 2,517,215
5: Substation Flood Monitors	$ 632,859		$ 632,859
6: Hazard Tree Removal	$ -	$ 10,647,850	$ 10,647,850
7: Resilience Modeling	$ -	$ 234,202	$ 234,202
ME.005279: Resiliency Program - Maui	**$ 28,849,289**	**$ 11,394,097**	**$ 40,243,386**
1: Critical T-Line Hardening	$ 8,432,862		$ 8,432,862
2: Critical Customer Circuit Hardening	$ 4,768,120		$ 4,768,120
3: Critical Pole Hardening	$ 7,708,259		$ 7,708,259
4: Wildfire Prevention & Mitigation	$ 6,243,176		$ 6,243,176
5: Substation Flood Monitors	$ 664,174		$ 664,174
6: Maui Distribution Feeder Ties	$ 1,032,699		$ 1,032,699
7: Hazard Tree Removal	$ -	$ 11,159,895	$ 11,159,895
8: Resilience Modeling	$ -	$ 234,202	$ 234,202
PE.005838: Resiliency Program - Oahu	**$ 95,924,008**	**$ 10,831,761**	**$ 106,755,770**
1: Critical T-Line Hardening	$ 54,194,006		$ 54,194,006
2: Critical Customer Circuit Hardening	$ 15,444,153		$ 15,444,153
3: Critical Pole Hardening	$ 16,103,347		$ 16,103,347
4: Wildfire Prevention & Mitigation	$ 5,341,118		$ 5,341,118
5: Substation Flood Monitors	$ 662,607		$ 662,607
6: Lateral Undergrounding	$ 4,178,777		$ 4,178,777
7: Hazard Tree Removal	$ -	$ 10,597,559	$ 10,597,559
8: Resilience Modeling	$ -	$ 234,202	$ 234,202
Grand Total	**$ 156,619,315**	**$ 33,107,909**	**$ 189,727,224**

Although the investments to improve system reliability, resiliency and recovery are substantial, the Companies submit that they are reasonable in terms of the Companies' overall capital expenditures as well as the range of investments that other utilities are making to address many of these same issues. For example, assuming an approximate capital investment of $155 million for the period 2023-2027, this would average approximately $31 million annually. This would be equivalent to a range of approximately 9-15% of the Companies' forecasted annual capital expenditures.

The Edison Electric Institute recently surveyed member companies on their Adaptation, Hardening and Resilience (AHR) expenditures. EEI's report demonstrates that investor-owned utilities are spending significant and growing amounts on AHR initiatives (approximately $20 billion per year) which represent 24% of distribution spending and 21% of transmission spending on capital expenditures, respectively.[46] Additionally, and particularly in the face of recent severe events that have resulted in significant outages, northeast utilities such as Consolidated Edison, National Grid and Public Service Enterprise Group are investing billions of dollars to strengthen their systems and incorporate climate change into their planning and operations; and are already seeing dividends from those investments.[47]

As noted above, while the Companies are seeking EPRM recovery for these important investments which need to be made as soon as possible, they are also consistently working to evaluate other funding or cost-share opportunities as they may arise. This includes most notably, the Bipartisan Infrastructure Investment and Jobs Act, passed by Congress on November 6, 2021 and signed into law by President Biden on November 15, 2021, which includes significant funding for both grid reliability and resiliency as well as flood and wildfire mitigation and coastal resiliency. The Companies are actively working to comprehensively evaluate funding opportunities under the Act which the Companies may pursue. These include both a one-time national competitive grant opportunity, which set aside $2.5 billion to fund grid resilience enhancement projects, as well as annual funding opportunities through the state formula funding award of which the State of Hawaiʻi will be allocated approximately $3.1M annually over five years.

[46] EEI 2020 Financial Review, Annual Report of the U.S. Investor-Owned Electric Utility Industry at 45-46.
[47] "Northeast utilities are spending billions on resilience, and the investments are paying off", Utility Dive, November 10, 2021.

A. Inflation Adjustment Mechanism

The Companies' estimated Project costs through 2027 are based on several assumptions. As reflected in Exhibit A, one of the assumptions is that the Companies have incorporated a constant inflation projection in estimating non-labor (e.g., materials, outside services) Project costs for years 2023-2027. This inflation escalation for non-labor Project costs is based on the forecasted Gross Domestic Product Price Index ("GDPPI"), similar to the I factor in the annual revenue adjustment approved in Docket No. 2018-0088 and filed in the Companies' PBR Fall Revenue Reports and the non-labor cost escalation rate and the revenue adjustment cap used previously in the rate adjustment mechanism ("RAM"). See Exhibit I in this Application for the April 2022 Blue Chip Economic Indicators Report. As shown in Exhibit I, page 5, the forecasted GDPPI for 2023 is 2.9%. Therefore, non-labor Project costs in UIPlanner were escalated by 2.9% in 2023-2027 in order to calculate the Project's total cost of $189.7M.

Separate from the above, in favor of transparency and accuracy, the Companies are also proposing to apply an inflationary adjustment mechanism which would calculate a one-time adjustment that would true-up or true-down the Commission's approved EPRM recovery amount at the end of the Project's term (2027) to account for actual inflation that occurred during the 2023-2027 timeframe. In other words, if actual inflation from 2023-2027 is higher than the projected 2.9% that was used to calculate the Project's non-labor cost in this Application, there would be a true-up adjustment to calculate and add the additional inflation adjustment to the non-labor costs of the Commission approved EPRM recovery amount of the Project. If actual inflation is lower than 2.9%, there would be a corresponding downward adjustment to the non-labor costs of the Commission approved EPRM recovery amount. Consistent with the

EPRM guidelines, EPRM recoverable costs will still be limited to the lesser of actual net incurred project/program costs or Commission-approved amounts, net of savings.

The illustrated example below shows how the Companies would apply their proposed inflation mechanism. If actual inflation during 2023-2027 is lower than 2.9% by the amounts shown the illustrative example below, the approved EPRM recovery amount will be reduced by $1,500,000 at the end of 2027. If actual inflation is higher by the amounts shown in the example, the approved EPRM amount would be increased by $300,000.

Oahu

	2023	2024	2025	2026	2027	Grand Total
Project Non-labor Cost Before Inflation	$ 10,000,000	$ 10,000,000	$ 10,000,000	$ 10,000,000	$ 10,000,000	$ 50,000,000
2.9% GDPPI	2.9%	2.9%	2.9%	2.9%	2.9%	
Inflation Multiplier	102.900%	105.8%	108.7%	111.6%	114.5%	
Illustrative EPRM Approved Amount	**$ 10,290,000**	**$ 10,580,000**	**$ 10,870,000**	**$ 11,160,000**	**$ 11,450,000**	**$ 54,350,000**

Scenario 1 Actual Inflation Lower	2023	2024	2025	2026	2027	Grand Total	
Project Non-labor Cost Before Inflation	$ 10,000,000	$ 10,000,000	$ 10,000,000	$ 10,000,000	$ 10,000,000	$ 50,000,000	
Actual GDPPI	2.0%	2.0%	2.0%	1.5%	1.5%		
	102.000%	104.0%	106.0%	107.5%	109.0%		**True-Down**
Senario 1 Total (Revised EPRM Amount)	**$ 10,200,000**	**$ 10,400,000**	**$ 10,600,000**	**$ 10,750,000**	**$ 10,900,000**	**$ 52,850,000**	**$ (1,500,000)**

Scenario 2 Actual Inflation Higher	2023	2024	2025	2026	2027	Grand Total	
Project Non-labor Cost Before Inflation	$ 10,000,000	$ 10,000,000	$ 10,000,000	$ 10,000,000	$ 10,000,000	$ 50,000,000	
Actual GDPPI	3.0%	3.5%	3.0%	3.0%	2.5%		
	103.000%	106.5%	109.5%	112.5%	115.0%		**True-Up**
Senario 2 Total (Revised EPRM Amount)	**$ 10,300,000**	**$ 10,650,000**	**$ 10,950,000**	**$ 11,250,000**	**$ 11,500,000**	**$ 54,650,000**	**$ 300,000**

Therefore, for calendar years 2023-2026, EPRM recovery would be based on actual recorded capital and incremental O&M expenditures incurred during the preceding calendar year. At the end of calendar year 2027, the Companies would calculate whether actual inflation during the 2023-2027 timeframe was higher or lower than 2.9% and whether an inflation adjustment is warranted. If there is an adjustment, the Companies would then determine the "revised EPRM recovery amount" (i.e., approved EPRM recovery amount plus/minus inflation adjustment) for the Project and compare that against the Project's total cost during 2022-2027. In the Companies' 2028 Spring Revenue Report, which would be filed no later than March 31, 2028, the Companies would detail how the inflation adjustment was calculated and how it impacts the Commission approved EPRM recovery amount for the Project. If actual Project costs for the entire Project are lower/less than the revised EPRM recovery amount, no action would be needed as EPRM recovery is limited to the lesser of actual incurred costs or Commission approved amounts. If actual project costs exceed the revised EPRM recovery amount, the Companies' EPRM recovery for the total project would be limited to the revised EPRM recovery amount. Any over-recoveries of revenues under the EPRM adjustment mechanism would be refunded, with interest, in accordance with the reconciliation provisions of the EPRM Guidelines.

As established in the PBR proceeding, the current MRP began in 2021 and will last for five years with the next MRP beginning in 2026. Even if rates are reset for the next MRP to include the recovery of the Project's recorded capital and incremental O&M expenditures that went into service in years prior, the same methodology as described above can be used to determine the total authorized amount of the Project.

In their Project cost estimates, the Companies should and have reflected the projected impact of current global issues such as, but not limited to, the ongoing COVID-19 pandemic, the supply-chain crisis, the war in Ukraine, high inflation driving commodities prices higher, in addition to other market conditions that have arisen during the development of this Application. The risks and global issues highlighted above are well outside the Companies' control and the Companies can only mitigate inflation and Project impacts to a certain degree. Allowing an adjustment for actual inflation will reduce uncertainty and bring the authorized amount in closer alignment with the actual costs, regardless of whether the actual inflation is higher or lower than the original inflation estimate. If the Companies are not allowed this mechanism to control for inflation risk, higher than expected inflation could reduce the magnitude of scope executed, in turn reducing the magnitude of resilience benefits derived from this initial program. In consideration of these risks that are currently impacting Company-wide projects and programs financially and logistically, as well as to account for unknown risks that the Companies cannot anticipate through 2027, the Companies are respectfully requesting Commission approval of the above inflation adjustment mechanism to be applied at the end of the Project's term.

XIV. PROJECT BENEFITS

A. Current State of the Industry with Respect to Cost-Benefit Analysis for Power System Resilience

The evaluation of system resilience and quantification of resilience benefits is an eminent challenge in the power industry. A 2020 report developed by the Pacific Northwest National Laboratory ("PNNL") under the U.S. DOE's Grid Modernization Laboratory Consortium ("GMLC") notes that "no consensus exists at present on how to define or quantify resilience."[48]

Part of the challenge with measuring resilience has to do with the high level of uncertainty concerning the frequency of severe events and the damage they cause. No one can predict with precision the expected frequency with which hurricanes or other severe events will impact Hawaiʻi's grid looking into the future, nor which areas will be affected or to what extent. In addition to the paucity of historical data, there is also uncertainty concerning the impacts of climate change on the frequency and severity of severe events to be expected in the future, which means that historical probabilities may not be accurate predictors of future probabilities.

Predicting the impacts of major disruptions on the system is another area of high uncertainty. Such analysis usually requires significant data along with complex modeling and technology capabilities that are still in early stages of development in the industry.

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[48] Petit, Vargas, et al. (2020, April). *Grid Modernization: Metrics Analysis (GMLC1.1) – Resilience*. Prepared for U.S. Department of Energy by Pacific Northwest National Laboratory.

As a result, the industry currently lacks sufficient means to precisely quantify resilience benefits, including the ability to quantitatively distinguish the benefit characteristics of one type of resilience enhancement activity from another. A report by the Electric Power Research Institute ("EPRI") describes these challenges:

> A central characteristic of extreme events is the fact that their impacts are uncertain and incompletely understood. In conventional cost-benefit analysis, prospective investments can be evaluated by comparing the costs and benefits expressed in present-value terms, which make comparisons straightforward. Resiliency investments are considered to avert the consequences of events characterized by low probability, uncertain timing, and high severity (while the costs are certain and large) … [T]here is no unifying perspective or framework for cost-benefit analysis of resiliency efforts, though there is much interest in advancing the state of the art. Despite growing concern over the critical need for enhanced resiliency, there is no standardized framework for assessing resiliency levels or evaluating investment options.[49]

Recognizing these uncertainties and the need for additional capabilities to evaluate resilience and support options analysis of resilience enhancements, the Companies are pursuing the development of performance-based resilience modeling capabilities, as discussed in Section XII.H, through partnerships with national labs and/or universities that will help to advance the state of the art and support further refinement of the Companies' proposed resilience improvements beyond initial no-regrets initiatives.

The Companies' position is that there are foundational, well-established, no-regrets resilience enhancements that can and should begin now. For the current Application, the Companies have performed two different types of analyses to quantify a portion of the potential benefits of the proposed Project. However, these analyses are not intended to be comprehensive depictions of the cost-benefit characteristics of the proposed resilience enhancements and are subject to significant uncertainty.

[49] Electric Power Research Institute. (2016, February). *Electric Power System Resiliency: Challenges and Opportunities*.

B. Benefit-Cost Analysis

This section summarizes the benefit-cost analysis performed for the Project. See Section 7 of Exhibit C (*Project Business Case*) for the complete benefit-cost analysis.

To perform a benefit-cost analysis, the Companies developed a statistical model for the probability of hurricanes of different categories making landfall on one of the Hawaiian Islands based on historical data. The Companies used this model to estimate an annualized GDP impact of tropical storms and hurricanes on the unhardened systems of today. An annualized revenue requirement for the Project was then calculated for each of the operating companies to compare to expected annual benefits. Break-even values for total length of restoration (TLR) reduction were then estimated that would result in GDP savings exceeding the cost of the investment, while acknowledging that GDP savings due to TLR reduction is only one of many benefits of resilience enhancement. The calculated break-even values for TLR reduction are 13% for O‘ahu, 31% for Maui County, and 37% for Hawai‘i Island.

As another way of comparing the benefits and costs of the Project, the Companies sought to identify a single extreme event that would result in full economic cost recovery (in terms of GDP savings). Using an assumption that the resilience investments will result in a 20% reduction in TLR, it was estimated that the benefits from this level of TLR reduction for a single Category 2 hurricane making landfall on O‘ahu would exceed costs for the O‘ahu resilience investments, while the benefits from this level of TLR reduction for a single Category 3 hurricane would exceed costs for the respective Maui County and Hawai‘i Island investments.

It should be noted that hurricanes are anticipated to become more frequent and severe in the future due to climate change. If hurricanes are more frequent and/or severe than this analysis assumed (based on historical data), this would increase the relative value of the proposed resilience investments.

Furthermore, given that GDP benefits were the only benefits quantified, it is expected that the actual benefits of the Project would be greater when considering all benefits. For example, significant customer value will be realized through other benefits such as:

1. Reduced storm restoration costs
2. Reduced customer interruption costs
3. Reduced food spoilage
4. Societal benefits of reduced interruptions and restoration times for hardened critical customer circuits, enabling quicker stabilization of community lifeline functions
5. Benefits related to other events such as prevention and/or mitigation of wildfires

It should also be noted that for some of the proposed initiatives, a reduction in TLR is secondary to the primary intended benefits of the initiative, which were not quantified. For example, enabling continued electric service and quicker restoration for community lifeline facilities (as in Critical Customer Circuit Hardening) has societal benefits that are not adequately captured by quantifying benefits solely in terms of reduced TLR of the whole system.

Based on the above, it is likely that the customer benefits of the proposed Project will exceed the amount of rate increases to customers.

XV. EPRM RECOVERY

A. EPRM Cost Recovery is Appropriate

The Companies seek recovery of the capital and O&M costs of the Project through the EPRM adjustment mechanism until new rates for the next MRP become effective that provide cost recovery of the Project's capital and O&M expenditures that went into service in the current MRP for each respective Company. As this Project would straddle the current five-year MRP and the next MRP, if rates are reset for the next MRP to include recovery of the Project's capital and O&M expenditures that went into service during the current MRP, the Companies propose that the Commission authorize the recovery of the Project costs for the remaining years of the Project through the EPRM until new rates that provide recovery of the Project's investments become effective for the MRP thereafter.

The purpose of the EPRM is to provide a mechanism for recovery of revenues for net costs of approved "Eligible Projects" placed in service during a Multi-Year Rate Period that are not provided for by other effective tariffs, the Annual Revenue Adjustment, Performance Incentive Mechanisms, or Shared Savings Mechanisms.[50] As discussed in detail in Exhibit E (*Exceptional Project Recovery*), attached hereto, the Companies maintain that the Project qualifies as an eligible project under Section III.B.1(d) (approved or accepted plans, initiatives, and programs) of the EPRM Guidelines.

B. EPRM Recovery Will Follow Established EPRM Guidelines

The Companies are seeking to recover Eligible Project costs through the EPRM adjustment mechanism pursuant to the process set forth in the EPRM Guidelines approved in Decision and Order No. 37507 in Docket No. 2018-0088.

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[50] EPRM Guidelines, Section II.Al.

Section III.C.4.e. of the EPMR Guidelines states the following:

> "Accrual of revenues recovered through the EPRM adjustment mechanism for an Eligible Project shall commence upon certification of the project's completion and/or in-service date in accordance with terms approved by the Commission at the time cost recovery through the EPRM adjustment mechanism is approved in the underlying proceeding for EPRM relief."

Since the Companies plan to install the various Projects over the course of the year, to reduce the administrative burden, the Companies propose to simplify the EPRM recovery as follows. This would be consistent with the approved MPIR recovery process for advanced meters and telecommunications network components of the Grid Modernization Phase 1 project.[51]

- The Companies will begin accruing target revenues beginning January 1 following the year of installation of the resilience Projects, based on the actual capital and O&M expenses for those projects, rather than begin accruing target revenues as the Projects go into service, as the EPRM Guidelines allow.
- In the annual February filing of the PBR Annual Review Cycle,[52] the Companies will reflect the accrual of target revenues for the January-December period of that year for existing resilience Projects and those that went into service in the prior year.
- The accrual of target revenues as reflected in the February filing are subject to Commission review as part of the Spring Revenue Report filed at the end of March. Recovery of those proposed target revenues is through the RBA Rate Adjustment effective from June 1 of that year to May 31 of the following year.

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[51] See Order No. 38131, issued on December 20, 2021 which approved the Companies' proposed adjustments to target revenues related to Grid Modernization Phase 1 elements completed through July 1, 2021.
[52] See Decision and Order No. 37507, Docket No. 2018-0088 at 199. By February 28, Companies file schedules and other supporting workpapers for all known attained PIMs and SSMs and EPRM revenue adjustments.

EPRM recovery would be based on actual recorded costs and the depreciation, tax and authorized return rates in place at the time. Recovery of on-going incremental O&M costs would be based on actual recorded costs for the previous year. As proposed in Section XIII above, after the last year of the program, the Companies are requesting approval to determine the final authorized EPRM recovery amount based on actual GDPPI over the five-year period. The final EPRM recovery amount will be used as the limit in calculating the amount of recovery requested in Year 5 in the annual EPRM filing to be filed on or before February 28, 2028 (such that the total recovery over the five-year period will not exceed the lesser of the actual or authorized cost of the Project), with any impact to Target Revenues effective January 1, 2028. As explained above, the current MRP began in 2021 and will last for five years with the next MRP beginning in 2026. Even if rates are reset for the next MRP to include the recovery of the Project's capital and O&M expenditures that went into service in years prior, the same methodology as described above can be used to determine the total authorized amount of the Project.

C. **Accounting Treatment**

In Exhibit L, the Companies propose the accounting and ratemaking treatment specific to the proposed Project investments and expenses identified in Section XII. The Project primarily consists of traditional capital expenditures to strengthen the transmission and distribution infrastructure, as well as the incurrence of expenses for the Hazard Tree Removal and Resilience Modeling components of the Project. The Companies are requesting approval to recover the estimated capital and O&M costs of the Project through the EPRM until new rates for the next MRP become effective that provide cost recovery for the Project's capital and O&M expenditures that went into service in the current MRP. In addition, the Companies are requesting recovery through the EPRM of Project capital and O&M costs that go into service during the next MRP.

D. Revenue Requirements

An overview of the various revenue requirement components impacted by this Project is provided in Exhibit D (*Revenue Requirements and Bill Impact Calculation*) of this Application. These high-level revenue requirement calculations include simplifying assumptions (e.g., Project in-service dates, capital components treated as one unit to which the most likely treatment applies rather than parsed into specific classifications) which will generally model the expected accounting, tax and ratemaking treatment for the Project or capital investment. This is based on the current tax and accounting rules and the expected ratemaking treatment determined for the Project or capital investment at that time. In the Spring Revenue Report, the Companies will provide detailed calculations based on actual information and the depreciation, tax and allowed return rates in place at that time, as discussed further below.

Table 1 below summarizes the proposed ratemaking treatment of the various costs of this Project:

Table 1: Proposed Ratemaking Treatment of Various Impacted Costs

Cost Component or Savings	Proposed Ratemaking Treatment
Climate Adaptation Resilience Program Capital	EPRM
Climate Adaptation Resilience Program Incremental O&M	EPRM

E. Bill Impact

The Companies estimates that the average monthly bill impact of this Project for a typical residential customer using 500 kWh will be $0.33 for Hawaiian Electric, $0.86 for Hawai‘i

Electric Light, and $0.71 for Maui Electric, based on the revenue requirements associated with the cost of the Project shown in Exhibit D to this Application.

XVI. NON-WIRES ALTERNATIVES ANALYSIS

Based on the discussion in Exhibit F (*Non-Wires Opportunity Evaluation*), the Companies respectfully request that the evaluation of Non-Wires Alternatives ("NWA") be waived for this Project, or, in the alternative, that the Commission determine that NWAs need not be further evaluated for this Project.

XVII. GREENHOUSE GAS ANALYSIS

As stated earlier, pursuant to HRS § 269-6(b), the Companies submit in Exhibit G[53] a Greenhouse Gas Emissions Analysis ("GHG" or "emissions" analysis), which was performed by Hawaiian Electric's consultant, Ramboll US Consulting, Inc. ("Ramboll"). The estimated GHG emissions result is presented in metric tons ("MT") of carbon dioxide equivalent ("CO2e") and in kilograms of CO2e per megawatt-hour ("MWh") for the Project lifetime. Detailed calculations including assumptions and inputs are included with the accompanying GHG analysis report.

The Project GHG emissions are based on the best reasonably available public data that has undergone scientific peer review and the most current information including emission factors available to Ramboll at the time the analysis was completed. This information was then localized where practical, and where it may have a material impact on the total GHG emissions, to account for unique location-specific factors applicable to a project in Hawai‘i such as additional transportation. Direct emissions were calculated to account for the Project's upstream, operations, and downstream emissions. The use of a combination of localized peer-reviewed

[53] As part of this Application, the Companies are submitting the source excel files which includes the GHG Analysis supporting calculations and associated assumptions.

published studies and direct emissions calculations for the Project represents the "GHG Analysis" approach in this evaluation. Based on this approach, Ramboll has estimated that the Project would result in an estimated 27,506 metric tons ("MT") of carbon dioxide-equivalents ("CO_2e") **("**MT CO_2e") for the Project lifecycle. There is no net increase in operations and maintenance expected from the Project; therefore, GHG emissions from Project operations were not quantified.

XVIII. REPORTING

For informational purposes only, Hawaiian Electric shall file an annual report in this docket detailing the status and spend of the Project and its component initiatives, including items such as changes to proposed costs, scope, and timelines.

As part of their ongoing efforts to maximize system resilience in the most cost-effective manner reasonably possible, the Companies will continue to seek to optimize and prioritize investments and improve efficiency to the benefit of customers. In other words, the Companies will need flexibility with respect to the allocation of total Project costs to the component parts. To the extent that these efforts result in any necessary modifications to the proposed prioritization of investments, the Companies will incorporate any such improvements as a part of their reporting. Estimated costs per component may change over the course of the Project, with the expectation that the total Project cost will not.

XIX. CONCLUSION

Wherefore, the Hawaiian Electric Companies respectfully request that the Commission issue two decisions and orders and approve the specific requests set forth in Section V, Requested Approvals, herein.

DATED: Honolulu, Hawai‘i, June 30, 2022.

/s/ Joseph P. Viola
Joseph P. Viola

Senior Vice President, Customer, Legal & Regulatory Affairs

Vice President
Hawai‘i Electric Light Company, Inc.
Maui Electric Company, Ltd.

Transmission and Distribution Resilience Program
Project Cost Estimate Summary

HE.005575: Resiliency Program - Hawaii Island	**$**	**42,728,069**
1: Engineering	$	6,070,068
2: Materials	$	9,614,180
3: Install	$	16,161,769
4: O&M	$	10,882,051
ME.005279: Resiliency Program - Maui	**$**	**40,243,386**
1: Engineering	$	4,755,713
2: Materials	$	9,271,572
3: Install	$	14,822,004
4: O&M	$	11,394,097
PE.005838: Resiliency Program - Oahu	**$**	**106,755,770**
1: Engineering	$	14,957,141
2: Materials	$	28,727,613
3: Install	$	52,239,254
4: O&M	$	10,831,761
Grand Total	**$**	**189,727,224**

Transmission and Distribution Resilience Program
Project Cost Estimate By Program

	1: Engineering	2: Materials	3: Install	4: O&M	Grand Total
HE.005575: Resiliency Program - Hawaii Island	**$ 6,070,068**	**$ 9,614,180**	**$ 16,161,769**	**$ 10,882,051**	**$ 42,728,069**
1: Critical T-Line Hardening	$ 3,080,720	$ 2,609,853	$ 6,694,989		$ 12,385,563
2: Critical Customer Circuit Hardening	$ 793,274	$ 1,811,786	$ 1,896,758		$ 4,501,817
3: Critical Pole Hardening	$ 1,651,655	$ 4,405,897	$ 5,751,012		$ 11,808,563
4: Wildfire Prevention & Mitigation	$ 410,729	$ 635,946	$ 1,470,540		$ 2,517,215
5: Substation Flood Monitors	$ 133,690	$ 150,699	$ 348,470		$ 632,859
6: Hazard Tree Removal				$ 10,647,850	$ 10,647,850
7: Resilience Modeling				$ 234,202	$ 234,202
ME.005279: Resiliency Program - Maui	**$ 4,755,713**	**$ 9,271,572**	**$ 14,822,004**	**$ 11,394,097**	**$ 40,243,386**
1: Critical T-Line Hardening	$ 1,614,906	$ 2,357,744	$ 4,460,212		$ 8,432,862
2: Critical Customer Circuit Hardening	$ 829,212	$ 1,946,145	$ 1,992,762		$ 4,768,120
3: Critical Pole Hardening	$ 1,083,200	$ 2,909,953	$ 3,715,105		$ 7,708,259
4: Wildfire Prevention & Mitigation	$ 943,310	$ 1,624,889	$ 3,674,977		$ 6,243,176
5: Substation Flood Monitors	$ 136,192	$ 161,875	$ 366,108		$ 664,174
6: Maui Distribution Feeder Ties	$ 148,894	$ 270,966	$ 612,839		$ 1,032,699
7: Hazard Tree Removal				$ 11,159,895	$ 11,159,895
8: Resilience Modeling				$ 234,202	$ 234,202
PE.005838: Resiliency Program - Oahu	**$ 14,957,141**	**$ 28,727,613**	**$ 52,239,254**	**$ 10,831,761**	**$ 106,755,770**
1: Critical T-Line Hardening	$ 8,390,978	$ 13,623,304	$ 32,179,723		$ 54,194,006
2: Critical Customer Circuit Hardening	$ 2,610,039	$ 6,373,494	$ 6,460,620		$ 15,444,153
3: Critical Pole Hardening	$ 2,235,614	$ 6,125,682	$ 7,742,051		$ 16,103,347
4: Wildfire Prevention & Mitigation	$ 844,507	$ 1,388,285	$ 3,108,326		$ 5,341,118
5: Substation Flood Monitors	$ 154,726	$ 149,377	$ 358,504		$ 662,607
6: Lateral Undergrounding	$ 721,277	$ 1,067,471	$ 2,390,030		$ 4,178,777
7: Hazard Tree Removal				$ 10,597,559	$ 10,597,559
8: Resilience Modeling				$ 234,202	$ 234,202
Grand Total	**$ 25,782,922**	**$ 47,613,365**	**$ 83,223,027**	**$ 33,107,909**	**$ 189,727,224**

Transmission and Distribution Resilience Program
Project Cost Estimate By Program By Year

	Initiative Name	Phase	Sum of 2021-2022	Sum of 2023	Sum of 2024	Sum of 2025	Sum of 2026	Sum of 2027	Sum of Grand Total
HE.005575: Resiliency Program - Hawaii Island			**$1,055,104**	**$ 936,193**	**$ 5,620,142**	**$ 7,788,105**	**$12,778,372**	**$14,550,153**	**$ 42,728,069**
1: Capital	1: Critical T-Line Hardening	1: Engineering	$ 927,469	$ 209,860	$ 225,999	$ 626,219	$ 1,063,582	$ 27,590	$ 3,080,720
		2: Materials	$ -	$ -	$ 137,253	$ 282,543	$ 799,091	$ 1,390,966	$ 2,609,853
		3: Install	$ -	$ -	$ 352,093	$ 724,800	$ 2,049,887	$ 3,568,210	$ 6,694,989
	1: Critical T-Line Hardening Total		$ 927,469	$ 209,860	$ 715,345	$ 1,633,562	$ 3,912,560	$ 4,986,766	$ 12,385,563
	2: Critical Customer Circuit Hardening	1: Engineering	$ 16,528	$ 195,145	$ 184,846	$ 193,563	$ 199,019	$ 4,173	$ 793,274
		2: Materials	$ -	$ -	$ 433,698	$ 446,394	$ 459,089	$ 472,604	$ 1,811,786
		3: Install	$ -	$ -	$ 454,038	$ 467,330	$ 480,621	$ 494,769	$ 1,896,758
	2: Critical Customer Circuit Hardening Total		$ 16,528	$ 195,145	$ 1,072,582	$ 1,107,287	$ 1,138,729	$ 971,546	$ 4,501,817
	3: Critical Pole Hardening	1: Engineering	$ 16,528	$ 134,008	$ 240,071	$ 495,424	$ 761,451	$ 4,173	$ 1,651,655
		2: Materials	$ -	$ -	$ 318,553	$ 655,756	$ 1,348,811	$ 2,082,777	$ 4,405,897
		3: Install	$ -	$ -	$ 415,806	$ 855,958	$ 1,760,602	$ 2,718,646	$ 5,751,012
	3: Critical Pole Hardening Total		$ 16,528	$ 134,008	$ 974,431	$ 2,007,137	$ 3,870,864	$ 4,805,596	$ 11,808,563
	4: Wildfire Prevention & Mitigation	1: Engineering	$ 16,528	$ 48,205	$ 26,853	$ 155,099	$ 159,457	$ 4,588	$ 410,729
		2: Materials	$ -	$ -	$ 52,802	$ 44,061	$ 265,632	$ 273,451	$ 635,946
		3: Install	$ -	$ -	$ 122,099	$ 101,884	$ 614,238	$ 632,320	$ 1,470,540
	4: Wildfire Prevention & Mitigation Total		$ 16,528	$ 48,205	$ 201,755	$ 301,043	$ 1,039,326	$ 910,359	$ 2,517,215
	5: Substation Flood Monitors	1: Engineering	$ 16,528	$ 38,333	$ 22,668	$ 25,956	$ 26,653	$ 3,552	$ 133,690
		2: Materials	$ -	$ -	$ 36,074	$ 37,130	$ 38,186	$ 39,310	$ 150,699
		3: Install	$ -	$ -	$ 83,415	$ 85,857	$ 88,299	$ 90,898	$ 348,470
	5: Substation Flood Monitors Total		$ 16,528	$ 38,333	$ 142,157	$ 148,943	$ 153,137	$ 133,760	$ 632,859
2: O&M	6: Hazard Tree Removal	4: O&M	$ -	$ 137,963	$ 2,513,873	$ 2,590,132	$ 2,663,756	$ 2,742,126	$ 10,647,850
	6: Hazard Tree Removal Total		$ -	$ 137,963	$ 2,513,873	$ 2,590,132	$ 2,663,756	$ 2,742,126	$ 10,647,850
	7: Resilience Modeling	4: O&M	$ 61,522	$ 172,679	$ -	$ -	$ -	$ -	$ 234,202
	7: Resilience Modeling Total		$ 61,522	$ 172,679	$ -	$ -	$ -	$ -	$ 234,202
ME.005279: Resiliency Program - Maui			**$ 238,910**	**$ 924,534**	**$ 6,332,124**	**$ 8,654,890**	**$12,592,790**	**$11,500,138**	**$ 40,243,386**
1: Capital	1: Critical T-Line Hardening	1: Engineering	$ 111,631	$ 173,864	$ 186,810	$ 388,170	$ 732,966	$ 21,465	$ 1,614,906
		2: Materials	$ -	$ -	$ 122,683	$ 315,686	$ 649,329	$ 1,270,045	$ 2,357,744
		3: Install	$ -	$ -	$ 232,084	$ 597,194	$ 1,228,356	$ 2,402,580	$ 4,460,212
	1: Critical T-Line Hardening Total		$ 111,631	$ 173,864	$ 541,577	$ 1,301,050	$ 2,610,651	$ 3,694,089	$ 8,432,862
	2: Critical Customer Circuit Hardening	1: Engineering	$ 16,439	$ 204,187	$ 193,797	$ 202,564	$ 208,280	$ 3,945	$ 829,212
		2: Materials	$ -	$ -	$ 465,861	$ 479,498	$ 493,135	$ 507,652	$ 1,946,145
		3: Install	$ -	$ -	$ 477,020	$ 490,983	$ 504,947	$ 519,812	$ 1,992,762
	2: Critical Customer Circuit Hardening Total		$ 16,439	$ 204,187	$ 1,136,678	$ 1,173,045	$ 1,206,362	$ 1,031,408	$ 4,768,120
	3: Critical Pole Hardening	1: Engineering	$ 16,439	$ 78,632	$ 189,294	$ 326,638	$ 468,253	$ 3,945	$ 1,083,200
		2: Materials	$ -	$ -	$ 171,088	$ 528,289	$ 905,523	$ 1,305,052	$ 2,909,953
		3: Install	$ -	$ -	$ 218,427	$ 674,461	$ 1,156,072	$ 1,666,146	$ 3,715,105
	3: Critical Pole Hardening Total		$ 16,439	$ 78,632	$ 578,809	$ 1,529,388	$ 2,529,848	$ 2,975,143	$ 7,708,259
	4: Wildfire Prevention & Mitigation	1: Engineering	$ 16,439	$ 128,758	$ 168,277	$ 492,873	$ 133,018	$ 3,945	$ 943,310
		2: Materials	$ -	$ -	$ 202,676	$ 302,511	$ 887,098	$ 232,603	$ 1,624,889
		3: Install	$ -	$ -	$ 458,389	$ 684,183	$ 2,006,332	$ 526,074	$ 3,674,977
	4: Wildfire Prevention & Mitigation Total		$ 16,439	$ 128,758	$ 829,342	$ 1,479,567	$ 3,026,448	$ 762,621	$ 6,243,176
	5: Substation Flood Monitors	1: Engineering	$ 16,439	$ 38,651	$ 23,714	$ 26,722	$ 27,442	$ 3,223	$ 136,192
		2: Materials	$ -	$ -	$ 38,749	$ 39,883	$ 41,017	$ 42,225	$ 161,875
		3: Install	$ -	$ -	$ 87,638	$ 90,203	$ 92,768	$ 95,499	$ 366,108
	5: Substation Flood Monitors Total		$ 16,439	$ 38,651	$ 150,100	$ 156,808	$ 161,228	$ 140,947	$ 664,174
	6: Maui Distribution Feeder Ties	1: Engineering	$ -	$ 67,443	$ 40,138	$ 41,313	$ -	$ -	$ 148,894
		2: Materials	$ -	$ -	$ 122,756	$ 73,066	$ 75,144	$ -	$ 270,966
		3: Install	$ -	$ -	$ 277,636	$ 165,252	$ 169,952	$ -	$ 612,839
	6: Maui Distribution Feeder Ties Total		$ -	$ 67,443	$ 440,530	$ 279,631	$ 245,096	$ -	$ 1,032,699
2: O&M	7: Hazard Tree Removal	4: O&M	$ -	$ 60,318	$ 2,655,089	$ 2,735,400	$ 2,813,158	$ 2,895,929	$ 11,159,895
	7: Hazard Tree Removal Total		$ -	$ 60,318	$ 2,655,089	$ 2,735,400	$ 2,813,158	$ 2,895,929	$ 11,159,895
	8: Resilience Modeling	4: O&M	$ 61,523	$ 172,679	$ -	$ -	$ -	$ -	$ 234,202
	8: Resilience Modeling Total		$ 61,523	$ 172,679	$ -	$ -	$ -	$ -	$ 234,202
PE.005838: Resiliency Program - Oahu			**$ 349,818**	**$2,561,325**	**$ 9,742,622**	**$23,547,988**	**$29,901,800**	**$40,652,216**	**$ 106,755,770**
1: Capital	1: Critical T-Line Hardening	1: Engineering	$ 168,209	$1,485,050	$ 2,503,069	$ 3,981,996	$ 158,217	$ 94,438	$ 8,390,978
		2: Materials	$ -	$ -	$ -	$ 2,430,185	$ 4,332,120	$ 6,860,999	$ 13,623,304
		3: Install	$ -	$ -	$ -	$ 5,740,360	$10,232,938	$16,206,424	$ 32,179,723
	1: Critical T-Line Hardening Total		$ 168,209	$1,485,050	$ 2,503,069	$12,152,541	$14,723,276	$23,161,861	$ 54,194,006
	2: Critical Customer Circuit Hardening	1: Engineering	$ 17,155	$ 202,179	$ 382,983	$ 788,441	$ 1,208,945	$ 10,336	$ 2,610,039
		2: Materials	$ -	$ -	$ 460,813	$ 948,605	$ 1,951,167	$ 3,012,909	$ 6,373,494
		3: Install	$ -	$ -	$ 467,113	$ 961,572	$ 1,977,840	$ 3,054,095	$ 6,460,620
	2: Critical Customer Circuit Hardening Total		$ 17,155	$ 202,179	$ 1,310,909	$ 2,698,619	$ 5,137,952	$ 6,077,339	$ 15,444,153
	3: Critical Pole Hardening	1: Engineering	$ 17,155	$ 138,402	$ 374,162	$ 644,247	$ 1,051,312	$ 10,336	$ 2,235,614
		2: Materials	$ -	$ -	$ 338,469	$ 1,045,131	$ 1,791,425	$ 2,950,657	$ 6,125,682
		3: Install	$ -	$ -	$ 427,780	$ 1,320,907	$ 2,264,124	$ 3,729,240	$ 7,742,051
	3: Critical Pole Hardening Total		$ 17,155	$ 138,402	$ 1,140,410	$ 3,010,286	$ 5,106,860	$ 6,690,233	$ 16,103,347
	4: Wildfire Prevention & Mitigation	1: Engineering	$ 17,155	$ 164,829	$ 306,191	$ 169,846	$ 174,537	$ 11,949	$ 844,507
		2: Materials	$ -	$ -	$ 266,629	$ 548,869	$ 282,239	$ 290,548	$ 1,388,285
		3: Install	$ -	$ -	$ 596,975	$ 1,228,899	$ 631,925	$ 650,527	$ 3,108,326
	4: Wildfire Prevention & Mitigation Total		$ 17,155	$ 164,829	$ 1,169,795	$ 1,947,614	$ 1,088,701	$ 953,024	$ 5,341,118
	5: Substation Flood Monitors	1: Engineering	$ 17,155	$ 39,970	$ 27,132	$ 31,807	$ 32,627	$ 6,034	$ 154,726
		2: Materials	$ -	$ -	$ 35,757	$ 36,804	$ 37,851	$ 38,965	$ 149,377
		3: Install	$ -	$ -	$ 85,817	$ 88,330	$ 90,842	$ 93,516	$ 358,504
	5: Substation Flood Monitors Total		$ 17,155	$ 39,970	$ 148,707	$ 156,941	$ 161,319	$ 138,515	$ 662,607
	6: Lateral Undergrounding	1: Engineering	$ 51,466	$ 193,413	$ 149,411	$ 158,064	$ 162,470	$ 6,453	$ 721,277
		2: Materials	$ -	$ -	$ 255,527	$ 263,007	$ 270,487	$ 278,450	$ 1,067,471
		3: Install	$ -	$ -	$ 572,116	$ 588,864	$ 605,611	$ 623,439	$ 2,390,030
	6: Lateral Undergrounding Total		$ 51,466	$ 193,413	$ 977,054	$ 1,009,935	$ 1,038,568	$ 908,342	$ 4,178,777
2: O&M	7: Hazard Tree Removal	4: O&M	$ -	$ 164,802	$ 2,492,679	$ 2,572,053	$ 2,645,124	$ 2,722,902	$ 10,597,559
	7: Hazard Tree Removal Total		$ -	$ 164,802	$ 2,492,679	$ 2,572,053	$ 2,645,124	$ 2,722,902	$ 10,597,559
	8: Resilience Modeling	4: O&M	$ 61,523	$ 172,679	$ -	$ -	$ -	$ -	$ 234,202
	8: Resilience Modeling Total		$ 61,523	$ 172,679	$ -	$ -	$ -	$ -	$ 234,202
Grand Total			**$1,643,832**	**$4,422,052**	**$21,694,889**	**$39,990,982**	**$55,272,962**	**$66,702,508**	**$ 189,727,224**

Resilience Working Group Report for Integrated Grid Planning

Hawaiian Electric Company, Maui Electric Company, and Hawai‘i Electric Light Company

April 29, 2020

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1. Executive Summary

1.1 Resilience Working Group Objectives and Process

The Hawaiian Electric Companies (the Utilities) have embarked on the development of a long-term Integrated Grid Planning (IGP) process, one of the first of its kind in the U.S. The IGP will evaluate a combination of generation resources, transmission options and distribution assets in an integrated manner to provide a solution that meets the Utilities' environmental, regulatory, reliability, and resilience objectives in an affordable manner.

As this is the first of its kind, the Utilities have organized several stakeholder working groups, including the Resilience Working Group (RWG), to allow the Utilities to consider stakeholder inputs to the process. The goal of the RWG is to:

- Identify and prioritize resilience threat scenarios and potential grid impacts
- Identify key customer and infrastructure sector capabilities and needs following a severe event and loss of power
- Identify gaps and priorities in grid and customer capabilities following a severe event and loss of power
- Provide recommendations and inputs for the IGP to address resilience needs
- Recommend additional grid and customer actions to close gaps in capabilities following severe events

The Utilities retained Siemens and Where Talk Works, Inc. to facilitate a series of six RWG meetings and assist the RWG in reaching consensus around the definition of resilience of the grid, its importance to its customers, the vulnerability of the grid to severe events, and utility and customer options for mitigating these vulnerabilities.

1.2 Assessment of Grid Resilience Needs in Hawai'i

A methodical process was applied to develop the RWG inputs through a series of presentations, group discussions, and breakout sessions over a six-month period. The process included the following steps:

- Agree on a definition of resilience
- Identify severe threats to Hawaiian Electric service areas
- Screen the threats to focus on those having the most severe impacts on the power grids and to consolidate threats that have similar or overlapping impacts
- Identify and prioritize key customers and infrastructure sectors with focus on system recovery and public safety and well-being
- Identify gaps and opportunities to improve grid resilience, some of which can be with the Utilities and the grid itself and some of which can be provided by customers, particularly critical infrastructure partners

- Provide inputs to the IGP process for those resilience options that involve power grid enhancements

The RWG adopted the Public Utility Commission (PUC) Staff's definition of resilience as "the ability of a system or its components to adapt to changing conditions and withstand and rapidly recover from disruptions." With regard to the electric power system in particular, this can be interpreted as the ability to anticipate, absorb, adapt to, and rapidly recover from a catastrophic event.

Resilience objectives that were discussed by the RWG consistent with the PUC's definition include:

- Reduce the likelihood of power outages during a severe event
- Reduce the severity and duration of any outages that do occur during and after a severe event
- Reduce restoration and recovery times following a severe event
- Return critical infrastructure customers' power rapidly to enable mutual support and recovery during an emergency
- Return all customers within appropriate times
- Limit environmental impacts of a severe event

The RWG determined by consensus that five types of severe events were determined to be of utmost importance to consider for achieving a resilient grid. They are:

- Hurricanes
- Earthquakes and tsunamis
- Volcanos (Hawaiʻi Island)
- Wildfires
- Physical and cyber-attacks

Siemens constructed twenty-three scenarios to represent different potential impacts on grid infrastructure for these five events on Oʻahu, Hawaiʻi Island and Maui County (Maui, Molokaʻi, and Lānaʻi). These scenarios identify facilities that could be impacted and possible lengths of time that the facilities would be out of service. The five event types and applicability to the islands are summarized in Exhibit 1. Each event type has a moderate and severe case, which would translate to 24 possible cases to study. However, the volcano scenario has only one severe case, so the total number of possible scenarios constructed for consideration in the IGP is 23. The Utilities are not expected to study all cases presented, but rather a select number of cases to assess the benefits and costs of mitigation strategies.

Exhibit 1: Consolidated Threat Scenarios for IGP

Threat	Includes	Oahu	Hawai'i	Maui County
Hurricane	Flood, Wind	X	X	X
Tsunami	Earthquake	X	X	X
Wild Fire		X		X
Physical Attack	Cyber Attack	X	X	X
Volcano			X	

Each of the scenarios has a brief narrative that provides some key assumptions for the case, as described more fully in the body of the report. In the description of these scenarios, there are instances where certain critical infrastructures could be out of service for weeks or even months. The RWG recommends the Utilities consider the impacts of these events in the IGP though they do not necessarily need to run all 23 scenarios in the IGP. The scenario descriptions include maps of areas most vulnerable to damage on each of the affected islands to assist the Utilities in identifying the potential impacts of these events on grid infrastructure.

In addition to the development of the risk of these events on grid infrastructure, the RWG provided a summary of the relative priorities of customer groupings based on how critical it is to return these types of organizations to electric service during an extended outage. These are summarized in Exhibit 2.

Exhibit 2: RWG Recommended Customer Classifications by Tier

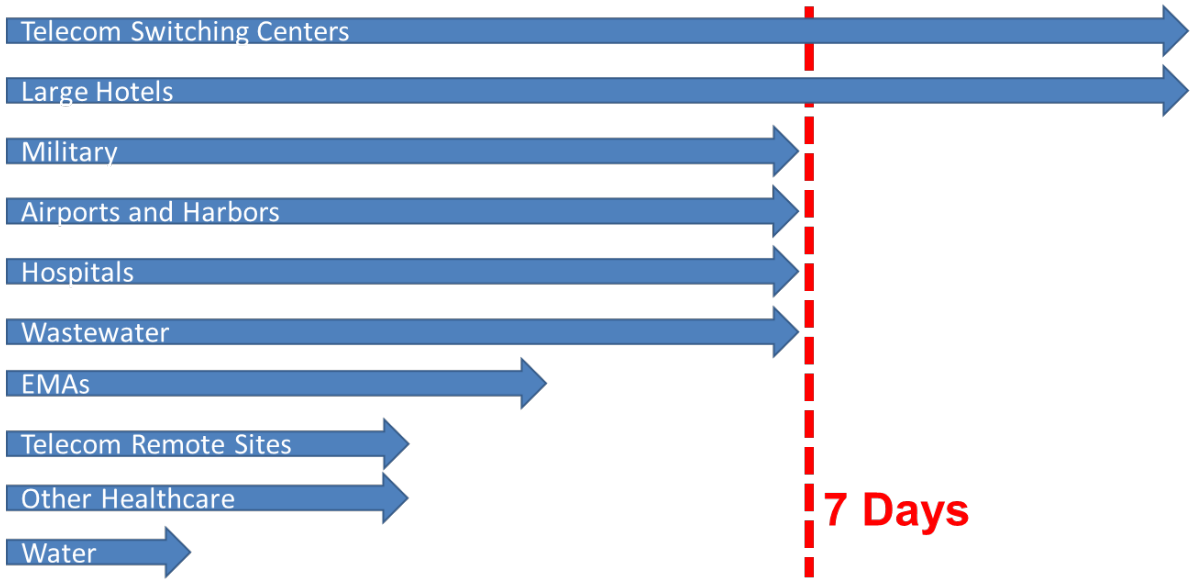
Tier 1	Tier 2	Tier 3
• Military	• Transportation	• Remaining customers
• Telecommunications	• Hospitality	
• Hospitals and critical healthcare	• Banking and finance	
• Water and wastewater		
• Emergency management and first responders		

This identification of customer groups represents the stakeholders' views of the prioritization of customers with the greatest need to be returned to service quickly. An action item for the RWG and the Utilities should be to reconcile these customer priorities with the Utilities' and, at a strategic level, emergency managements' restoration plans to ensure that they are in alignment. The RWG and the Utilities should remain flexible to adjusting customer groupings and Tiers over time to ensure that prioritized customers and sectors are cross-validated with other sources such as FEMA's Community Lifelines construct and DHS's Critical Infrastructure Sectors[1].

[1] One member offered the following recommendation for future work and reporting by the RWG: RWG selected these particular sectors (in Tiers 1 & 2 above) during breakout discussions with a scope of providing inputs to the IGP – focused on resilience of the power grid. The RWG has not identified the whole "Energy" sector in its Tiers and priorities. Electricity is commonly a subcomponent of Energy (https://www.cisa.gov/energy-sector; https://www.fema.gov/lifelines). The work of the RWG was focused on making the grid more resilient and the interdependencies with other critical sectors. However, the RWG should have considered including other elements of the Energy sector including, for example, liquid fuels, gas, and other energy subcomponents. This is relevant to the RWG because it led to "Energy" not being specifically called out in the RWG Tiers nor identified in the "Sector Interdependencies", "Customer Sector Needs vs Capability", or in the discussion of key customers / capabilities by

The RWG also provided general information on the ability of customer classes to withstand severe events, as shown in Exhibit 3.

Exhibit 3: Summary of Backup Power and Fuel Capabilities by Customer Class



When comparing the potential vulnerability of critical infrastructure in remote locations for weeks to months, to the current backup power capability of the stakeholders, there are gaps between customers' ability to withstand an outage and the potential downtime associated with the severe events contemplated by the RWG.

By listening to the discussions through the stakeholder process and by conducting interviews with experts within the Utilities, Siemens was able to draft an initial list of some of the options available to mitigate these gaps. The recommendations were refined after review and discussion with the RWG. This is not meant to be a comprehensive list but rather a starting point for further evaluation. In addition to IGP process recommendations presented later, the Utilities should consider the following potential mitigation actions to improve grid resilience:

- Utilities continue to explore and develop advanced resilience data as demonstrated by the technologies of Jupiter Intelligence
- Utilities partner with key customers and the government to develop microgrids for power that can be isolated from the grid when needed (severe events)
- Utilities reinforce fuel resupply options by increasing distributed storage and delivery capability for severe event emergencies

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sector. In general, it would be preferential to align the definition of the sectors to the extent possible with the DHS/FEMA designated functions so that there is a common language being used by all.

- Utilities plan for additional crews during emergencies and provide more robust and regular training for emergency situations
- Utilities expand critical resources, supplies, backup equipment, and materials to restore damaged circuits, substations or generators, including distribution more quickly following severe events
- Utilities plan for emergency access to additional helicopters on the islands to support repairs in remote, difficult to access sites
- Utilities plan for enhanced vegetation management, particularly in critical grid areas susceptible to damage from wind and falling or flying debris
- Utilities continue hardening or reinforcing critical transmission circuits, including upgrading wind criteria and flood mitigation, upgrading structures, and using enhanced construction methods and materials
- Utilities continue efforts at enhancing physical and cyber security of assets, resources, and systems.
- Utilities continue planning for expanding underground cables (water resistant) and locating equipment outside flood prone areas
- Utilities consider alternative paths for transmission circuits to increase diversity of location and enhance performance during severe events
- Utilities establish one or more priority circuits with enhanced restoration capabilities and greater hardening
- Utilities continue to require that new RFPs for renewables bids include grid-forming inverters, meaning they can provide a blackstart capability
- Utilities consider adopting advanced technologies in a more distributed resource approach, including grid-forming renewable energy sources, battery storage, and joint projects with key customers to provide microgrid capabilities for emergency and backup operations
- Utilities develop wildfire mitigation strategies for worst case wildfire event at Maalaea
- Utilities develop and test capabilities of expanded use of drones for emergency response and regular maintenance inspections
- Utilities evaluate options for distribution automation, digital meters and associated communications networks which can be valuable in assessing system conditions, the extent of outages, and how to best prioritize recovery efforts to get key customers reenergized more quickly
- Utilities consider actions to reduce tsunami risk impacting generation in inundation zones on Oʻahu

Additionally, the RWG identified mitigation and resiliency recommendations for key customers and critical infrastructure sectors:

- Infrastructure owners and operators work together in close partnerships to coordinate disaster planning and recovery. Recovery and risk mitigation are shared responsibilities between the power companies, key customers and the government.
- Key customers develop and implement load management/load curtailment capabilities to limit power usage to mission critical loads during emergencies with loss of offsite utility power

- Key customers maintain ample onsite fuel supplies for generators during extended power outages and transportation disruptions and have in place plans and fuel supply arrangements resupply fuel for outages exceeding operational expectations; coordinate resupply plans so that multiple facilities, sectors, and geographic areas are not relying on the same fuel resources at the same time; provide backup power sources that can supply essential loads during prolonged outages and emergencies; test and exercise backup power resources
- Under their Continuity of Operations Planning (COOP), key customers should consider relocating essential functions to alternative facilities at sites/locations with more robust infrastructure support
- Key customers consider developing plans and arrangements for deployment of temporary emergency power generators that can be relocated to critical sites during prolonged outages
- Key customers consider partnering with Utilities and the government to develop local microgrids for power that can be isolated from the grid when needed (during severe events); consider alternative technologies, such as renewables and storage, and other blackstart resources,
- Key customers in the transportation sector ensure availability of adequate road clearing equipment to speed recovery of key roads, ports and airports
- Key customers reinforce harbors and port facilities against catastrophic flooding and storm damage to ensure they can maintain maritime operations during extended power outages
- Customers maintain training and exercise programs that address performing emergency and contingency operations with loss of utility power

1.3 Resilience Considerations for Integrated Grid Planning and Other Activities

The RWG was intentionally not prescriptive in defining inputs to the IGP. Much of the IGP is very technical, but the RWG focused on developing general guidance rather than detailed planning requirements for the IGP process. Both Siemens and the Utilities provided a high-level description of the planning process, so the RWG offered recommendations for consideration in both the IGP and for activities outside of the IGP.

Objectives

Siemens provided the RWG a high-level perspective to utility planning that suggested that utilities begin with a list of objectives that customers are looking for in a plan. The list includes grid qualities such as least cost, reliable, resilient, sustainable, and flexible. Each objective would typically have a corresponding metric which could be measured so that the Utilities has a basis to assess tradeoffs between each objective.

- The least cost objective typically uses the Net Present Value (NPV) of costs over a planning horizon as a metric
- Reliability is often measured by a loss of load probability
- Sustainability is often measured in terms of percentage of renewable resources in the portfolio or carbon tons emitted

Resilience is relatively new as an objective in utility resource planning. Currently, no formal grid resilience definitions, metrics, or analysis methods have been universally accepted. The RWG didn't have a specific metric in mind, but the group did express the view that costs should not be the only measure of resilience to consider. Hence Siemens facilitated an RWG discussion of possibilities that the Utilities might consider.

The RWG reached general agreement that all relevant costs need to be captured, which includes the costs that utilities might incur to mitigate (and recover from) severe outages, as well as the cost of the outage to customers and stakeholders. It might also include costs that customers incur to mitigate the impact of severe outages, especially if those measures might be more cost effective than those incurred by the utility.

Regarding the measure of resilience, the RWG provided no guidance other than there should be metrics to measure the resilience of electricity distribution systems that are not strictly cost based to measure its performance. In this way, the Utilities will have an analytical framework to quantify resilience metrics and a process to utilize them to measure tradeoffs between cost and resilience, just as it can measure the cost associated with greater levels of sustainability or cost and flexibility.

Inputs to the Process

Once again, the RWG did not have a view towards what technical inputs the Utilities should consider in tracking resilience. However, the RWG expressed a lot of interest in the presentation made by Jupiter Intelligence in developing forecasts of future weather patterns, such as sea level rise, the frequency of future events such as hurricanes based on science, trends and weather patterns.

The RWG agreed that one needs forecasts and probability distributions of the frequency, duration, and severity of wind and flood damage associated with these events, considering the vulnerability of the grid to these events in terms of recovery times by location and other performance indicators. Customers need to understand their ability to withstand these events without future options being implemented.

Strategies That Might be Considered

Siemens also described to the RWG some strategies that could be considered in the context of an IGP. Strategies are high level activities that might shape the portfolio of actions the Utilities could take. The following are illustrations of the types of strategies the Utilities might consider in their IGP that appeared reasonable to the stakeholder group:

- One strategy that might be considered is different levels of power generation decentralization. By considering locating generation resources closer to load centers and key customers (decentralization), one can evaluate tradeoffs between more and less centralized generation strategies. If the Utilities were to construct portfolios of options that are more decentralized, one can assess how much moving more of its generation closer to load pockets improves resilience and at what cost.
- A second type of strategy would be to evaluate what actions (portfolios) the Utilities can undertake on their own versus a strategy that considers the most cost-effective solutions with potential customer and other service provider actions along with utility actions. This could come about through partnerships that are mutually beneficial to the Utilities and customers in terms of achieving resilience, environmental, sustainability and other mutual objectives.
- A third strategy might entail setting specific targets for recovery times and other performance measures for different classes of customers. By evaluating more stringent targets one can determine the cost effectiveness of each alternative.

The RWG did not express a view towards which of these strategies to consider but felt that these were reasonable ones that the Utility might choose to evaluate. It is also possible for the Utilities to consider combinations of strategies.

RWG Recommendations for Integrated Grid Planning Process

The RWG recommends that:

- The following threat scenarios be considered by the Utilities to guide the IGP process and other resilience initiatives, and also by key customers and critical infrastructure partners in developing resilience preparations:
    - Hurricane/flood/wind
    - Tsunami/earthquake

  - Wildfire
  - Physical and cyberattack
  - Volcano

- Utilities consider the key customer and infrastructure priorities identified by the RWG when planning system expansion or improvements
- Utilities develop IGP objectives that include optimizing resilience and cost of resilience; and merge resilience with other planning goals such as reliability, renewable energy expansion, sustainability, carbon emissions reduction, environmental stewardship, rate stability, etc.
- Utilities should consider the following elements of resilience:
  - Reduce probability of power outages during severe and catastrophic events
  - Reduce outage severity and duration during and following a severe or catastrophic event
  - Reduce restoration and recovery times following severe and catastrophic events;
  - Optimize cost (including capital and operating costs, and probability weighted outage and recovery costs, etc.)
  - Return critical and priority customers power within specified times
  - Return power to other customers within specified times
  - Limit environmental impacts
- That the Utilities consider all possible lowest cost solutions, whether they are best accomplished solely through utility actions or through a combination of utility customer and other service provider actions; hence RWG recommends that some consideration of non-utility stakeholder actions be captured in the analysis of options
- That all relevant costs should be captured, which includes the costs that Utilities might incur to mitigate (and recover from) severe and catastrophic outages, as well as the cost of the outage to customers and other stakeholders; it might also include costs that customers or other service providers incur in response to and recover from the consequences of a prolonged severe outage, especially if those measures might be more cost effective than those incurred by the utility
- That Utilities develop measures of resilience for Integrated Grid Planning in collaboration with stakeholders to allow evaluation of resilience performance of various options or combination of options under assumed scenarios and conditions
- That resilience should not only be measured as a cost but should be a separate goal with its own measurable outcomes. This step requires the definition of each individual resilience goal and quantification of the degree of resilience achieved in a single and/or combination of metrics
- That Utilities consider options for more decentralized or distributed energy resources closer to load areas and options for expanding customer-based programs and other non-wires solutions for improving reliability and resilience
- That Utilities assess options for enhancing resilience through the mix and location of generation resources, including expanding renewable resources with grid-forming capabilities
- That Utilities consider configuring portions of the grid in several mini grids that could operate as independent islands which could be self-supplying over an extended period of time during severe emergencies and outages.
- That Utilities consider planning for best locations to expand and diversify blackstart resources and delivery paths to support grid restoration and timely recovery of key customers and critical infrastructure sectors

- That Utilities consider targeted transmission/sub-transmission additions to enhance redundancy and diversity of delivery paths and reduce risk from severe events

1.4 Organization and Uses of Report

The report is intended to be a starting point for the IGP, but it has value well beyond the analysis that the Utilities plan to consider in its upcoming study. For one, it brings the Utilities' interests and the customers interests together and creates a dialogue that can result in partnerships that might not otherwise exist. It also provides the Utilities with information that it could not find otherwise on the true vulnerabilities of the islands. Finally, it creates a vehicle for information sharing going forward to ensure that the Utilities are focused on customer interests. Stakeholder views will continue to evolve as technological advances occur. None of this report should be considered as final, since we are in a rapidly evolving energy future.

The RWG expressed a willingness to continue to contribute to the IGP as it evolves, over the next 18 months and into the future. The partnership between the Utilities and the stakeholders is critical to the achievement of joint resilience objectives for the future of Hawaiʻi.

Following Section 2 reviewing the RWG process, the remaining sections of the report describe the process used by the RWG to:

- Identify priority resilience threats impacting the grid and customers (Section 3)
- Identify priority customer and infrastructure sectors and their capabilities and needs (Section 4)
- Identify grid vulnerabilities and capabilities to withstand severe events (Section 5)
- Provide inputs for consideration in the IGP (Section 6)

Section 7 summarizes the RWG's recommendations from across all areas of the report.

2. Introduction

2.1 Resilience Working Group

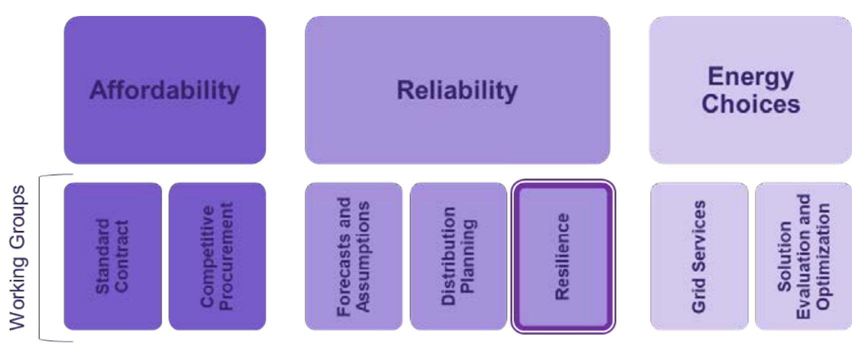
2.1.1 Goals and Objectives

The Hawaiian Electric Companies (the Utilities), comprised of Hawaiian Electric Company, Maui Electric Company, and Hawai‘i Electric Light Company, are undertaking a comprehensive Integrated Grid Planning (IGP) process, which brings together resource, transmission and distribution planning, seeking best solutions to provide affordable, reliable, resilient, and clean energy to Hawai‘i while minimizing risks. Noting the State's isolated island location, vulnerability to natural hazards, and history of disasters, resilience of electricity supply and delivery is a key consideration in the IGP. This report details the activities and recommendations of the 2019 Resilience Working Group (RWG).

An integrated grid planning process is new to Hawai‘i and to the industry. Few such processes have been performed and only a portion of those few have directly considered resilience in the planning process. For this reason, the Utilities decided to form several stakeholder groups to provide input to the process, including the RWG.

Stakeholder engagement is core to the IGP process. A broad stakeholder engagement process was launched in 2019 to identify customer and stakeholder inputs and to solicit feedback throughout the IGP process. Stakeholder activities early in the IGP process will support the identification of customer needs and how these translate into policy goals, objectives, forecasts and assumptions feeding into the IGP analysis. Several advisory working groups under the broader stakeholder process were formed to focus on key components of IGP. Exhibit 4 presents the organization of the IGP stakeholder process, including the RWG.

Exhibit 4: IGP Stakeholder Engagement Organization



Source: HECO

The goal of the RWG is to support the development of resilience planning inputs for Hawaii's power system including resource, transmission and distribution assets, in relation to potential societal and economic impacts of potential severe events. More specifically, the goals are to:

- Identify and prioritize resilience threat scenarios and potential grid impacts
- Identify key customer and infrastructure sector capabilities and needs following a severe event and loss of power
- Identify gaps and priorities in grid and customer capabilities following a severe event and loss of power
- Provide recommendations and inputs for the IGP to address resilience needs
- Recommend additional grid and customer actions to close gaps in capabilities following severe events

The RWG realized during the process that achieving resilience meant key customers and infrastructure sectors would be able to continue providing essential services during and following a severe event, even if power outages occur. This requires a strong partnership and cooperation between the Utilities and their key customers to support essential operations and disaster response. The Utilities are focused on rapid restoration and recovery of the power supply while customers can ensure their own emergency business continuity through backup power resources, fuel storage and resupply capabilities, and other measures to mitigate the consequences of possible power outages following severe events.

2.1.2 Member Organizations and Participants

The RWG members included a broad range of state and national agencies, commercial and industrial customers, and not for profit interest groups. It was important that the members were able to bring to the discussion expertise from their sectors, including:

- Defense
- Telecommunications
- Transportation (Energy as a subset)
- Water and wastewater
- Hospitals and health care
- Emergency management and first responders
- Hospitality industry

The RWG member organizations and individual representatives are listed in Exhibit 5. The Utilities retained Siemens Energy Business Advisory (Siemens EBA) to advise and facilitate the RWG through the stakeholder engagement process. Siemens EBA provided technical facilitators with expertise in integrated grid planning and resilience. The Utilities also retained Where Talk Works, Inc., a Hawai‘i-based company that provides collaborative meeting facilitation services.

Exhibit 5: Resilience Working Group External Member Organizations and Representatives

Name	Organization
Dan Kouchi	Chamber of Commerce
Hirokazu Toiya	City & County of Honolulu Emergency Management
Jennifer Walter	City & County of Honolulu Emergency Management
Crystal van Beelen	City & County of Honolulu Emergency Management
Rocky Mould	City & County of Honolulu Office of Climate Change, Sustainability and Resiliency
Chris Cunningham	City & County of Honolulu Office of Climate Change, Sustainability and Resiliency
Christian "Kaliko" Kabasawa	City & County of Honolulu Office of Climate Change, Sustainability and Resiliency
Dean Nishina	Consumer Advocate's Office
Marcey Chang	Consumer Advocate's Office
Talmadge Magno	County of Hawaii Civil Defense
Keith Okamoto	County of Hawaii Dept. of Water Supply
Jeffrey Pearson	County of Maui Department of Water Supply
Herman Andaya	County of Maui Emergency Management Agency
Alex de Roode	County of Maui Energy Commissioner
Eric Nakagawa	County of Maui Environmental Management
Andy Schwartz	Energy Freedom Coalition of America (EFCA)
Tristan Glenwright	Energy Freedom Coalition of America (EFCA)
Owen Sanford	Energy Freedom Coalition of America (EFCA)
William Rolston	Energy Island
Jeanne Johnston	Federal Emergency Management Agency
Janet Yocum	Federal Emergency Management Agency
Robert Harris	Hawaii PV Coalition
Judy Kern, Chief	Hawaii Department of Health
Thomas Travis	Hawaii Emergency Management Agency
David Lopez	Hawaii Emergency Management Agency
Chris Crabtree	Hawaii Healthcare Emergency Management
Daniel Kelly	Hawaii Healthcare Emergency Management
Paul Agena	Hawaii National Guard
Aaron Lau	Hawaii National Guard
Wade Ishii	Hawaii National Guard
Stan Garcia	Hawaii National Guard
Tony Moiso	Hawaii Society of Healthcare Engineers
William Giese	Hawaii Solar Energy Association (HSEA)
Carilyn Shon	Hawaii State Energy Office
Chris Yunker	Hawaii State Energy Office
Mark Want	Hawaii State Energy Office

Francis Alueta	Hawaiian Telcom
Dan Masutomi	Hawaiian Telcom
Kevin Ihu	Honolulu Board of Water Supply
Lori Kahikina	Honolulu Dept. of Environmental Services
Henry Curtis	Life of the Land
Raymond Tanabe	National Oceanic and Atmospheric Administration
John Bravender	National Oceanic and Atmospheric Administration
Leigh Anne Eaton	National Oceanic and Atmospheric Administration
Jonathan Choi	Par Hawaii
Wren Wescoatt	Progression HI Offshore Wind
Noelani Kalipi	Progression HI Offshore Wind
Dave Parsons	Public Utilities Commission
Jay-Paul D Lenker	Public Utilities Commission
Gina Yi	Public Utilities Commission
Samantha Ruiz	Public Utilities Commission
Clarice Schafer	Public Utilities Commission
Mike Wallerstein	Public Utilities Commission
Jason Prince	Public Utilities Commission
Erik Kvam	REACH
Eric Au	Sheraton Hotels
Jade Butay	State of Hawaiʻi Department of Transportation
Ed Sniffen	State of Hawaiʻi Department of Transportation
Ross Higashi	State of Hawaiʻi Department of Transportation
Gary Yokoyama	State of Hawaiʻi Department of Transportation
Peter Pillone	State of Hawaiʻi Department of Transportation
Joseph Beagley	State of Hawaiʻi Department of Transportation
Murray Clay	Ulupono Initiative
Keith Yamanaka	United States Army
Casey Ann Hiraiwa	United States Army
Glen Yanagi	United States Coast Guard
Jennifer DeCesaro	United States Department of Energy
Sonny Rasay	United States Marine Corps
Shaun Sakai	United States Marine Corps
Robert Malaca	United States Marine Corps
Joe Baysa	United States Marine Corps
Dan Lougen	United States Navy
Shereen Wachi	United States Navy
Peter Yuen	United States Navy
Gary Ting	United States Navy
Corey Shaffer	Verizon Wireless

2.1.3 Meetings and Exercises

The RWG held six meetings starting in July and concluding in December of 2019. A summary of the meetings and agendas is presented in Exhibit 6. The initial meetings focused on defining and raising awareness of resilience and threats to the electric grid. The next few sessions identified and prioritized threats to the islands and defined key customer needs and priorities under severe event scenarios. Looking at these factors, as well as the infrastructure and state of the electric grid today, the RWG formed inputs and considerations to address resilience in the IGP.

Exhibit 6: RWG 2019 Meeting Summary and Process Overview

Meeting	Date	Topics of Focus
1	July 22, 2019	• Introduce RWG • Define resilience and raise awareness • Solicit initial inputs
2	August 29, 2019	• Review needs and existing capabilities of critical infrastructure • Identify customer segments under severe hurricane scenario • Preliminary consensus on resilience process
3	September 17, 2019	• Define severe event priorities • Identify and map potential impacts of all hazards • Identify, assess, and discuss mitigation options
4	October 28, 2019	• Map threats, vulnerabilities, key customer needs and capabilities as related to the grid • Review planning criteria and scenarios
5	November 22, 2019	• Review outline of the final working group report
6	December 16, 2019	• Review final report and recommendations • Open comment period (through Jan 10, 2019) • Consensus and acceptance by RWG • Consider minority views

Source: RWG

2.1.4 Report Development and Review

Throughout the six-month process, the RWG sought consensus and inclusiveness in preparing its recommended inputs to the Utilities' IGP process and overall resilience planning efforts. The group met frequently in breakout groups to discuss threat scenarios, customer capabilities and needs during a severe event, and inputs to the IGP. Minority views were considered and incorporated when appropriate. Meeting notes were recorded for the general sessions and breakouts to ensure comments were captured and considered in the final report. Additionally, frequent use was made of a meeting collaboration and polling app (Sift.Ly) to assess consensus and collect individual written comments.

A draft of the RWG report was prepared by Siemens facilitators and distributed prior to the December 16, 2019 meeting. The draft report was discussed during the final meeting and the RWG provided feedback on key issues and recommendations. The report remained open for written comment by the RWG through January 10, 2020. All comments were given due consideration while striving to achieve strong consensus across the RWG.

2.2 Resilience Framework

2.2.1 Definition of Grid Resilience

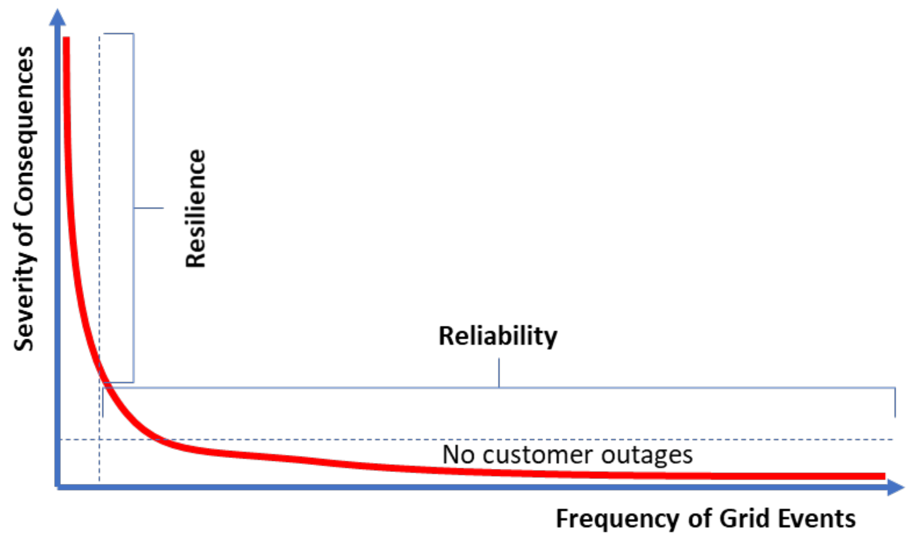
The RWG aligned on the definition of resilience as defined by the Hawaiian Public Utilities Commission (PUC) staff: "Resilience is the ability of a system or its components to adapt to changing conditions and withstand and rapidly recover from disruptions." As it relates to the electric grid and the IGP process, resiliency considers the ability to anticipate, absorb, adapt to, and rapidly recover from a potentially catastrophic event while sustaining mission critical functions.

The RWG's framework is consistent with the U.S. Federal Emergency Management Agency's (FEMA) National Preparedness Goal. The National Preparedness Goal describes the five mission areas as follows:

- Prevention: Prevent, avoid, or stop an imminent, threatened, or actual act of terrorism.
- Protection: Protect our citizens, residents, visitors, and assets against the greatest threats and hazards in a manner that allows our interests, aspirations, and way of life to thrive.
- Mitigation: Reduce the loss of life and property by lessening the impact of future disasters.
- Response: Respond quickly to save lives; protect property and the environment; and meet basic human needs in the aftermath of an incident.
- Recovery: Recover through a focus on the timely restoration, strengthening, and revitalization of infrastructure, housing, and a sustainable economy, as well as the health, social, cultural, historic, and environmental fabric of communities affected by an incident.

The RWG discussed the distinction between reliability and resilience. The facilitators presented the graphic in Exhibit 7 to address the concepts. Reliability provides a level of assurance that the lights will stay on through most normal events on the system (a power circuit or generator trips offline) or there are limited customer outages. At the bend of the curve one can see that reliability issues can sometimes lead to customer outages or in rare instances even an island wide outage. Reliability is achieved through achieving construction standards and accepted planning and operating practices; it addresses expected conditions during the life of the facilities in the system.

Exhibit 7: Grid Reliability vs. Resilience



Resilience addresses the performance of the system under more severe conditions such as the natural disasters discussed in this report that exceed the design expectations of the grid. As shown in Exhibit 7 on rare occasions a severe natural event such as a hurricane, flooding, high winds or wildfire could cause widespread grid outages and even permanent damage requiring weeks or even months to repair. The severity (consequences) axis in Exhibit 8 includes the magnitude and duration of power outages, and potential downstream impacts. The focus of the RWG in developing this report was to suggest recommendations to the IGP process that would reduce the frequency and consequences of system outages caused by severe events, in other words shift the steep part of the risk curve toward the left and downward. This can be achieved by improving the capability of the grid to withstand more severe events, and by being able to reduce the impact of the event and restore power more quickly once an event occurs.

The RWG also discussed the meaning of the term "disruption" in the PUC staff definition and agreed it would include any outage or loss of firm load. The report is focused on severe events that result in prolonged large-scale disruptions.

2.2.2 Framework for Assessing Grid Resilience Needs

It is important to note that grid resilience was the focus of the RWG work, which is somewhat different than other resilience initiatives that focus on the entire spectrum of resilience issues. The goal of this effort was to develop stakeholder inputs to guide the IGP process to address resilience risks involving extensive and potentially long-term electrical outages.

The framework for this assessment went through the following methodical steps in a series of presentations, group discussions, and breakout sessions:

- Agree on a definition of resilience

- Identify severe threats to Hawaiian Electric service areas
- Screen the threats to focus on those having the most severe impacts on the power grids and to consolidate threats that have similar or overlapping impacts
- Identify and prioritize key customers and infrastructure sectors with focus on system recovery and public safety and well-being
- Identify gaps and opportunities to improve grid resilience, some of which can be with the Utilities and the grid itself and some of which can be provided by customers, particularly critical infrastructure partners
- Provide inputs to the IGP process for those resilience options that involve power grid expansion or enhancement

Subject to future assessments the RWG believes the resilience objectives at the core of the IGP process should be:

- Reduce outage risk during severe events
- Increase ability to anticipate, absorb, adapt to, and/or rapidly recover from a potentially catastrophic event
- Reduce restoration and recovery time following a severe event
- Optimize cost (including capital and operating costs, and probability weighted outage and recovery costs, etc.)
- Return critical and priority (Tier 1 and 2) customers' power within specified time
- Return power to other customers within specified time
- Limit environmental impacts

The RWG is cognizant that all of these objectives may not be explicitly addressed within the current IGP process; rather, some objectives will support the Utilities' broader resiliency planning efforts and may be addressed through other means such as; grid modernization, resilience and asset strategies, operating procedures, and future IGP planning cycles.

For customers, resilience objectives aim to maintain critical functions, limit fatalities and human suffering, limit infrastructure and property damage, and limit the overall cost and economic impacts of an outage.

3. Prioritizing Threats to Grid Resilience

A grid resilience needs assessment begins first with identifying and prioritizing severe threats and understanding their impacts on the grid and customers. The RWG spent several meetings working on severe event scenarios and conducting tabletop exercises in breakout sessions to discuss the event impacts within their various sectors. The RWG recommends that the threat scenarios proposed here be used by the Utilities to guide the IGP process and other resilience initiatives, and by key customers and critical infrastructure partners in developing resilience preparations.

3.1 Historical Perspective on Severe Events Affecting Hawaiian Infrastructure

Hawaiʻi is a paradise and an attractive tourist destination. At the same time, being an island state and subject to natural events and climate change, Hawaiʻi has experienced its share of severe events. Exhibit 8 from Hawaii's 2018 Hazard Mitigation Plan identifies just a few events of note and demonstrates that severe events have happened in the past and are likely to continue in the future. Some hazards are expected to increase in both frequency and severity in the future due to climate change impacts, as will be discussed later.

Exhibit 8: Overview of Hazards and Projected Future Change in Hawaiʻi

Hazard	Projected Change			Confidence in Changing Future Conditions [a]
	Location	Extent/ Intensity	Frequency/ Duration	
Climate Change and Sea Level Rise	↑	↑	↑	Highly Likely
Chronic Coastal Flood	↑	↑	↑	Highly Likely
Dam Failure	— [b]	— [b]	↑ [b]	Likely
Drought	↑	↑	↑	Highly Likely
Earthquake	—	—	—	Uncertain
Event-Based Flood	↑	↑	↑	Highly Likely
Hazardous Materials	—	—	—	No Change
Health Risks	—	—	—	No Change
High Wind Storms	—	—	↓ [c]	Likely
Hurricane	↑	↑	↑	Highly Likely
Landslide and Rockfall	—	—	↑	Highly Likely
Tsunami	↑	↑	—	Highly Likely
Volcanic (lava flow and vog)	— [d]	— [d]	— [d]	Uncertain
Wildfire	↑	↑	↑	Highly Likely

Note: Arrow direction indicates a projected increase or decrease; straight line indicates uncertain and/or no change expected at this time.

Source: Hawai‘i 2018 Hazard Mitigation Plan

3.2 Prioritization of Threats to the Power Grid

The RWG considered and prioritized a range of severe events including natural, technological, and attack events. The RWG started with an initial list of threats that they felt would be the most important to address regarding impacts on the electric system.

Exhibit 9 is a summary of threats listed in the FEMA Threat and Hazzard Identification Report CPG 201. The RWG considered the threats under Column C (Considered by RWG) as possibly being important to the grid and supply of electricity to customers in Hawai‘i. Column P (Prioritized by RWG) indicates the RWG made the scenario a priority for IGP consideration. Scenarios not recommended as input to the IGP were screened out because (1) they do not apply to Hawai‘i, (2) they do not affect the power grid and cause system-wide power outages, (3) the impacts were redundant with other threats, or (4) they were considered outside the scope of the resilience planning. the utility outage box is not checked, but obviously is an overarching focus of the entire RWG efforts and the IGP process.

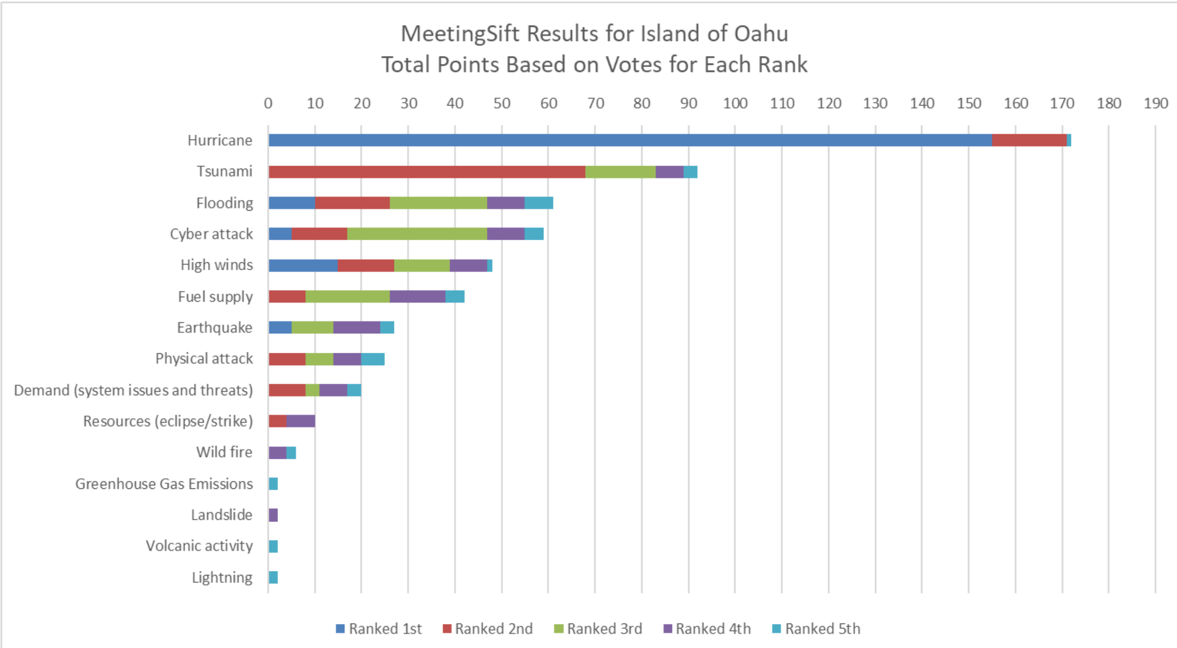
Exhibit 9: Severe Events Considered and Prioritized by the RWG

Natural	C	P	Technological	C	P	Attack	C	P
Avalanche			Dam failure			Physical (shooter)	X	X
Drought						Physical (explosive)	X	
Earthquake	X	X				Cyber	X	
Epidemic						Chemical		
Flood	X	X	Mine Accident			Improvised nuke		
Hurricane	X	X				Terrorist nuke		
High wind	X	X				Radiological		
Space weather								
Tornado								
Tsunami	X	X						
Volcano	X	X						
Wildfire	X	X		X				
Landslides	X			X				
Greenhouse gas	X					**C - Considered**		
Lightning	X					**P – Prioritized**		

Source: FEMA Threat and Hazzard Identification Report CPG 201 and the RWG

Through a series of breakout sessions over several meetings, the RWG discussed how each of the threat scenarios would impact the electric system of each island and difficulties associated with recovery and the associated social and economic consequences for each island. The scenarios were then prioritized by electronic vote of the members. A sample vote is shown in Exhibit 10 for Oʻahu. Similar votes were taken for the other islands serviced by the Utilities. (Note the electronic votes were weighted at five points for first choice, 4 points for second choice, etc.)

Exhibit 10: Prioritization of Critical Threats – O‘ahu



Source: RWG

Exhibit 11 shows how the threats were prioritized by island during breakout discussions and electronic votes to assess consensus. The graphic confirms that the top five priority events for each island are included in the final recommended set of scenarios for input to the IGP.

Exhibit 11: Ranking of Critical Threats – Top Five by Island

	O'ahu	Hawai'i	Maui	Lāna'i	Moloka'i
Hurricane	X	X	X	X	X
Tsunami	X	X	X	X	X
Flooding	X	X	X	X	X
Cyber attack	X				
High winds	X		X	X	X
Fuel supply				X	X
Earthquake		X			
Physical attack					
Demand (system issues and threats)					
Resources (eclipse/strike)					
Wild fire			X		
Greenhouse Gas Emissions					
Landslide					
Volcanic activity		X			
Lightning					

Source: RWG

Hurricane, tsunami, flooding, and high winds were common themes across all islands, according to the RWG. The scenarios highlighted in pink are included in the recommendations for consideration in the IGP. In later discussions, fuel supply was deemed to be an extremely important issue, but it was common to all severe events and outages – if the power is out for an extended period, resupply of fuel for backup power is a common concern for all critical sectors. Therefore, backup power and fuel supply should be considered across all scenarios and is not a scenario by itself.

Exhibit 12 presents the results of additional work to consolidate the list of threat scenarios. The goal of the RWG was to recommend a reasonable number of scenarios that could be used by the Utilities in the planning process to test the grid's ability to withstand severe conditions and recover in a timely manner. Hurricanes, floods and wind were consolidated into one threat scenario; earthquake and tsunami were combined; and physical and cyberattack were combined. These three combined threat scenarios were considered by the RWG to be important to all five islands. To allow further consolidation down to 12 scenarios for study, the RWG agreed to combine Maui, Moloka'i, and Lāna'i into one group of scenarios covering Maui County. Wildfires were deemed most important regarding grid impacts on O'ahu and Maui. Volcano threats are most relevant on Hawai'i Island.

Exhibit 12: Final Consolidated List of Recommended Threat Scenarios for IGP

Threat	Includes	Oahu	Hawai'i	Maui County
Hurricane	Flood, Wind	X	X	X
Tsunami	Earthquake	X	X	X
Wild Fire		X		X
Physical Attack	Cyber Attack	X	X	X
Volcano			X	

Source: RWG

This consolidation allows a reasonable number of resilience threat scenarios to be submitted into the integrated grid planning process, while capturing the most severe potential impacts and avoiding overlapping or redundant impacts to the grid. Below these threats are described in more detail using two levels of severity for each event except volcano, for a total of 23 possible scenarios covering Oʻahu, Hawaiʻi, and Maui Counties.

3.3 Threat Cases for Grid Resilience Planning

Siemens developed and the RWG commented on reference cases for each threat scenario by county. Except for volcanos, Siemens developed two cases for each threat scenario, a moderate case and a severe case. Only a severe case is suggested for a volcano on Hawaiʻi as a moderate volcano is likely to have limited direct impacts on the grid and a single severe case is enough.

Moderate cases are ones deemed to be less severe but more likely (approximately 50% or greater likelihood to occur in the IGP study period, through 2040, based on historical experience). The severe cases are intended to be more severe and realistically plausible but low probability of occurring during the IGP study period (e.g., less than 20% chance of occurring over the twenty-year period). However, the severity of impacts in the severe cases are important for consideration in testing the system under stressful conditions and evaluating recovery capabilities. The two cases for each threat are intended to provide a range of assumptions regarding grid impacts to see how well proposed solution options stand up under different conditions. Solutions that perform well on both resilience metrics and cost under all or most threat scenarios, both moderate and severe, should be deemed to be the most favorable options.

The RWG reviewed and supported assumptions regarding the impacts to the grid from each threat scenario. A summary of the severe event cases considered the threats to infrastructure and electric supply. The scenarios are developed to provide the Utilities a perspective on how components of the grid could be affected by different types of events. With this guidance, the Utilities can construct scenarios that reflect outages to key grid infrastructure.

It is important to note that the RWG discussed alternative views about providing moderate and severe scenarios. Some thought only the most severe cases (e.g. Category 4 hurricane) should be considered in the IGP process. One reason supporting this view is that the Hawaiʻi legislature has stated a Category 3 hurricane is the target basis for resilience and studying a Category 2 hurricane might be viewed as lowering the bar. However, others on the RWG preferred to keep both the moderate (e.g. Category 2 hurricane) and the severe (Category 4) cases for consideration in the IGP process due to the ability to provide a more comprehensive look at the frequency and costs associated with two types of events. In either case, note that these events should not be considered as targets but rather as scenarios that could be evaluated to determine the best overall investment solution. Utilities are encouraged to consider the impacts of both moderate and severe cases in the IGP process, but if only one is selected, it should be the severe case.

This discussion of the severity of the threat scenarios raises an important point of principle. The threat scenarios and case examples are not intended to set targets or standards of performance under severe conditions (i.e. the RWG is not saying the grid must withstand a Category 2 or Category 4 hurricane). The threat scenarios are intended to provide a set of stressed conditions to evaluate the performance of the grid under a variety of conditions and to determine which strategies or investment portfolios perform the best for the least cost. Once the tradeoffs between resilience benefits and costs can be demonstrated through analysis, appropriate goals and plans can be determined. This concept is described further in Section 6 of the report.

3.3.1 Hurricane/Wind/Flood Scenarios

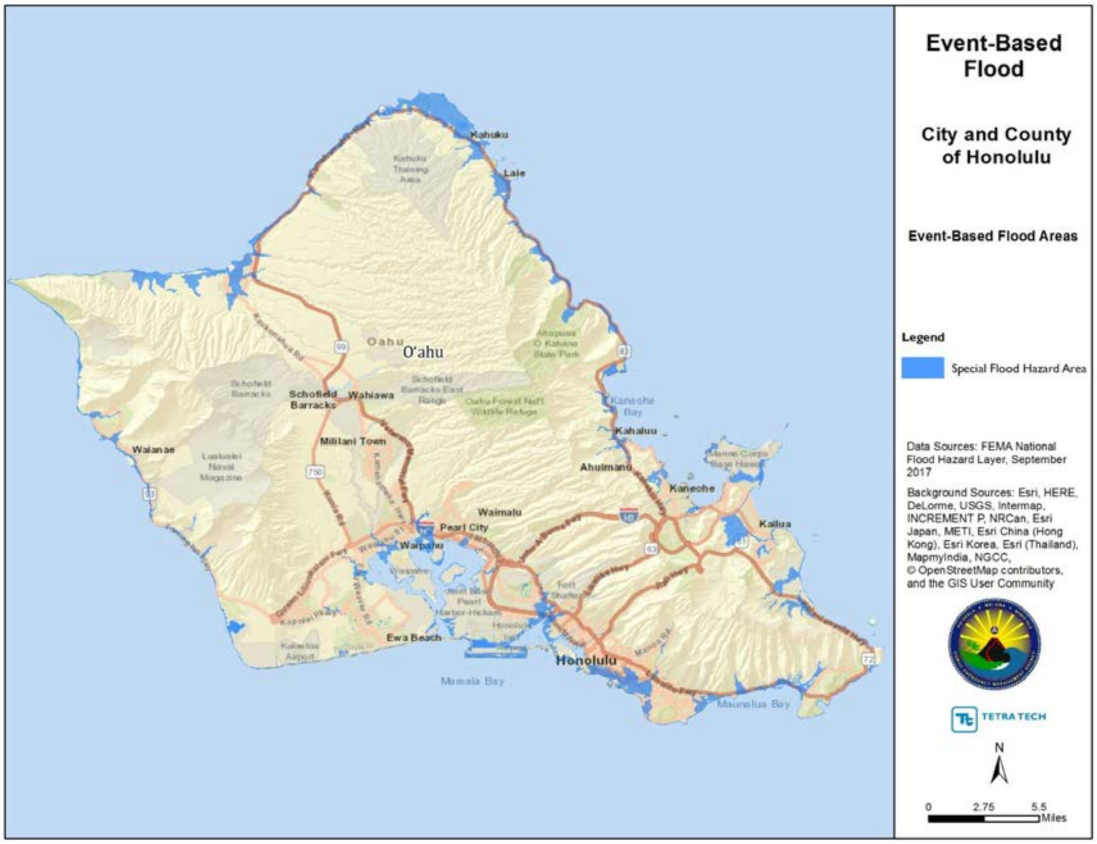
Exhibit 13 shows the proposed moderate and severe hurricane conditions proposed for all three counties (six cases total). The threat impacts are based on representative historical events in Hawaiʻi. These scenarios combine hurricane, flooding, and high wind conditions.

Exhibit 13: Hurricane, Flood, Wind Moderate and Severe Cases

Hurricane: Depending on path of hurricane, all islands and locations can be subject to damaging wind, rain and coastal and inland flooding.		
	Moderate	Severe
Scenario Description	Category 2 hurricane with wind speeds of 96 to110 mph, 6 to 10-foot surge	Category 4 hurricane with wind speeds of 130 to 156 mph, 13 to 20-foot surge
Scenario Impacts	• 10-foot storm surge • Coastal infrastructure damage • Damage to distribution lines and poles due to wind, falling trees/branches, and flying debris • 5-8% of transmission circuits have sustained outage and restored in 3-7 days • 20-30% of distribution circuits out and restored in 1-4 weeks • Roads cleared 3-7 days • Fuel resupply chain is available after 3-4 days	• 20-foot storm surge weeks

Exhibit 14 shows a flood map for Oʻahu. Under the hurricane and flood cases, the most severe flooding would be expected along the southern and northern coasts of Oʻahu with more limited coastal impacts on Maui. Key customers and backup generators are expected to flood in these coastal areas as well as utility distribution substations and lines in affected areas. Flooding impacts to electrical infrastructure are expected to be minimal on Hawaiʻi Island.

Exhibit 14: Coastal Flooding Impact Areas in O‘ahu



Source: FEMA, State of Hawai‘i 2018 Emergency Management Plan

During the RWG discussions, it was suggested that rain bombs should also be on the list of scenarios studied. Rain bombs in Hawai‘i can be severe. For example, on April 28, 2018, approximately 50 inches of rain was recorded at Waipa on Kaua‘i in a 24-hour period, the greatest amount in U.S. recorded history. After some discussion, the majority of the RWG agreed that while rain bombs can result in severe flooding and heavy damage to local infrastructure and human suffering, that these storms typically do not impact the power grid more severely than a hurricane event that incorporates high winds and flooding. The group consensus was to acknowledge the importance of rain bombs in general when discussing resilience, but to focus on the two hurricane cases for the purpose of stress-testing the grid for resilience planning.

The primary impacts from the hurricane scenarios are expected to affect transmission and distribution circuits. Transmission circuits are much fewer in number compared to the distribution system, but transmission lines can traverse remote, difficult terrain with limited access, such as on the western slope of O‘ahu. Some repairs may only be possible with the assistance of helicopters.

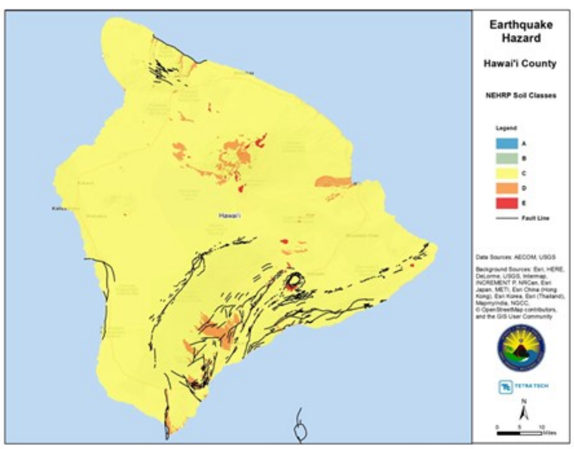
Distribution feeders would also be affected by hurricanes and would be much greater in number to repair. Even though distribution feeders are likely in more accessible areas, the sheer number of poles, transformers, and conductors to be repaired or replaced could make recovery last weeks to months under these hurricane conditions.

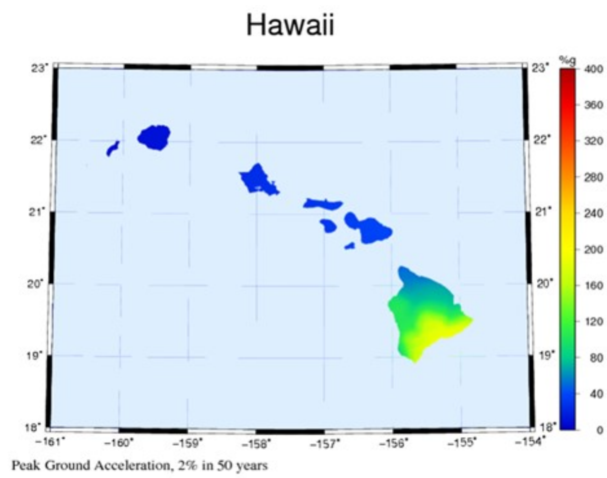
3.3.2 Earthquake/Tsunami Cases

Earthquakes are relatively common in Hawai‘i, particularly on the Island of Hawai‘i. Exhibit 15 depicts earthquake impacts for Hawai‘i. The island of Hawai‘i has the highest risk due to fault lines on the east portion of island near Hilo including areas with critical infrastructure. On May 4, 2018 a magnitude 6.9 earthquake struck the island with the epicenter on the south side of Kilauea. Minimal impact to the grid was experienced with this earthquake.

Seismic damage is a risk on the remaining islands, but much lower impacts would be expected. In addition to the grid, earthquakes can affect harbors and fuel supply, and possibly create hazmat conditions that could delay recovery of electricity if fuel supplies are not available for weeks or more.

Exhibit 15: Earthquake Impacts Hawai‘i

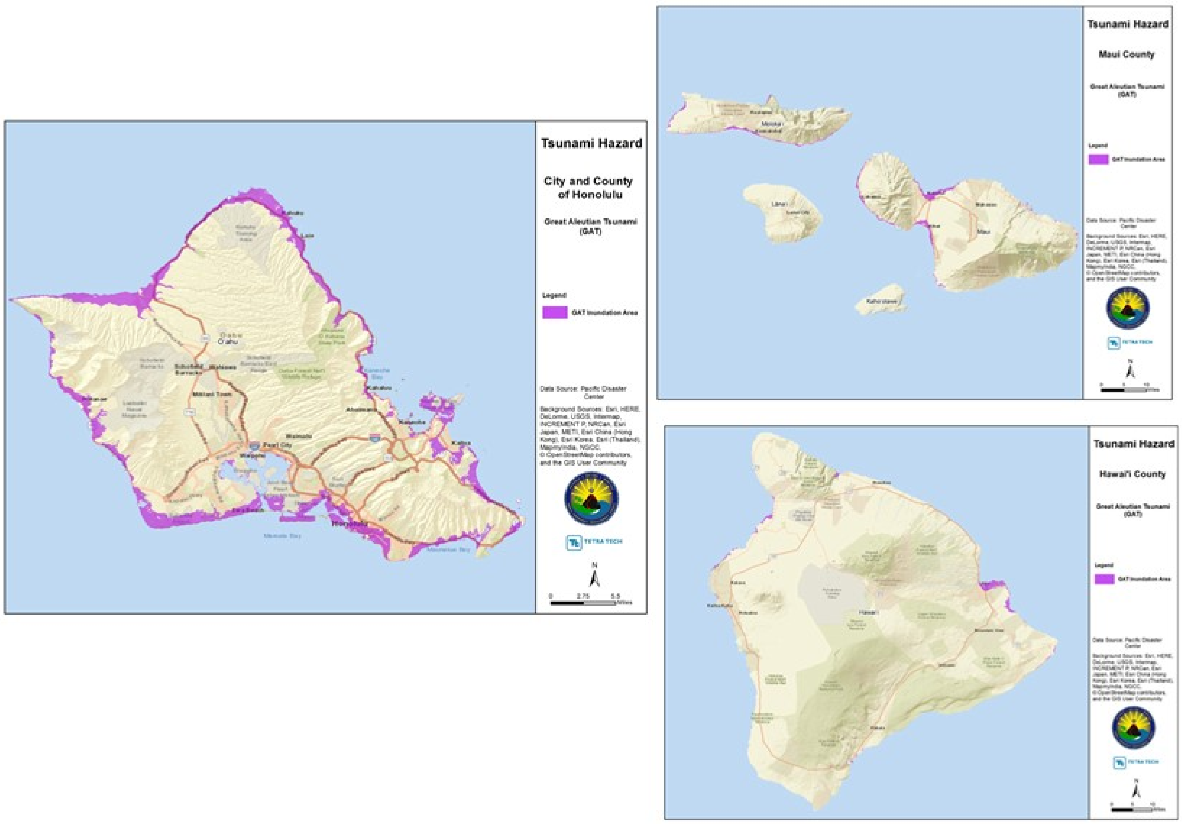




Source: State of Hawai‘i 2018 Emergency Management Plan

As shown in Exhibit 16, tsunami impact areas and infrastructure risks are the greatest on O‘ahu. In a severe event, significant damage to utility and customer infrastructure would be expected along coastal areas. Some coastal infrastructure damage, albeit more moderate, would also be expected in Maui. From an electric grid infrastructure perspective, critical facilities on Hawai‘i Island are not in the tsunami or flood impact areas.

Exhibit 16: Tsunami Impact Areas focused in O‘ahu and Maui



Source: State of Hawai‘i 2018 Emergency Management Plan

The second set of threat scenarios recommended for consideration in the IGP, shown in Exhibit 17, is a combination of earthquake and tsunami impacts. The moderate case proposed by the RWG is a 7.0 magnitude earthquake on Hawai‘i Island. A magnitude 6.9 earthquake struck in May 2018 and resulted in minimal impact to the grid. Much of this can be attributed to lessons learned being addressed from a 2006 earthquake that resulted in island-wide power outages in Hawai‘i, O‘ahu, and Maui Counties. These outages were predominantly the result of unintended operations of protection and control systems on generators and did not result in permanent damage to equipment due to the seismic activity. As a result, power systems were restored in a relatively short period of time. Although it is unlikely a 7.0 magnitude earthquake will impact electricity infrastructure on Hawai‘i Island, the RWG considers it important to keep earthquake in the list of severe events for consideration.

The severe case recommended by the RWG is a massive seismic event that results in grid and other infrastructure damage well inland on O‘ahu and Maui, due to major tsunami conditions.

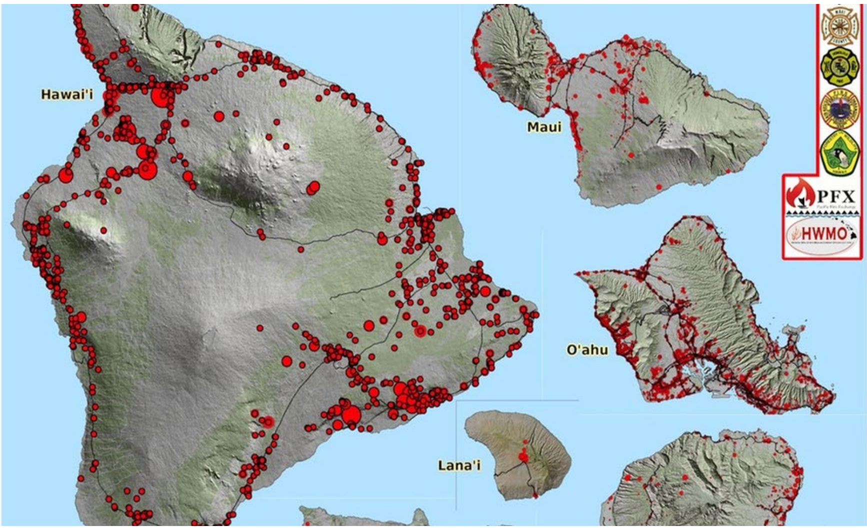
Exhibit 17: Earthquake/Tsunami Moderate and Severe Cases

Earthquake/Tsunami: Hawai‘i has the highest earthquake risk with major fault lines on the eastern portion of the island. Tsunami risk is the highest in O‘ahu.		
	Moderate	Severe
Scenario Description	7.0 earthquake on Hawai‘i island	8.5 earthquake near East Aleutian islands
Scenario Threats	• Infrastructure damage on two weeks	• 50+ foot runup moving as far

3.3.3 Wildfire Scenarios

Wildfires continue to present greater threats to infrastructure and the power grid. As shown in Exhibit 18, the risks to the grid from wildfires are most prevalent in Maui and O‘ahu – Moloka‘i also experiences wildfire risks, although there is less grid infrastructure on that island. On O‘ahu, the threat has the greatest potential impacts on the transmission circuits on the western slope where transmission lines traverse rough terrain and vegetation. Wildfires can damage power lines and poles, as well as substations and other facilities in fire prone areas. On Maui, the greatest risks are to the main power plant at Maalaea.

Exhibit 18: Wildfire Impact Areas



Source: HWMO, a 501(c)(3) Organization based in Waimea on Hawaii Island

The frequency and impacts of wildfires have increased recently. This may be attributable in some parts of the islands to the decline of the sugarcane industry. Sugarcane enterprises historically managed wildfire risks on the islands, including responding to fires. However, today these areas present vast amounts of vegetation that can burn longer and with less ability and resources to control them.

Maui presents unique wildfire risks. Risk is highest along the saddle road due in part to existence of an invasive grass species prone to drying out. The main power plant on the island at Maalaea is in this high-risk area for wildfire. A worst-case consequence is the potential loss of the plant and/or the associated switchyard for months or longer and the resulting power shortages during that period.

As shown in Exhibit 19, the RWG proposes a moderate scenario to include wildfires on the western slope of Oʻahu causing permanent damage to poles, conductors and other equipment. The impacts are worsened by the difficult access to many portions of these facilities.

The severe scenario is proposed to occur in Maui and affect the Maalaea power plant and switchyard, thus damaging the main supply of power to Maui Island.

Exhibit 19: Wildfire Moderate and Severe Cases

Wildfire: Depending on path of hurricane, all islands and locations can be subject to damaging wind, rain and coastal and inland flooding.		
	Moderate	Severe
Scenario Description	Massive wildfire on western slopes of Oʻahu	Severe wildfire in northeastern Maui
Scenario Threats	• Damage all northern	• Destroys Maalaea power plant

3.3.4 Physical and Cyber Security Scenarios

The RWG recommends that cyber and physical security scenarios also be considered in the IGP process. Physical attacks can result in long-term outages to key electrical equipment, especially hard to replace bulk power transformers. A worst-case condition, outlined in the two scenarios in

Exhibit 20, includes permanent loss of high voltage transformers due to high caliber rifles or explosives. It would be optimistic to replace one of these transformers in 12-18 months, as they would be built overseas and shipped in and transported through very complex procedures and equipment.

Manmade attacks on the grid are not limited to substations and transformers. Historically in the United States, most attacks occur on transmission lines, which can be more remote but still accessible in some areas. Attacks have included shooting at insulators, taking down poles or towers, or shorting out conductors by dropping objects over conductors. These impacts generally though can be readily repaired, and power restored. In some cases, no customers lose power if a transmission line is damaged.

Although the impacts of physical attacks on the grid can be more obvious and longer lasting, cyberattacks are also considered by the RWG to be a significant threat condition. A cyberattack is much less likely to result in permanent damage to grid equipment and therefore allow recovery in a reasonable time. In December 2016, a Russian cyberattack on the Ukraine power grid resulted in loss of power across most of the country. However, Ukraine operators we able to gain manual control of the grid and restore customers within hours. The effect of a cyberattack in scenarios recommended above is to delay restoration and recovery by disrupting situation awareness and damage assessment and requiring manual operations where control computers are removed from service.

In the cases below, one substation is attacked in the moderate case and two of the most critical substations are attacked in the severe case. Half of the high voltage transformers at these affected substation(s) are destroyed in each case (if there are two transformers, one is destroyed; if four, then two are destroyed.)

Exhibit 20: Physical/Cyber Security Moderate and Severe Cases

Physical/Cyber Attack: The relative risk for a physical or cyber attack is fairly constant across all islands.		
	Moderate	Severe
Scenario Description	Moderate physical attack	Severe physical attack
Scenario Threats	• Most critical substation repaired in two to six weeks	• Two most critical substations sustain communications for 24 hours

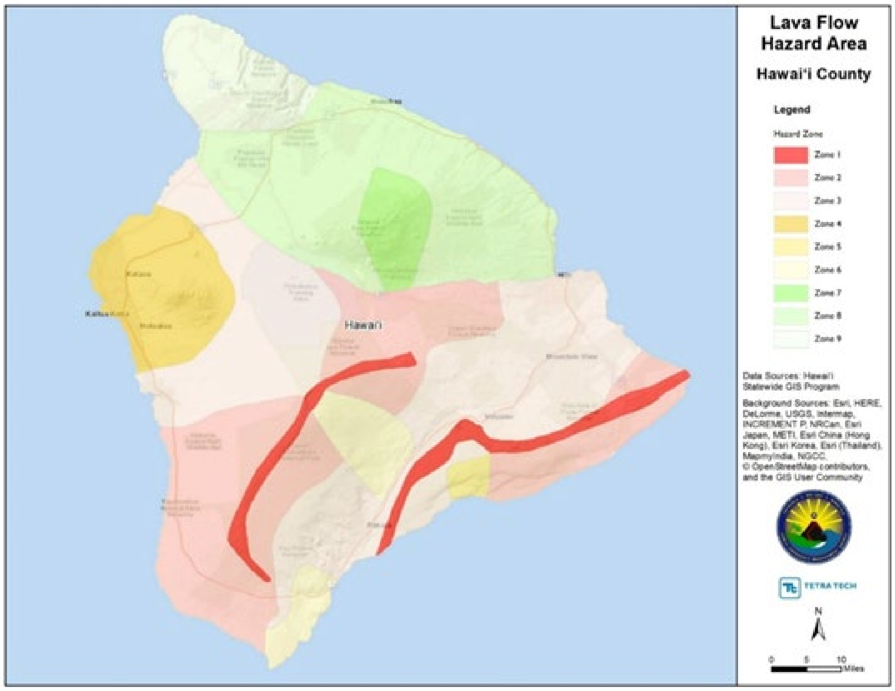
Source: RWG

There was a suggestion that cyber and physical security would not be an issue of concern on Hawai‘i Island. However, the majority of the RWG preferred to recommend the physical and cyber security cases in all three counties.

3.3.5 Volcano Scenarios

The final threat scenario recommended by the RWG is a massive volcano eruption on Hawai‘i Island affecting power generators and limiting access to the area to rebuild for months or possibly years. Historically, the Puna Geothermal Venture has supplied as much as 27% of power to the island. The site is currently inoperable due to the impacts of the 2018 Kilauea lava event affecting operations. Although volcanic activity seems unlikely to affect other electrical infrastructure on the island, the RWG recommends volcanoes remain a grid resilience threat case to be considered. The Kilauea volcano began erupting in 1983 and continued off and on over several decades. Although not currently erupting at the time of this report, Kilauea remains seismically active and can present additional risks in the future. Mauna Loa also remains potentially active.

Exhibit 21: Volcano Impact Areas, Hawai‘i



Source: State of Hawai‘i 2018 Emergency Management Plan

Exhibit 22: Volcano Severe Case

Volcano: Hawai‘i island has the highest risk of a volcano event. Moderate events would not be expected to have a significant impact to the grid and electric supply.	
Scenario Description	Severe eruption on Kilauea
Scenario Threats	• Experiences massive eruption including record lava flows and toxic gases through the south and central portions of the island • Severe activity continues for one month • Transmission outages include north-south corridor in east and east-west corridor splitting the loop • Worker access limited for indefinite period due to conditions • All geothermal and other resources in the area remain out of service indefinitely

3.4 Future Impacts of Climate Change on Infrastructure – Reference to Jupiter Intelligence Report

The Utilities are working with Jupiter Intelligence to assess future climate trends affecting the islands of Hawai‘i.

Hazards in Hawai‘i that lead to flood peril include: (1) riverine and pluvial (direct rain-on-ground) flooding due to heavy rainfall; the flooding is expected to be affected by rising sea levels especially in coastal plains. An emerging view is that rainfall intensity will increase on the wet, windward zones of the islands, and a slight decrease in rainfall event frequency on the dry, leeward zones of the islands during the winter; (2) coastal flooding resulting from tropical cyclone and synoptic winter-storm events, which will be affected by rising sea levels and lead to increased impacts. A scientific consensus about intensification of storms that cause coastal flooding has not yet been established; (3) coastal flooding resulting from high tides, which is sometimes called a King Tide or sunny day flood. The frequency of these events will increase with rising sea levels. Though currently the sea level rise around Hawaii is modest, the rate of sea level rise is expected to increase later this century.

Three primary wind systems affect the Hawaiian Islands. The Trade Winds define nearly 70% of the low-level wind type and variability throughout the year. While Trade Wind strength, which is defined as the wind speed, varies throughout the year, the winds are marked by a persistent direction from the northeast. The most notable exception to the dominant Trade-Wind regime is the occurrence of Kona Lows, which result in a shift in wind direction from the northeast to the south or southwest. Tropical cyclones impact the islands less frequently as they typically pass to the south of the islands, which can result in strong winds from the east.

An analysis of climate projections indicate that even though projected changes to key atmospheric circulations over the eastern North Pacific may occur, they do not translate into significant changes in the Trade Wind systems that affect Hawai‘i. A poleward shift in the primary midlatitude storm track over the eastern North Pacific is a quite robust result from many climate studies. There is some indication that this shift may result in fewer Kona Low type events, but the confidence is low. Furthermore, most extreme wind events over Hawai‘i occur due to Kona Lows and winter storms so a more important factor may be projected changes in the character of the future wind distributions rather than the frequency of events. Finally, tropical cyclones rarely impact the islands directly, but when they have occurred impacts have been severe. There is a low-confidence projection that the large-scale environment of the central North Pacific may become more favorable for tropical cyclone occurrence, which could impact the frequency of hurricane events in the region of the islands.

4. Capabilities of Key Customers and Infrastructures

The second stage of understanding resilience needs related to the power grid is assessing the capabilities of key customers and infrastructure sectors to withstand severe events. These events include extended power outages while continuing to provide essential services under emergency conditions and, in some cases, assisting in restoring power. The RWG determined the most critical capability for most key customers and infrastructure sectors was having backup power capabilities and the ability to acquire fuel resupply if outages are extended beyond a few days into weeks.

4.1 Prioritizing Customers and Infrastructure Sectors

The RWG worked in breakout exercises by sector to develop inputs on customer priorities, needs and capabilities. They identified and prioritized key customers, their roles in recovery and emergency operations, gaps in capabilities and potential solutions to mitigate risks. It is important that critical infrastructure owners and operators work together in a close partnership to plan and coordinate disaster recovery. Recovery and risk mitigation are shared responsibilities between the power companies and key customers.

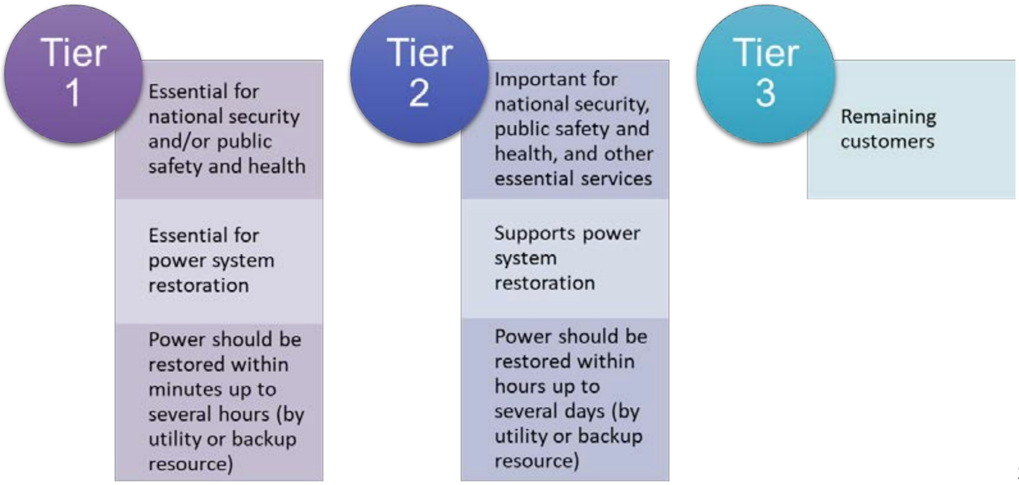
The RWG identified the following objectives for key customers/sectors during a severe emergency:

- Maintain critical functions and services
- Limit fatalities and human suffering
- Limit infrastructure damage
- Limit property damage
- Limit cost and economic impacts
- Limit environmental impacts

It was clear during the severe event scenarios discussed during breakout sessions that loss of electricity in critical customer and infrastructure sectors, whether utility-supplied power or customer-owned backup power, could have severe impacts. These impacts include severe disruption to mission critical services, impacts to life and health of the public, damage to infrastructure and property, environmental impacts, and immense cost and economic implications.

The RWG developed a framework for prioritizing customers and infrastructure sectors from a perspective of importance to supporting (1) national security and/or public safety and health and 2) essential for power system recovery. Exhibit 23 presents the prioritization criteria and customer classifications.

Exhibit 23: Criteria for Identifying Customers and Sectors



[2]

Through a series of breakout discussions, the stakeholders identified which sectors should be in each tier, as shown in Exhibit 24. As a future action item, the Utilities and the RWG need to collaborate to ensure that their priority list is consistent with the Utilities' and emergency managements' restoration plans. Specifically, it was also noted by one member during final review of the report that the energy sector should have been considered. The RWG report does capture important aspects the non-electricity energy sector by

[2] Comment received regarding need to include energy as a separate segment in future RWG work and reports for consistency with state, federal and local emergency planning programs:

Criteria used by the RWG to identify critical customers/sectors should be open for further cross validation with additional subject matter experts and sources. This cross validation would strengthen and more comprehensively and holistically consider all critical facilities'/sectors' energy capabilities and needs following a severe event and extended loss of power. The RWG did not have adequate time, situational awareness of means and data/information to identify critical power (and lifeline) interdependencies and dependencies. It was pointed out in meetings that details may not be known by individual RWG members, facility owners/operators, and emergency response planners.

Because the focus of RWG's work was on electric grid planning inputs, the use and designation of Tier classifications and customers for electric power purposes may vary from the tiering and prioritization of these sectors/customers under existing emergency management, homeland security, and hazard mitigation/resiliency frameworks. There should be a transparent, objective, and justifiable rationale for using any utility regulatory-based tier criteria as a basis for assessments/decisions that are directed at supporting overall resiliency objectives within emergency management's hazard evaluation/mitigation and response planning. The Utilities should consider existing and developing energy resiliency planning priorities in developing planning inputs.

RWG selected these particular eight sectors (in Tiers 1 & 2 above) during breakout discussions with a scope of providing inputs to the IGP – focused on resilience of the power grid. The RWG has not identified the whole "Energy" sector in its Tiers and priorities. Electricity is commonly a subcomponent of Energy (https://www.cisa.gov/energy-sector; https://www.fema.gov/lifelines). The work of the RWG was focused on making the grid more resilient and the interdependencies with other critical sectors. However, the RWG should have considered including other elements of the Energy sector including, for example, liquid fuels, gas, and other energy subcomponents. This is relevant to the RWG because it led to "Energy" not being specifically called out in the RWG Tiers nor identified in the "Sector Interdependencies", "Customer Sector Needs vs Capability", or in the discussion of key customers / capabilities by sector. In general, it would be preferential to align the definition of the sectors to the extent possible with the DHS/FEMA designated functions so that there is a common language being used by all.

focusing so much attention on the storage and transportation of fuel during an emergency, particularly for backup power generation. However, future work should consider adding energy as another critical sector.

Exhibit 24: RWG Recommended Customer Classifications by Tier

Tier 1	Tier 2	Tier 3
• Military • Telecommunications • Hospitals and critical healthcare • Water and wastewater • Emergency management and first responders	• Transportation • Hospitality • Banking and finance	• Remaining customers

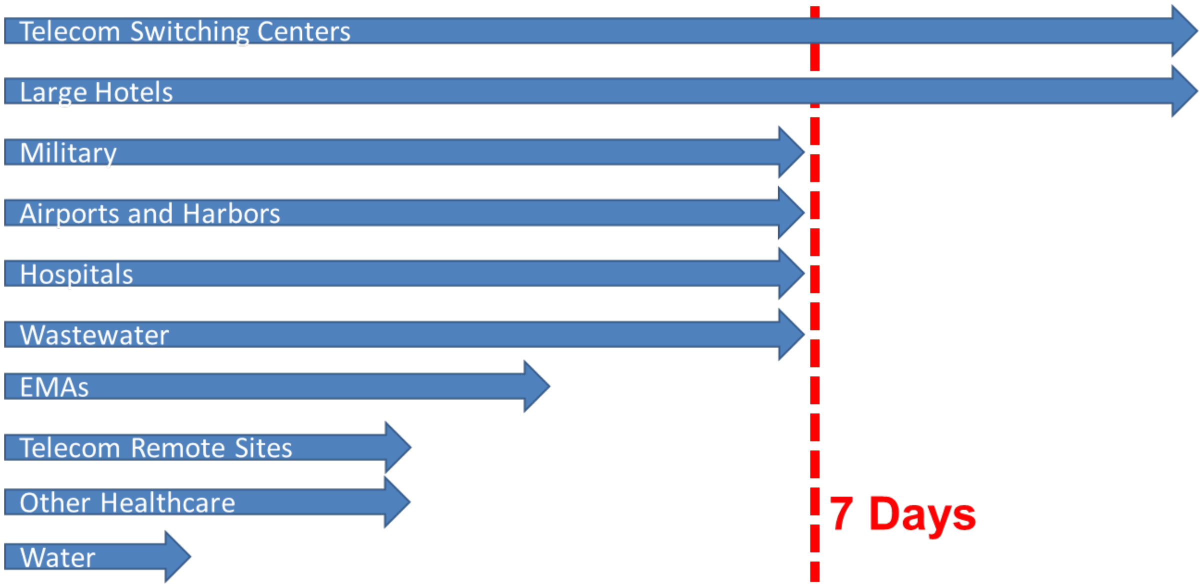
Source: RWG (Transportation included 'Energy' sector)

Tier 1 addressed not just priority but also urgency, in terms of time to restore power. These are life sustaining services. Harbors and airports can come back in a few days and would likely be closed the initial few days while situation assessment is ongoing. It should be noted that this prioritization is broad brush and that within each sector there is a wide range of capabilities and needs. For example, during a disaster there may need to be an emphasis on restoring harbors, ports, and airports to bring in urgent supplies. Not all military facilities rise to the same level of criticality to national defense.

4.2 Key Customer Capabilities and Needs

The RWG worked through a series of breakout sessions to evaluate the capabilities of key customers and sectors to operate during power outages. The first exercise in August looked at initial impacts, impacts after seven days and then impacts after four weeks without offsite power. Once again, these tests were not intended as expectations, but stress tests to find the range of capabilities in the key customer sectors. As shown in Exhibit 25 below, most sectors reported having backup power at key sites and generally a seven-day supply of fuel. Telecommunications main switching centers reported more than seven days of backup fuel supply. Many water facilities were deemed to not have backup power supply onsite (some portable facilities are available) and in many cases have a one-day fuel supply.

Exhibit 25: Summary of Backup Power and Fuel Capabilities



Source: RWG

The summaries above are not uniform across each sector but represent a broad estimate for the sector. Facilities vary in importance and remoteness, therefore there is a wide dispersion of capabilities across various sectors.

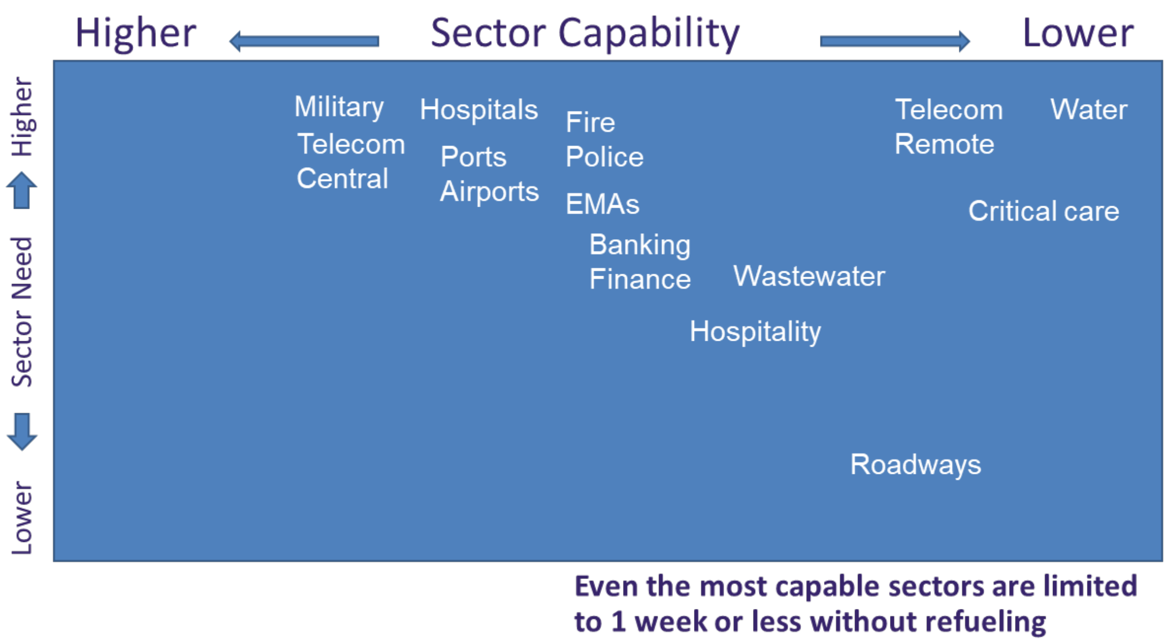
Resilience goes to issues beyond the utility grid that are not under the control of Utilities. For example, fuel supply and distribution, water availability, and communication issues were identified as significant issues across all segments.

Normal planning contingencies for power outages lasting days or a week is insufficient for major events that result in outages that could last weeks or even months in some areas. In these situations, road access to transport fuel and the shipping, ports, loading/unloading facilities and fuel storage become very critical on all islands.

Exhibit 26 below shows the relative capabilities of each sector compared to the need or importance of that sector to defense, health and welfare or system recovery. Most sectors are aligned as would be expected, most urgent need sectors have the highest capabilities to maintain backup power for longer periods when offsite power is unavailable. Three exceptions were noted where there is a high level of urgency for backup power and continuous operation, yet there are comparatively limited capabilities. These areas are:

- Telecommunications remote sites (e.g. cell towers and other distributed facilities)
- Water facilities and remote pumping stations
- Critical care facilities other than major hospitals

Exhibit 26: Customer Sector Need v. Capability to Self-Supply



Source: RWG

Once again, this graphic is a simplification showing a high-level, aggregated perspective discussed during breakout sessions. There are variations by facility within each sector. For example, not all military facilities have backup power. Generally, the mission critical facilities within each sector do have backup power capabilities.

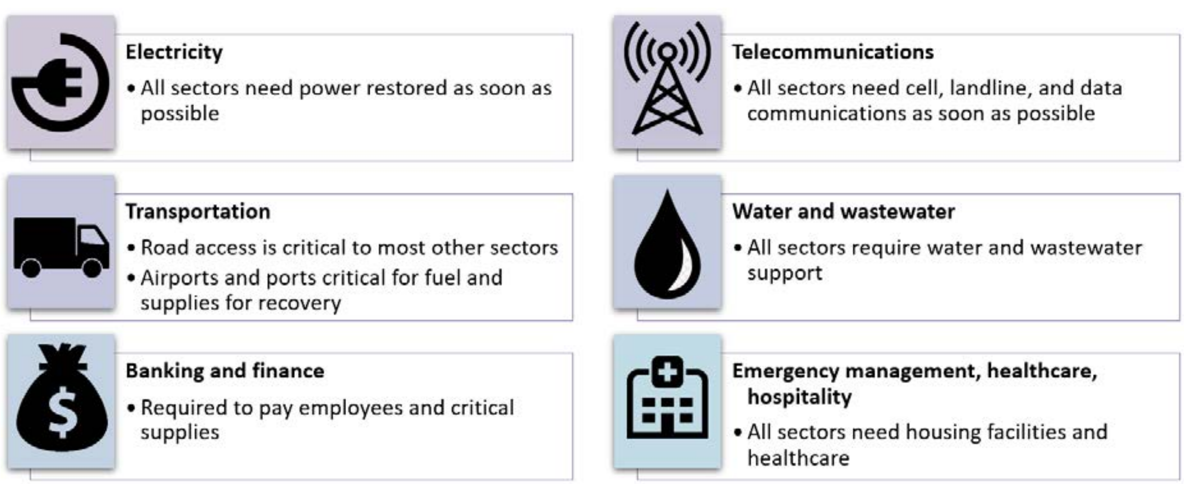
It should be noted that even the most capable sectors are shifted somewhat to the right and there is a blank area on the left of this diagram. That area could be called 'the backup fuel' gap. All sectors could be moved to the left (greater resilience capability) with longer-term backup fuel plans and resources.

A key result of the exercises that included simulation of extended power outages was that all sectors are heavily dependent on replacement fuel if there is an extended power outage on one or more of the islands. Access to fuel replenishment depends on clearing of roadways, access to and distribution of fuel storage and supplies, and in the longer term, the ability of ports and ships to bring in more bulk fuel. Worst case scenarios with extended power outages are those that also include severe disruption of the fuel supply chain resulting, for example, from damage to harbors, ports, storage tanks, loading/offloading equipment, and distribution capabilities (pipelines, tanker trucks, barges).

Key customers and infrastructure sectors, such as hospitals, first responders, emergency management, and food supplies, are not only important to the health and safety of the public during emergencies, they are also part of FEMA's Community Lifelines construct. A lifeline enables the continuous operation of critical government and business functions and is essential to human health and safety or economic security. The 7 identified Lifelines are the most fundamental services in the community that, when stabilized, enable all other aspects of society to function. The response prioritizes the rapid stabilization of Community Lifelines after a disaster. The integrated network of assets, services, and capabilities that provide lifeline services are used day-to-day to support the recurring needs of the community and enable all other aspects of society to function. When disrupted, decisive intervention (e.g., rapid re-establishment or employment of contingency response solutions) is required to stabilize the incident.

These sector interdependencies became clear as the RWG worked through several severe event scenarios and identified capabilities and needs of each sector to ensure essential services could survive during and after severe events.

Exhibit 27: Sector Interdependencies



4.3 Opportunities for Critical Customers to Improve Resilience from Loss of Power Events

It is important to realize that grid resilience is not limited to grid solutions and what the Utilities invest for resilience enhancements. The goal of resilience, as previously mentioned includes the health and safety of the public, national security, minimizing the environmental and economic impacts of disasters, and other objectives. These objectives are a shared responsibility of the critical infrastructure sectors, including electricity but not the sole responsibility of the power companies.

There are several steps key customers and sectors can take to mitigate the risks of extended power outages due to disasters:

- Infrastructure owners and operators work together in close partnerships to coordinate disaster planning and recovery. Recovery and risk mitigation are shared responsibilities between the power companies, key customers and the government
- Key customers develop and implement load management/load curtailment capabilities to limit power usage to mission critical loads during emergencies with loss of offsite utility power
- Key customers maintain ample onsite fuel supplies for generators during extended power outages and transportation disruptions and have in place plans and fuel supply arrangements resupply fuel for outages exceeding operational expectations; coordinate resupply plans so that multiple facilities, sectors, and geographic areas are not relying on the same fuel resources at the same time; provide backup power sources that can supply essential loads during prolonged outages and emergencies; test and exercise backup power resources
- Under their Continuity of Operations Planning (COOP), key customers should consider relocating essential functions to alternative facilities at sites/locations with more robust infrastructure support
- Key customers consider developing plans and arrangements for deployment of temporary emergency power generators that can be relocated to critical sites during prolonged outages
- Key customers consider partnering with Utilities and the government to develop local microgrids for power that can be isolated from the grid when needed (during severe events); consider alternative technologies, such as renewables and storage, and other blackstart resources
- Key customers in the transportation sector ensure availability of adequate road clearing equipment to speed recovery of key roads, ports and airports
- Key customers reinforce harbors and port facilities against catastrophic flooding and storm damage to ensure they can maintain maritime operations during extended power outages
- Customers maintain training and exercise programs that address performing emergency and contingency operations with loss of utility power

Key customers and critical infrastructure owners and operators should consider partnerships with the Utilities, other energy companies, and the government in developing local resilience solutions that can provide resilient power for essential service providers and enhance the overall resilience of the grid for all customers in mutually beneficial projects. Key customers and critical infrastructure owners and operators should also consider alternative technologies, such as microgrids, renewables and storage, and other blackstart resources, potentially working in partnership with the utilities. Recently, utilities began requiring in their RFPs that renewables bids have grid-forming inverters, meaning they can provide a blackstart capability which is something that renewable energy projects normally cannot do.

5. Opportunities to Improve Grid Resilience

This section examines the configuration and capabilities of the power grid on each island and how key customers and infrastructure sectors map to each grid. This allows the RWG to identify opportunities for solutions that may improve grid resilience in important ways that allow the critical sectors to provide essential services during emergencies.

5.1 Characteristics of Power Grid on Each Island

O‘ahu is characterized by a concentration of generation on the leeward side of the island in the southwest corner (Exhibit 28). Two primary transmission corridors deliver bulk power to the major load centers along the southern coast. This area is also where many of the critical customer facilities are located. It should be noted, however, that not all key customer sites are in the major load center area in the south. Some are remote and require alternative solutions between the Utilities and the customers to ensure these critical sites can perform mission critical functions during extended power outages.

The northern transmission corridor is comprised of four circuits that traverse steep and rugged terrain. This key backbone of the system can be susceptible to high wind events due to vegetation and flying debris. Being on the leeward side of the island, this corridor can also be susceptible to severe impacts from wildfire. Being remote, this corridor could also be susceptible to physical sabotage. The southern transmission corridor has two circuits, with some under underground cable sections. This corridor is easier to access during system restoration, but some portions could experience flood risks.

There are blackstart units available in the area surrounding Honolulu Harbor, providing an option to restore power from the load end of the system. Typically, during a blackstart situation, however, the priority of the Utilities would be to reenergize backbone circuits and then add load as the system was reconnected. During severe, extended events such as those contemplated in the recommended scenarios, alternative strategies may be needed to reconnect essential customers as a priority before being able to restore the backbone of the system.

Exhibit 28: O‘ahu Grid Characteristics and Key Customers

[MAP REMOVED FOR SENSITIVITY]

The configuration of the O‘ahu power system has most of the generation on the southwest side of the island, transmission lines delivering bulk power to the major load centers, and then distribution facilities delivering power the final step. One potential resilience challenge in some sections of the transmission network is that individual lines are physically close in proximity, in places sharing the same easement. Electrically the circuits are networked and can provide uninterrupted power flow during N-1 and N-1-1 events. However, impacts of some of the severe events contemplated in this report may result in multiple circuits lost in the same easement. This impact could be further exacerbated by some locations having difficult access for repairs. A summary of O‘ahu grid resilience characteristics is presented in Exhibit 29.

Exhibit 29: **Summary of O‘ahu Grid Resilience Characteristics**

Characteristics

- More linear system
- Load concentration in Honolulu
- Generation concentration in one location

Major Vulnerabilities

- Transmission disruption
  - ➢ Towers and poles damaged
  - ➢ Difficult access in some areas
  - ➢ Limited spares
- Generation flooding
- Fuel disruption

Resilience and flexibility could be enhanced on O‘ahu for the severe events presented by considering some alternative strategies:

- Expanding blackstart capabilities at or near substations serving key customers and infrastructure facilities.
- Expanding generation at an alternative site such as Schofield Barracks and reinforcing circuits from there into the load centers, rather than relying on in-city blackstart or restoring the transmission circuits from the west.
- Establishing one or more circuits with enhanced restoration capabilities and greater hardening to serve as primary paths for system recovery.
- Adopting advanced technologies in a more distributed resource approach, including grid-forming renewable energy sources, alternative blackstart resources, battery storage, and joint projects with key customers to provide microgrid capabilities for emergency operations and disaster recovery.
- Configuring the grid in several mini grids that could operate as independent islands that could be self-supplying over an extended period during severe or prolonged utility power outages.
- Developing alternative facilities and transportation to import replacement fuel.

- Expanding critical resources, supplies, backup equipment, and materials to more quickly restore damaged circuits, substations, generators, and distribution facilities following severe events.

The Hawaiʻi Island grid is characterized by a ring configuration (a loop around the island), which is beneficial from a resilience perspective because there can be alternative paths and resources available if one part of the system becomes damaged. Generation is located on the system in three areas on the east and northwest coasts and in the south. Puna Geothermal Ventures, a clean energy resource in the eastern portion of the island, makes up 27% of the generating capacity for the island and is currently non-operational due to the impacts of the 2018 Kilauea lava event. A depiction of the grid and key customers is presented in Exhibit 30.

Exhibit 30: Hawaiʻi Island Grid Characteristics and Key Customers

[MAP REMOVED FOR SENSITIVITY]

Load centers and key customers in Hawaiʻi are much less concentrated than on Oʻahu and are also distributed around the island similar to the generation resources, mostly around Hilo and the west and northwest coastal areas. This configuration has some advantages from a resilience perspective that generation is already more distributed and closer to the loads than on Oʻahu. Grid facilities also are generally outside inundation zones, on Hawaiʻi Island, which is an important feature.

Exhibit 31: Summary of Hawai‘i Island Resilience Characteristics

Characteristics

- Ring system with cross ties
- Load center and key loads
  - Hilo
  - Kona
- Generation distributed around ring

Major Vulnerabilities

- Vegetation impacting power lines and access
- Fuel disruption
- Earthquakes
- Volcanic activity
- Spares, supplies and road access

Resilience and flexibility could be enhanced on Hawai‘i Island for the severe events presented by considering some alternative strategies:

- Expanding blackstart capabilities at or near substations serving key customers and infrastructure facilities in the Hilo area and along the west and northwest coast.
- Adopting advanced technologies in a more distributed resource approach, including grid-forming renewable energy sources, battery storage, and joint projects with key customers to provide microgrid capabilities for emergency operations and disaster recovery.
- Configuring the grid into two or three mini grids that could be self-supplying during severe emergencies over extended periods.
- Developing alternative facilities and transportation to import and distribute replacement fuel, as disruption to the port at Hilo could result in major delays in energy system recovery.
- Expanding critical resources, supplies, backup equipment, and materials to restore damaged circuits, substations or generators, including distribution more quickly following severe events.

Exhibit 32: Maui Grid Characteristics and Key Customers

[MAP REMOVED FOR SENSITIVITY]

Maui has resilience characteristics similar to O‘ahu (Exhibit 33). First, the generation is concentrated in one area, mainly Maalaea power plant near the southern saddle coast. Several load centers are served from that point, the city of Kahului to the north and the residential and tourist loads along the western and southern shore areas. Once again, though much fewer in number, the key customer sites are somewhat concentrated in the load centers but also many are remote.

The south-central area near Maalaea has increasingly become a severe wildfire danger area. With the main plant for the island there, severe wildfire damage to the plant, switchyard or transmission could lead to extended outages across the island with limited options to provide alternative sources. In addition to the wildfire risk at Maalaea, generation facilities and the control room located in an inundation area and present a major resilience risk.

Exhibit 33: Summary of Maui Resilience Characteristics

Characteristics

- Load center at Kahului
- Resort and residential load along west coast
- Generation at Maalaea

Major Vulnerabilities

- Fuel disruption
- One major generating plant
- Wildfire hazards
- Coastal flooding
- Spares, supplies and road access

Resilience and flexibility could be enhanced on Maui for the severe events presented by considering some alternative strategies:

- Expanding blackstart capabilities at or near substations serving key customers and infrastructure facilities in the Kahului area and along the west coast.
- Adopting advanced technologies in a more distributed resource approach, including grid-forming renewable energy sources, battery storage, and joint projects with key customers to provide microgrid capabilities for emergency operations and disaster recovery.
- Configuring the grid into two or three mini grids that could be self-supplying during severe emergencies.
- Developing alternative facilities and transportation to import and distribute replacement fuel, as disruption to the port at Kahului could result in major delays in energy system recovery.
- Expanding critical resources, supplies, backup equipment, and materials to restore damaged circuits, substations or generators, including distribution more quickly following severe events.
- Consider extraordinary wildfire mitigation strategies to minimize risk of damage at Maalaea.

Exhibit 34: Molokaʻi Grid Characteristics and Key Customers

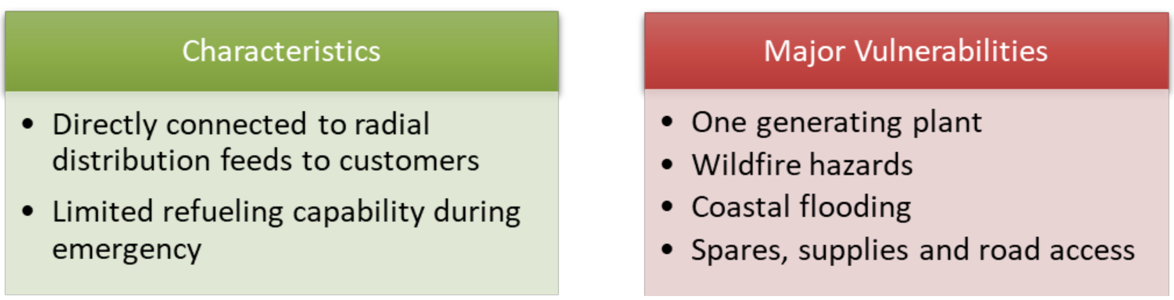
[MAP REMOVED FOR SENSITIVITY]

Exhibit 35: Lānaʻi Grid Characteristics and Key Customers

[MAP REMOVED FOR SENSITIVITY]

Exhibit 34 and Exhibit 35 show grid characteristics and key customers in Molokaʻi and Lānaʻi. Both have similar characteristics regarding resilience. They have much less development and load and fewer key customer sites. The system is predominantly radial supplied by a central generator site, and there is a single site for bringing in fuel and supplies. Therefore, each system has limited flexibility in the event of severe grid damage from one of the scenarios contemplated in this resilience assessment. Resilience characteristics of the islands are summarized in Exhibit 36.

Exhibit 36: Summary of Molokaʻi and Lānaʻi Resilience Characteristics



Please Add: "Fuel Disruption" (Resupply and Distribution) to and within Maui County (Lanai & Molokai) is and has been a major vulnerability for years.

Resilience and flexibility could be enhanced on Molokaʻi and Lānaʻi for the severe events presented by considering some alternative strategies:

- Expanding blackstart capabilities at alternative locations.
- Adopting advanced technologies in a more distributed resource approach, including grid-forming renewable energy sources, battery storage, and joint projects with key customers to provide microgrid capabilities for emergency operations and disaster recovery.

- Developing alternative facilities and transportation to import and distribute replacement fuel, as disruption to ports could result in major delays in energy system recovery.
- Expanding critical resources, supplies, backup equipment, and materials to restore damaged circuits, substations or generators, including distribution more quickly following severe events.

5.2 Additional Options for Improving Grid Resilience

There are numerous options for enhancing grid resilience to the threats identified in this report. The priority is to close gaps identified in the ability to withstand severe events or recover from them in a timely manner. This objective applies to grid facilities as well as key customer capabilities.

An integrated plan should consider options across generation resources, transmission and distribution. The previous summary of options for each island provides good examples of how a combination of resource, transmission and distribution options may provide more flexible and effective risk mitigation while also providing better investment value, as will be discussed in the next section.

It is also worth noting that some grid resilience solutions may not be about the grid at all or may not be developed through an IGP process. An example is enhancement of the resilience or redundancy of fuel supply and distribution facilities and airports to ensure fuel and critical supplies can be delivered to end users. From an operational perspective, fuel supply is a very significant concern as barge schedules become disrupted with hurricanes/surf/wind conditions, and any significant damage to pipelines, barges, or ground transportation will impact all Community Lifelines. This, when coupled with the shutdown of certain renewable resources during stormy conditions (wind, solar), will strain energy system recovery even more. It doesn’t take many missed barges to get into a fuel shortage situation and this has happened in the past. One solution is to define a minimum fuel supply based on missing barges and a changed fuel mix during emergency conditions.

Other resilience options for the Utilities to consider outside of the grid planning process include:

- Utilities continue to explore and develop advanced resilience data as demonstrated by the technologies of Jupiter Intelligence
- Utilities partner with key customers and the government to develop microgrids for power that can be isolated from the grid when needed (severe events)
- Utilities reinforce fuel resupply options by increasing distributed storage and delivery capability for severe event emergencies
- Utilities plan for additional crews during emergencies and provide more robust and regular training for emergency situations
- Utilities expand critical resources, supplies, backup equipment, and materials to restore damaged circuits, substations or generators, including distribution more quickly following severe events
- Utilities plan for emergency access to additional helicopters on the islands to support repairs in remote, difficult to access sites
- Utilities plan for enhanced vegetation management, particularly in critical grid areas susceptible to damage from wind and falling or flying debris

- Utilities continue hardening or reinforcing critical transmission circuits, including upgrading wind criteria and flood mitigation, upgrading structures, and using enhanced construction methods and materials
- Utilities continue efforts at enhancing physical and cyber security of assets, resources, and systems.
- Utilities continue planning for expanding underground cables (water resistant) and locating equipment outside flood prone areas
- Utilities consider alternative paths for transmission circuits to increase diversity of location and enhance performance during severe events
- Utilities establish one or more priority circuits with enhanced restoration capabilities and greater hardening
- Utilities continue to require that new RFPs for renewables bids include grid-forming inverters, meaning they can provide a blackstart capability
- Utilities consider adopting advanced technologies in a more distributed resource approach, including grid-forming renewable energy sources, battery storage, and joint projects with key customers to provide microgrid capabilities for emergency and backup operations
- Utilities develop wildfire mitigation strategies for worst case wildfire event at Maalaea
- Utilities develop and test capabilities of expanded use of drones for emergency response and regular maintenance inspections
- Utilities evaluate options for distribution automation, digital meters and associated communications networks which can be valuable in assessing system conditions, the extent of outages, and how to best prioritize recovery efforts to get key customers reenergized more quickly

Utilities consider actions to reduce tsunami risk impacting generation in inundation zones on O‘ahu

The RWG also considers these solution options to be available over the full period of the Integrated Plan – not everything has to be done at once. Many of the enhancements such as hardening select facilities can be done over time through regular maintenance or scheduled replacement. Thus, the existing system would be continuously improved and expanded, rather than replaced.

One option identified by the RWG was the increased use of underground cabling. Certainly, underground cable addresses the risk of many of the threats identified by the RWG. It is, however, much more expensive than overhead circuits and the IGP process should examine these tradeoffs. There has been use on O‘ahu of special water-resistant cables that can better address the flooding risk along the southern transmission corridor. One option could be to expand this program to upgrade and expand cables with water resistant technologies.

Drones and access to additional helicopters may need to be planned to address the severe scenarios considered in this report. Drones have gained rapid acceptance across the United States in providing damage assessments and condition inspections, helping to prioritize restoration and rebuilding facilities.

Distribution automation, digital meters and associated communications networks can be valuable in assessing system conditions, the extent of outages and how to best prioritize recovery efforts to get customers reenergized more quickly.

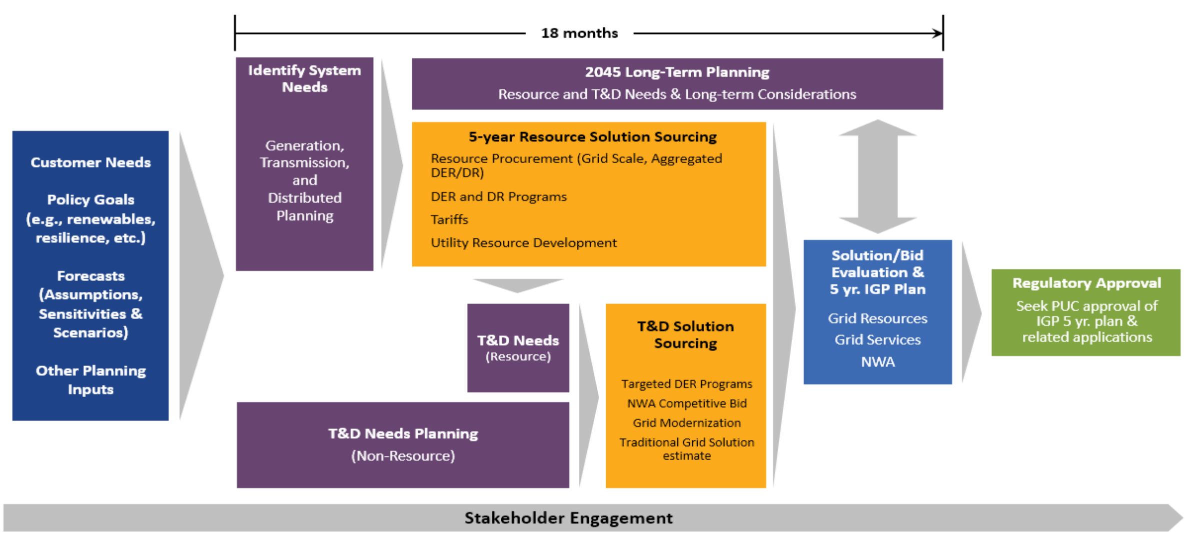
A robust vegetation management program should be considered as a top strategy for resilience risk management. Finally, fuel supply assurance under a range of severe conditions will have resilience benefits for the Utilities as well as key customers and infrastructure sectors.

6. Inputs to Integrated Grid Plan and Other Related Activities

6.1 Resilience Related Objectives

Building on the work performed and alignment on resilience priorities, a key outcome of the RWG is to provide recommendations and inputs for the IGP process to address resilience needs. The intent of the RWG is to provide guidance to the IGP process and related activities rather than to be prescriptive regarding inputs to a very technical process. There are several areas of development of an IGP that must consider resilience inputs, including defining resilience objectives and how resilience will be measured, defining alternative resilience strategies, consideration of a number of low probability, high impact scenarios, and measuring relevant costs of alternative strategies and various levels of resiliency. As shown in Exhibit 37, the RWG process to date aims to provide some perspectives on how resilience might influence inputs into the analysis.

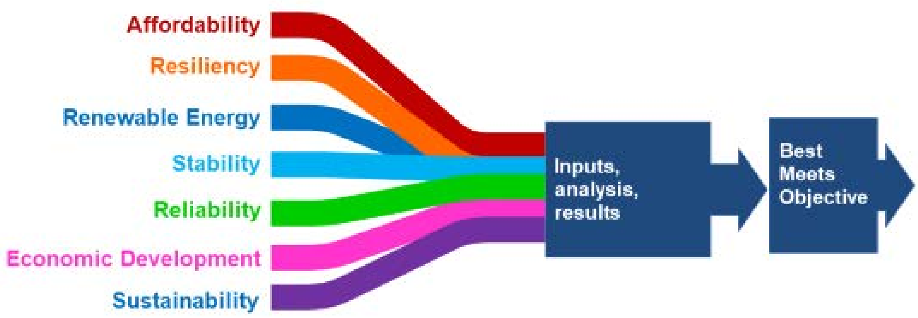
Exhibit 37: Overview of the IGP Process



Source: HECO

One of the first steps in any planning process is to define objectives and assign one or more metrics to each objective. Most stakeholders have multiple objectives. For example, some customers are interested in receiving power at the lowest possible cost. Other customers would pay more for reliability. Other customers might target resilience as a critical objective. Still others may value sustainability. Objectives are largely driven by customer needs. Since customers have different needs, the Utilities should evaluate multiple objectives and determine a portfolio of options that best meets all objectives at a reasonable cost. Exhibit 38 presents common utility objectives in a planning process.

Exhibit 38: Common System Objectives in Utility Planning



Source: HECO

Once selected, the Utilities can track how well each portfolio performs across all events or scenarios. A portfolio of options that performs well across all scenarios and all objectives/metrics is considered a the "viable" portfolio.

Siemens provided the RWG a high-level perspective to utility planning that suggested that utilities begin with a list of objectives that customers are looking for from a plan. The list includes things such as least cost, reliable, resilient, sustainable and flexible. Each objective typically should have a metric that can be measured so that the Utilities can assess tradeoffs between each objective.

- The least cost objective typically uses the NPV of costs over a planning horizon as a metric
- Reliability is often measured by a loss of load probability
- Sustainability is often measured in terms of renewable percentage of the portfolio or carbon tons.

Resilience is relatively new as an objective in planning. The RWG didn't propose a specific metric, but the group did express the view that costs should not be the only measure of resilience to consider. Hence Siemens facilitated a discussion of possibilities that the Utilities might consider as a resilience metric.

The RWG reached general agreement that all relevant costs need to be captured, which includes the costs that utilities might incur to mitigate severe outages, as well as the cost of the outage to customers and stakeholders. It might also include costs that customers incur to mitigate the impact of severe outages, especially if those measures might be more cost effective than those incurred by the utility.

The Least Cost Objective:

Nearly every planning effort looks to achieve a portfolio that is cost effective over a planning horizon as one objective. However, traditional planning by utilities tends to focus on actions under the control of the utility. The RWG recommends that the Utilities consider all possible lowest cost solutions, whether they can best be accomplished solely through utility actions or through a combination of utility, other energy sector market participants, and stakeholder actions. Hence RWG recommends that some consideration of market participant and stakeholder actions be captured in the analysis of options.

In addition, when the RWG recommends that several low-probability, high impact events are considered in the analysis phase, it becomes critical to consider the outage costs as an offset to the costs associated with building resilience into the grid. In other words, the incremental costs of actions to manage resilience may be cost justified relative to the cost to society if the outages occur without mitigation. For planning purposes, one needs to sum the costs applied in the grid to the cost of the outages (times the probability of the outage) to achieve the expected value of the net present value of costs over the planning horizon as the appropriate cost metric.

The Resilience Objective:

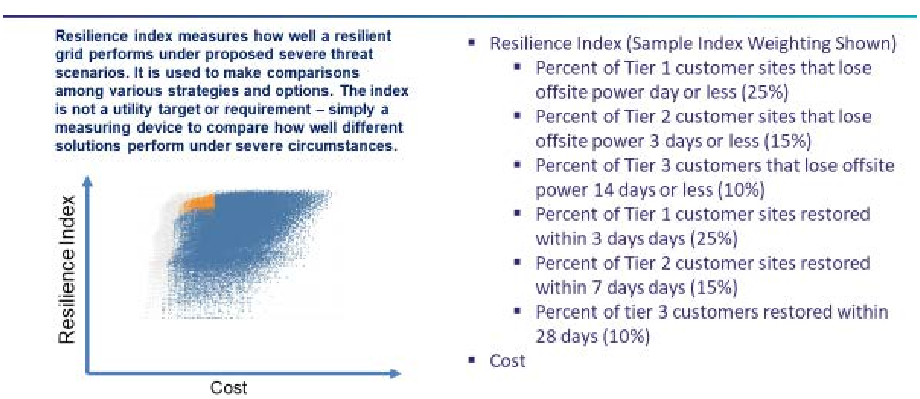
The second IGP recommendation of the RWG is that resilience should not only be measured as a cost but should be a separate goal with its own measurable outcomes. This step requires the definition of resilience goals and quantification of the degree of resilience achieved in a single or combination of metrics.

There is little experience to draw from in the construction of a resilience metric. Siemens provided an illustration of the concept. The example in Exhibit 39 shows an illustration of a resilience index that measures resilience performance across the three different customer tiers (Tier 1- Critical, Tier 2 – Priority and Tier 3 All). The index has two components. The first is the percentage of customers that do not lose power or lose power only for a relatively short time (times are specified by tier).

The concept is that enhanced resilience should result in critical customers having no interruption or interruptions for a shorter time. The second component of the resilience index is how long it takes to restore customers who do have extended outages caused by a severe event impacting the grid. Resilience enhancements would be expected to shorten recovery times.

If an index is constructed, it could allow for comparisons that allow one to determine the cost of higher levels of resilience, just as one can compare the cost of incremental levels of carbon reduction. The percentage numbers in parentheses indicate the relative weight of each component of the resilience metric (totaling 100%).

Exhibit 39: Example Resilience Metric



Source: Siemens

Policies, Assumptions and Other Inputs:

Policy goals are different than metrics. Policy goals for planning purposes can be considered in analysis as requirements to be met or constraints in modeling and analysis. So rather than simply tracking how quickly customers are returned to service after an event, the Utilities could establish goals that must be achieved through options. For example, the Utilities could specify that all critical customers should not have an outage of more than one day. This would require the Utilities and stakeholders to define a target for one or more of the most extreme events regardless of cost in order to assess the relative cost of resiliency.

Again, the RWG does not intend to define a policy goal, but some members of the RWG suggested that the Utilities should consider defining a realistic goal or goals during or at the end of the process, once the resilience benefits and costs are better understood from the planning analysis. The Utilities could then evaluate different policy goals and analyze the cost of each.

Key Inputs to the Analysis:

Data and inputs specific to assessing resilience will be needed to measure the relative costs and resilience characteristics of proposed portfolios and solutions in the IGP process. A forward view on the likelihood or relative risk of severe events specific to individual systems is needed and is likely to vary by island.

To properly determine the risks associated with different events such as hurricanes, tsunamis or volcanos one must have forecasts of both the frequency and the severity of future weather-related events. The Utilities already retained an organization that can provide forecasts of sea level rise, the probabilities of wind and flood damage and the severity of those events. These are critical to evaluating the need for mitigation measures and are critical for assessing the expected costs of outages with and without mitigation options.

Other inputs might include:

- Current restoration times for events by customer tier and location
- Costs to restore service under events (without mitigation options) by location
- Determining the cost of an outage to customers by class (e.g. the cost of load not served), and the state as a whole, will be another important input to the IGP process
- Current levels of backup power, fuel and water held by customer tier and location

Exhibit 40: Example Resilience Policy Goals, Forecasts and Other Inputs

Customer Needs		
Policy Goals (Renewable, Resilience, etc.)	**Forecasts** (Assumptions and forecasts)	**Other Planning Inputs**
▪ Meeting renewable and carbon goals ▪ Tier 1 backup power available to maintain until restoration occurs under all scenarios ▪ Tier 2 power returned within hours/days until restoration occurs under all scenarios	▪ Future weather patterns (impacting surge etc ▪ Impacts of hurricanes, earthquakes, tsunamis, fires etc on levels of flooding, wind damage ▪ Recovery times for locations on each island	▪ Days supply of power for each Tier 1 and 2 customers ▪ Days supply of fuel and water for each Tier 1 and 2 customer ▪ Vulnerability assessment, including downtimes for all Tiers of customers for each scenario

Forecasting extreme events and the impacts to systems and recovery times will require structured inputs that when varied consistently measure the relative resilience of the system in the IGP process. This measure will be compared to the objectives and policy goals defined upfront in the IGP process.

6.2 Potential Solutions and Strategies

A solution is really a portfolio of options to achieve a set of target objectives. The RWG does not want to specify exactly how the alternatives might be developed but there are at least several strategies that might be considered, either as part of the IGP or separately as part of the Utility Bid process, or future utility stakeholder partnerships. Exhibit 41 shows some of the types of strategies that might be considered.

Exhibit 41: Potential Resilience Solutions

Potential Solutions to Consider in Planning Analysis		
Centralized/decentralized	Centralized resources	Decentralized resources
Transmission	High transmission expansion	Low/no transmission expansion
Solar	High solar energy	Low solar
Wind	High wind including offshore	Low wind
New technologies/non-wires	Yes	No
Underground	High underground expansion	Low/no underground expansion
Black start	High black start resources	Low new black start resources
System hardening	High	None
Fuel supply hardening	High	None
Recovery/construction supplies	High increase	No change

Some examples of potential strategic options include:

1. Varying the level of decentralization. Today most of the Hawaiian islands have a highly centralized system where generation is on one part of the island and long transmission lines carry the power to load centers (Hawai'i island is the exception). At the other extreme would be a highly decentralized system where existing fossil generation is replaced by renewables and small-scale ramping technologies closer to load centers distributed throughout the islands. An in between strategy would be to focus the local generation at more remote parts of the islands. The RWG recommends that the Utilities consider two to three different levels of decentralization to determine how well each strategy performs on resilience and costs. In any event, consideration of blackstart technologies needs to be considered for each strategy.
2. Setting up different policy targets for recovery periods in the event of severe events. The RWG recommends that the Utilities consider defining alternative targets for recovery times for its customer tiers by region/location. More severe targets will cost more to comply with but may reduce outage costs. The Utilities will need to determine alternative portfolios that would meet the requirements of the policy targets.
3. Having separate strategies for the Utilities-only solutions and the Utilities-plus-stakeholder solutions. The RWG recommends that two separate strategies be considered to show whether focusing solely on the Utilities options is more expensive than one with stakeholder options.

Portfolio construction will consider a wide range of options. Different levels of renewables, storage, non-wire alternatives and grid hardening will be used in varying degrees in portfolios. By defining alternative strategies, the combinations of assets in each portfolio will be more clearly defined.

6.3 Alternative Scenarios

Each strategy will have several alternative portfolios to achieve the objectives of the strategy. Once the portfolios are developed, it is then necessary to test how well each portfolio performs against a wide range of scenarios.

In this context, the RWG understands that planning studies will always test portfolios against a range of future market and regulatory outcomes (by changing fuel market conditions or technology cost assumptions). In addition, for this study, the RWG developed a list of scenarios that should be evaluated.

Earlier in this report, up to 23 scenarios were described. These 23 scenarios consist of several different types of events, including those summarized in Exhibit 42.

Exhibit 42: Consolidated Threat Scenarios for IGP

Threat	Includes	Oahu	Hawai'i	Maui County
Hurricane	Flood, Wind	X	X	X
Tsunami	Earthquake	X	X	X
Wild Fire		X		X
Physical Attack	Cyber Attack	X	X	X
Volcano			X	

The RWG considered a wide range of events and developed a consensus that all these events should be considered. The Utilities could either evaluate these scenarios directly or simply consider the impacts of these events on the vulnerability of the grid and factor the implications of these scenarios in the IGP.

6.4 Harmonization of Resilience with Other Objectives

There are several working groups looking at other issues related to the IGP. Other working groups are looking into modeling issues, distribution issues, wire and non-wire alternatives and emerging technologies. There is a great deal of overlap between the development of the inputs to the Resilience committee and the findings from these working committees.

An integrated planning process can serve to bring the inputs from all these processes together. There is much to be studied. For example, until some of the emerging technologies (storage, hydrogen, etc.) become cost effective and proven for long duration, achieving resilience and sustainability goals may either not be achievable or only achievable at very high cost.

Ultimately the IGP will have to be continually updated as time goes on. In addition, stakeholder expectations may well change as technological advance occurs and as clarity around climate change and other issues evolve.

An IGP process will allow for the proper valuing of resources that have multiple uses such as storage and other non-wire alternatives. When viewed in individual use, some of these technologies might not be economic but when properly evaluated (using value stacking), some technologies may have greater value than traditional approaches consider.

6.5 Balanced Scorecard of Objectives

In the course of the IGP process, resilience should be considered in a fair and balanced manner along with all other objectives for the plan. Portfolios developed and analyzed can be compared on a common basis using a balanced scorecard. A balanced scorecard allows for the ranking of portfolios considering the relative importance of all objectives; objectives that often compete with one another.

An illustration of a balanced scorecard is shown in Exhibit 43. This example includes only three objectives but there could be many others. This example did not define or group portfolios under strategies, but rather just listed portfolios considered down the rows and listed some objectives across the columns. Where possible, one can calculate a value for each metric in every scenario run over the 20-year planning horizon. Then the results can be averaged across all scenarios so that each portfolio can be ranked accounting for every metric.

The RWG does not recommend one method for evaluating alternative strategies or portfolios. Rather we recommend that the Utilities in collaboration with stakeholders come up with a template for easily presenting the findings of the analysis in an understandable but thorough manner. A "viable" portfolio will be one that achieves high scores consistently across all metrics evaluated.

Exhibit 43: Sample Balanced Scorecard Including Resilience Metric

Criteria		Affordability			Resilience	Sustainability	
Portfolio		2020-2030 Cost NPV ($Mil)	2020-2040 Levelized Cost (2019 $/MWh)	Cost Rating Score	Resilience Composite Index	CO_2 Changes from (%)	Renewable Generation As % of Load (%)
Status Quo							
Portfolio 1							
Portfolio 2							
Portfolio 3							
Portfolio 4							
Portfolio 5							
Portfolio 6							
Portfolio 7							
Portfolio 8							
Portfolio 9							

6.6 Potential Actions outside of the IGP

There are a multitude of activities beyond the IGP that will benefit from the RWG. The Utilities have many activities on going including an emergency preparedness program, current bids for renewable power, and the traditional rate making processes. Education and training programs could be developed outside the IGP that could benefit stakeholders and utilities outside the IGP process. And there could be benefits on the operating side of the Utilities businesses, such as tree trimming and other programs. These actions were captured in Section 5 and are summarized in the recommendations listed at the end of the report.

6.7 How RWG Input Can Best Be Used

Ultimately, the RWG believes that its role is to guide but not prescribe inputs to the IGP process and other activities. The RWG is willing to continue to work with the Utilities after completion of this final report, in the belief that a continuing dialogue can be mutually beneficial. It is likely that the continuing dialogue will support utility stakeholder partnerships and will ensure that the Utilities understand customers' needs.

This process is new to the stakeholders and to the Utilities alike. It is unlikely that the RWG has thought of every issue that may come up as the Utilities embark on the IGP analysis phase of its work. By meeting periodically, the RWG can learn from the process and the Utilities can learn from the RWG.

7. Summary of Recommendations

7.1 Integrated Grid Planning Process Recommendations

The RWG recommends that:

- The following threat scenarios be considered by the Utilities to guide the IGP process and other resilience initiatives, and by key customers and critical infrastructure partners in developing resilience preparations:
    - Hurricane/flood/wind
    - Tsunami/earthquake
    - Wildfire
    - Physical and cyberattack
    - Volcano
- Utilities consider the key customer and infrastructure priorities identified by the RWG when planning system expansion or improvements
- Utilities develop IGP objectives that include optimizing resilience and cost of resilience; and merge resilience with other planning goals such as reliability, renewable energy expansion, sustainability, carbon emissions reduction, environmental stewardship, rate stability, etc.
- Utilities should consider the following elements of resilience:
    - Reduce probability of power outages during severe and catastrophic events
    - Reduce outage severity and duration during and following a severe or catastrophic event
    - Reduce restoration and recovery times following severe and catastrophic events
    - Optimize cost (including capital and operating costs, and probability weighted outage and recovery costs, etc.)
    - Return critical and priority customers power within specified times
    - Return power to other customers within specified times
    - Limit environmental impacts.
- Utilities consider all possible lowest cost solutions, whether they are best accomplished solely through utility actions or through a combination of utility customer and other service provider actions; hence RWG recommends that some consideration of non-utility stakeholder actions be captured in the analysis of options
- All relevant costs should be captured, which includes the costs that Utilities might incur to mitigate (and recover from) severe and catastrophic outages, as well as the cost of the outage to customers and other stakeholders; it might also include costs that customers or other service providers incur in response to and recover from the consequences of a prolonged severe outage, especially if those measures might be more cost effective than those incurred by the utility
- Utilities develop measures of resilience for Integrated Grid Planning in collaboration with stakeholders to allow evaluation of resilience performance of various options or combination of options under assumed scenarios and conditions

- Resilience should not only be measured as a cost but should be a separate goal with its own measurable outcomes. This step requires the definition of each individual resilience goal and quantification of the degree of resilience achieved in a single and/or combination of metrics .
- Utilities consider options for more decentralized or distributed energy resources closer to load areas and options for expanding customer-based programs and other non-wires solutions for improving reliability and resilience
- Utilities assess options for enhancing resilience through the mix and location of generation resources, including expanding renewable resources with grid-forming capabilities
- Utilities consider configuring portions of the grid in several mini grids that could operate as independent islands which could be self-supplying over an extended period of time during severe emergencies and outages.
- Utilities consider planning for best locations to expand and diversify blackstart resources and delivery paths to support grid restoration and timely recovery of key customers and critical infrastructure sectors
- Utilities consider targeted transmission/sub-transmission additions to enhance redundancy and diversity of delivery paths and reduce risk from severe events

7.2 Recommendations for Key Customers and Infrastructure Partners

The RWG recommends that:

- Infrastructure owners and operators work together in close partnerships to coordinate disaster planning and recovery. Recovery and risk mitigation are shared responsibilities between the power companies, key customers and the government
- Key customers develop and implement load management/load curtailment capabilities to limit power usage to mission critical loads during emergencies with loss of offsite utility power
- Key customers maintain ample onsite fuel supplies for generators during extended power outages and transportation disruptions and have in place plans and fuel supply arrangements resupply fuel for outages exceeding operational expectations; coordinate resupply plans so that multiple facilities, sectors, and geographic areas are not relying on the same fuel resources at the same time; provide backup power sources that can supply essential loads during prolonged outages and emergencies; test and exercise backup power resources
- Under their Continuity of Operations Planning (COOP), key customers should consider relocating essential functions to alternative facilities at sites/locations with more robust infrastructure support
- Key customers consider developing plans and arrangements for deployment of temporary emergency power generators that can be relocated to critical sites during prolonged outages
- Key customers consider partnering with Utilities and the government to develop local microgrids for power that can be isolated from the grid when needed (during severe events); consider alternative technologies, such as renewables and storage, and other blackstart resources
- Key customers in the transportation sector ensure availability of adequate road clearing equipment to speed recovery of key roads, ports and airports

- Key customers reinforce harbors and port facilities against catastrophic flooding and storm damage to ensure they can maintain maritime operations during extended power outages
- Customers maintain training and exercise programs that address performing emergency and contingency operations with loss of utility power

7.3 Recommendations for Utilities Outside the Integrated Grid Planning Process

The RWG recommends that:

- Utilities continue to explore and develop advanced resilience data as demonstrated by the technologies of Jupiter Intelligence
- Utilities partner with key customers and the government to develop microgrids for power that can be isolated from the grid when needed (severe events)
- Utilities reinforce fuel resupply options by increasing distributed storage and delivery capability for severe event emergencies
- Utilities plan for additional crews during emergencies and provide more robust and regular training for emergency situations
- Utilities expand critical resources, supplies, backup equipment, and materials to restore damaged circuits, substations or generators, including distribution more quickly following severe events
- Utilities plan for emergency access to additional helicopters on the islands to support repairs in remote, difficult to access sites
- Utilities plan for enhanced vegetation management, particularly in critical grid areas susceptible to damage from wind and falling or flying debris
- Utilities continue hardening or reinforcing critical transmission circuits, including upgrading wind criteria and flood mitigation, upgrading structures, and using enhanced construction methods and materials
- Utilities continue efforts at enhancing physical and cyber security of assets, resources, and systems.
- Utilities continue planning for expanding underground cables (water resistant) and locating equipment outside flood prone areas
- Utilities consider alternative paths for transmission circuits to increase diversity of location and enhance performance during severe events
- Utilities establish one or more priority circuits with enhanced restoration capabilities and greater hardening
- Utilities continue to require that new RFPs for renewables bids include grid-forming inverters, meaning they can provide a blackstart capability
- Utilities consider adopting advanced technologies in a more distributed resource approach, including grid-forming renewable energy sources, battery storage, and joint projects with key customers to provide microgrid capabilities for emergency and backup operations
- Utilities develop wildfire mitigation strategies for worst case wildfire event at Maalaea

- Utilities develop and test capabilities of expanded use of drones for emergency response and regular maintenance inspections
- Utilities evaluate options for distribution automation, digital meters and associated communications networks which can be valuable in assessing system conditions, the extent of outages, and how to best prioritize recovery efforts to get key customers reenergized more quickly
- Utilities consider actions to reduce tsunami risk impacting generation in inundation zones on O‘ahu

Exhibit C

Climate Adaptation Transmission and Distribution Resilience Program Application

Project Business Case

1 Executive Summary

The Commission as well as Federal, State, and County governments, and Hawai‘i’s communities, have all identified the resilience of the electric system and the ability of the utility to continue to provide reliable power during emergencies as a critical matter for attention. Climate change has only exacerbated concerns and intensified focus on the issue of a resilient power system and its ability to recover from natural disasters and other emergencies.

This Project proposes key resilience investments which have been identified by the Integrated Grid Planning (“IGP”) Resilience Working Group (“RWG”) process as well as relevant studies and evaluations, as the immediate no-regrets projects and programs that are necessary to begin the critical process of hardening the electrical system against severe events such as major storms, hurricanes, flood events, and wildfires on O‘ahu, Maui County, and Hawai‘i Island.

Given the high degree of uncertainty with predicting severe events and the intrinsic challenges to evaluating power system resilience, more data and capabilities will be needed before the totality of benefits associated with individual investments can be clearly quantified and an optimal level of resilience spending can be ascertained. However, these initial investments are proposed based on the fact that there are common-sense, well-established, foundational, no-regrets resilience enhancements that can begin now in parallel with the ongoing IGP process.

Resilience solutions encompass a range of interventions, including risk prevention and risk mitigation. Preventive solutions prevent risks from being realized, while mitigation solutions lessen the impacts of risks that are realized. The Companies’ proposed solutions are largely focused on risk prevention as a foundational and complementary part of a holistic portfolio and structured solution framework.

The Climate Adaptation T&D Resilience Program investments include Critical Transmission Line Hardening, Critical Customer Circuit Hardening, Critical Pole Hardening, Substation Flood Monitoring, Distribution Feeder Ties (Maui), Lateral Undergrounding (O‘ahu), Hazard Tree Removal, Resilience Modeling, and Wildfire Prevention & Mitigation,

Although the investments to support system reliability, resiliency and recovery are substantial, they are reasonable in terms of the Companies’ overall capital expenditures as well as the range of investments that other utilities are making to address many of these same issues. For example, assuming an approximate Capital investment of $155 million for the period 2023-2027, this would average approximately $31 million annually. This would be equivalent to a range of approximately 9-15% of the Companies’ forecasted annual Capital expenditures.

Project implementation is anticipated to span from early to mid-2023 through the end of 2027; a total of approximately 4.5-5 years (contingent upon timely Commission approval of the Application). The Companies will commence with detailed scoping and conceptual engineering activities in 2022 prior to Commission approval. Upon Commission approval, the Companies will begin detailed engineering design in 2023 with the first installations expected in 2024.

Although no one can predict with precision the expected frequency with which hurricanes or other severe events will impact Hawai‘i’s grid looking into the future, nor which areas will be affected or to what extent, the Companies have performed two different types of analyses to quantify a portion of the potential benefits of the proposed Project. While these analyses are not intended to be comprehensive depictions of the cost-benefit characteristics of the proposed resilience enhancements due to the inherent level of uncertainty, some of the major benefits of a more resilient system have been recognized to include the following:

- Critical customer facilities are less likely to be interrupted.
- If critical customer facilities are interrupted, they can be restored much more quickly.
- The total length of restoration can be dramatically reduced, resulting in far fewer customers being out of power for extended periods of time.
- The local economy returns to normal much more quickly, minimizing the loss of GDP due to businesses being without power.
- Storm restoration costs are dramatically reduced.
- Storm inventory levels can be reduced which lessens storm preparation costs that are passed on to customers.
- Daily reliability is typically improved.

In support of this Application, the Companies have developed a statistical model for the probability of hurricanes of different categories making landfall on one of the Hawaiian Islands. This statistical model is based on historical hurricanes that tracked near the Hawaiian Islands. To perform a benefit-to-cost analysis (BCA), it is necessary to compare the cost of hardening to the economic benefits of hardening. The cost of hardening has been calculated as a net-present-value (NPV) for each of the operating companies. This NPV value has been converted to an annualized cost (assuming a discount rate of 7%) so that annualized costs can be compared to expected annual benefits. Break-even values for total length of restoration (TLR) reduction are estimated that would result in GDP savings exceeding the cost of investment, while acknowledging that GDP savings due to TLR reduction is only one of many benefits of resilience enhancement. In addition, it is estimated that only a single major hurricane would be required for GDP benefits to exceed investment costs.

2 Structured Solution Framework

Resilience solutions encompass a range of interventions, including risk prevention and risk mitigation. The "bowtie method" (see Figure 1 below) can be used as a structured framework for developing a holistic portfolio of resilience solutions.[1] Preventive solutions, those that prevent the risk from being realized, are shown on the left side of the bowtie. Event risk prevention generally entails solutions to either withstand (e.g., system hardening) or avoid risk. For example, the Companies' proposed Critical Pole Hardening & Mitigation initiative aims to perform targeted hardening of poles that would be most critical to withstand failure in a severe event in order to reduce the total length of restoration.[2] Other solutions, such as implementing non-grid-connected

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[1] *See, Distribution Resilience and Reliability Planning*, January 2022, Pacific Northwest National Laboratory, available at https://gridarchitecture.pnnl.gov/media/advanced/Resillience_Solution_Analysis_paper.pdf.
[2] *See,* Section 3.3.

microgrids in remote areas or undergrounding conductor are examples of preventive solutions geared toward risk avoidance.

Mitigation solutions can either reduce the impact of a failure event or facilitate recovery after the failure to reduce the consequences of an event. Mitigation solutions are shown on the right side of the bowtie. These can entail a combination of utility, third-party, and customer actions.

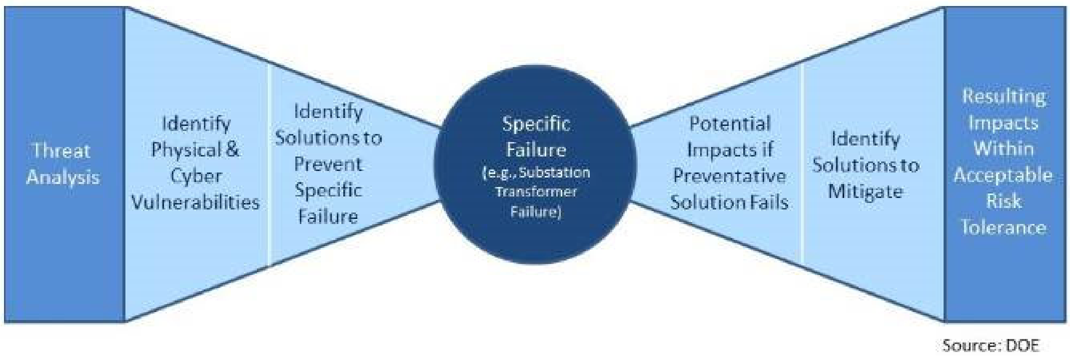

Figure 1: "Bowtie Method" – Risk – Threat Assessment

A holistic approach to resilience improvement will require a combination of both preventive and mitigation solutions to create an effective resilience enhancement portoflio. While preventive solutions are necessary to reduce damage, outages, and total length of restoration following severe events, some failures are inevitable in a severe event. Therefore, mitigation solutions are also important to reduce the consequences of damage and outages that do occur. For example, installing flood monitors improves situational awareness by alerting System Operators to substation flooding, allowing them to remotely de-energize the substation to reduce equipment damage. Likewise, incorporating switches with automation (e.g., SCADA and ADMS) for segmentation of the transmission and distribution system can reduce the outage exposure for a set of customers. These mitigation solutions may also reduce outage durations as well as facilitate post-event restoration.

Resilience solutions encompass a range of scope and societal reach, from point solutions benefiting individual customers, to large-scale solutions providing benefits for all customers. The DOE's Puerto Rico report,[3] for example, recommends a portfolio approach that incorporates preventive and mitigation solutions to achieve the level of resilience required. As such, preventive solutions and mitigation solutions are complementary and synergistic means of resilience enhancement. As part of the foundational investments in its proposed portfolio for Puerto Rico, the DOE recommended hardening the transmission and distribution system. This approach was subsequently approved by the Puerto Rico regulator, and is a primary focus for Federal Emergency Management Agency's ("FEMA") investment. The Companies' proposal is aligned with this portfolio approach, illustrated in the DOE[4] figure below.

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[3] *See,* United States Department of Energy's June 2018 report: *Energy Resilience Solutions for the Puerto Rico Grid.* https://www.energy.gov/sites/prod/files/2018/06/f53/DOE%20Report_Energy%20Resilience%20Solutions%20for%20the%20PR%20Grid%20Final%20June%202018.pdf

[4] DOE GMLC presentation, Energy Supply Task Force of the National Conference of State Legislatures, October 7, 2020

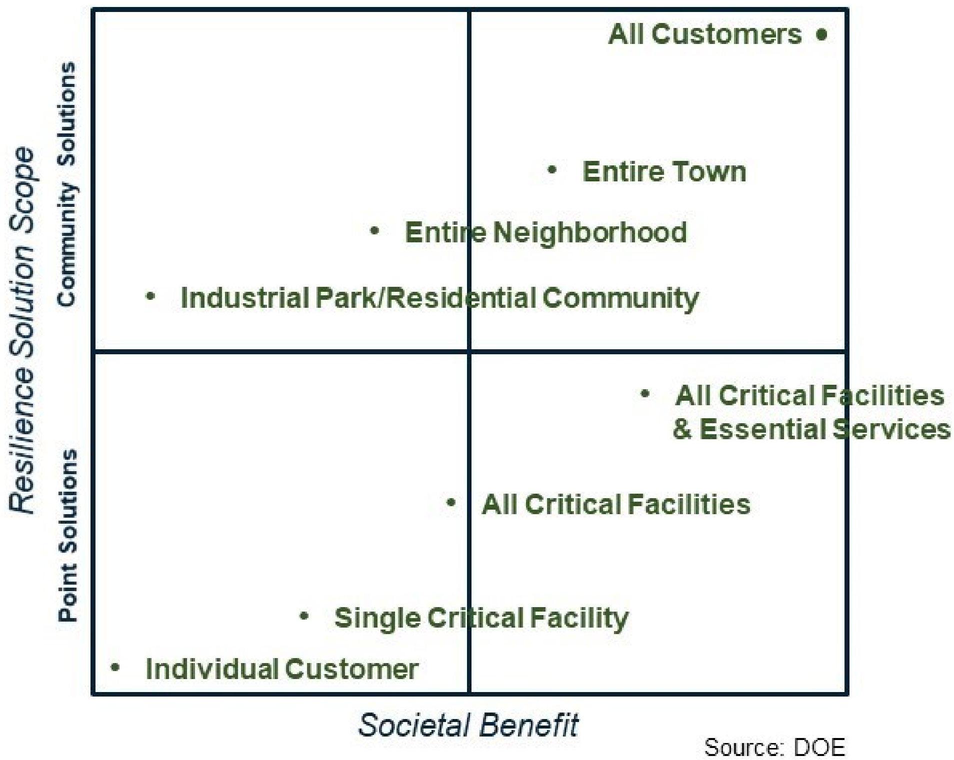

Figure 2: Resilience Solution Scope and Societal Benefit

Transmission hardening is an example of a resilience solution that would be placed near the top right corner of the above diagram, since hardening the transmission system has system-wide benefits to virtually *all* customers. It is also important to recognize that a robust transmission system is necessary to maximize the resilience value of grid scale renewables and storage, since the transmission system is necessary to transmit the energy generated from these resources to loads. Hardening the transmission system increases the probability that renewable generation resources will support recovery following a severe event.

Grid-connected customer and community microgrids,[5] along with customer back-up generation/battery solutions are considered mitigation solutions in the event the larger grid fails. Microgrids are localized energy grids that can island if the main grid fails in an event and continue to operate on their own. In 2018, the Hawaiʻi Legislature passed Act 200 directing the development of microgrids to increase resilience and reliability by providing services to the electric grid including energy storage, demand response, and other ancillary services. As of May 27, 2021, a microgrid services tariff is available. This tariff allows for customer microgrids where a customer's infrastructure is used to supply all their own electricity needs during emergencies as well as hybrid multi-customer microgrids in which an operator may combine utility infrastructure and customer distributed resources to supply electricity to microgrid members during an emergency. These microgrid distributed resources provide services to the grid under normal

[5] Community microgrids include multi-customer microgrids operating on utility-owned distribution or sub-transmission infrastructure. This would include hybrid microgrids of the type defined in the Microgrid Services Docket No. 2018-0163

conditions, which benefits all customers. These same resources can continue to provide needed services and energy following events that segment hardened portions of the grid.

However, it is important to recognize that microgrids alone are not a complete answer to Hawaiʻi's resilience needs. This is because the majority of microgrids are inherently limited in the level of resilience provided, both in the amount of load served and the length of time they can operate in islanded mode. This is due to microgrid economic factors[6] including, 1) microgrids depend on grid connection for import energy and to provide grid services, 2) microgrids are typically designed to only serve 80% of the load within the microgrid boundary, and 3) the design of clean energy-based microgrids is generally limited in islanding duration capability given cost considerations.[7] Mitigation solutions with potential customer and third-party solutions are currently enabled by the Companies' microgrid services tariff and opportunities identified in the IGP grid needs assessment and solution sourcing process.

Additionally, Hawaiian Electric is currently working to identify areas on Oʻahu that are potentially suited for developing microgrids through a mapping initiative as part of the U.S. Department of Energy's Inaugural Energy Transitions Initiative Partnership Project. The Companies have also been pursuing opportunities to fund the development of critical customer hubs ("CCH"), which are a variant of the microgrid concept developed as part of the Koʻolaupoko Community Resilience Initiative.[8] CCHs allow for geographically proximate groups of critical community lifeline facilities in key locations to be "islanded" and powered using mobile generation and distribution equipment in the event of a prolonged power outage.[9]

As described above, microgrids can improve resilience for a customer or group of customers if the transmission system fails in their area during a severe event by continuing to provide power while the host grid is repaired. However, community microgrids rely on the distribution system infrastructure on which they operate. Therefore, hardening the component distribution infrastructure upon which a community microgrid will operate is a necessary step in developing a community microgrid. By hardening distribution infrastructure, including hardening critical customer circuits as described in Section 3.2, the Companies' efforts will complement microgrids as a resilience solution by strengthening the distribution backbone, including the distribution lines serving groups of critical customers that may benefit from microgrid implementations in the future.

In summary, a portfolio of resilience solutions is needed to address Hawaiʻi's needs, and these begin with a solid foundation of hardening the transmission and distribution system to benefit the largest number of customers and connected energy supply resources. A robust, hardened grid will also enable future development of a more sophisticated fractal grid that may evolve over time with the development of microgrids and grid modernization capabilities.[10] Collectively, this portfolio

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[6] Comments of Microgrid Resources Coalition on Hawaiian Electric's Transmittal of a Draft Microgrid Services Tariff, HPUC Docket No. 2018-0163
[7] California PUC cited 96 hours duration as a criterion for multi-customer microgrids in their Microgrid Implementation Program. Available at: http://docs.cpuc.ca.gov/SearchRes.aspx?DocFormat=ALL&DocID=361442167
[8] *See* discussion in Section 3.2.
[9] *See,* FEMA Community Lifelines, https://www.fema.gov/emergency-managers/practitioners/lifelines
[10] T. Heidel and C. Miller, Agile Fractal Systems: Reenvisioning Power System Architecture - Frontiers of Engineering, 2017

will help to address Hawai‘i's resilience needs in an environment of increasing electricity reliance and growing resilience threats.

3 Proposed Project Components and Scope

The Companies are proposing an initial phase of "no-regrets" resilience enhancements based on the industry best practices discussed. These no-regrets resilience enhancements 1) do not compete with customer and third-party solutions, and 2) can be implemented in such a way as to produce optimal results for expenditure by targeting assets that are most critical and/or vulnerable and using the most cost-effective means to meet hardening standards.

The level of investment proposed and decision to focus on no-regrets actions is sensitive to the reality that power system resilience enhancement is still relatively new in the industry. Given the high degree of uncertainty with predicting severe events and the intrinsic challenges to evaluating power system resilience, more data and capabilities are needed before the benefits of individual investments can be clearly quantified and an optimal level of resilience spending can be ascertained. Such challenges are well-known across the industry, and there is significant interest in advancing capabilities in this area. However, it is the Companies' position that we cannot afford to wait for the state of the art to advance before taking action. As detailed previously, the cost of inaction can be catastrophic.

The proposed investments do not represent the totality of what the Companies believe must be done to achieve a resilient electric grid. Rather, these initial investments are proposed based on the Companies' position that there are common-sense, well-established, foundational, no-regrets resilience enhancements that can begin in parallel with the remaining steps in the IGP process. These types of investments, including those put forward by the RWG, will continue to be evaluated and implemented over time as a part of the Companies' ongoing and overall investments in projects to improve the resilience of the grid and ability to recover from severe events. This process will include incorporation of lessons learned from this initial set of investments, identification of additional and complementary resilience investments which may be necessary, and the consideration of modeling outputs to better inform subsequent investments.

As the various components of the Project are prioritized and implemented, the Companies will identify synergies between other transmission and distribution needs that are identified to ensure efficient investment. For example, there may be synergies with upgrades needed for renewable energy zones or to increase DER hosting capacity.

3.1 Critical Transmission Line Hardening

Strongly integrated and robust transmission networks are crucial for system resilience due to the flexibility they afford under severe event scenarios. Since resilience is inherently concerned with extreme, high-impact events, resilience planning must consider severe and uncommon operating scenarios, such as the sudden loss of multiple system resources simultaneously due to extreme weather. Under such scenarios, robust transmission networks enable the system to compensate for unplanned coincident outages of generation, ancillary equipment, and/or lines.

Without a resilient transmission system, the grid is more vulnerable to wide-spread outages or system-wide blackout. In late August 2021, Hurricane Ida made landfall in Louisiana as a

Category 4 storm. High winds knocked out all eight transmission lines delivering power to New Orleans, causing a city-wide blackout.[11]

After Winter Storm Uri, which struck Texas in February 2021, a report commissioned by the American Council of Renewable Energy (ACORE) found that "each additional 1 GigaWatt (GW) of transmission ties between the Texas power grid (ERCOT) and the Southeastern U.S. could have saved nearly $1 billion, while keeping the heat on for hundreds of thousands of Texans." The full report analyzed five recent severe events across the U.S. and concluded that "all generation sources are vulnerable to severe weather, making increased transmission to broaden the pool of available resources one of the best options for increasing resilience."[12]

For isolated island grids such as those in Hawaiʻi, the lack of transmission interties to other neighboring grids is already a constraining factor. This makes the need for a robust, hardened, island-wide transmission system even more crucial for system resilience. Given that each island is unable to leverage interties to other neighboring grids, system resilience is heavily influenced by the extent to which critical transmission lines connecting disparate regions and resources on the grid are able to withstand extreme weather events and be quickly restored when failures occur.

Hardening the transmission system is critical to ensuring that grid-scale solar, wind, and battery resources, community based renewable energy, along with customer distributed resources continue to operate or are quickly restored following a severe event. While many of the customer battery energy storage systems made today can operate during a grid outage to self-power a portion or all of a home's load, the majority of solar systems need the presence of the grid to operate. In order for these grid-connected systems to operate, the transmission system must be intact to signal to the inverters that the grid is present and operating. Following an event, grid connected, customer distributed generation and batteries can continue to provide energy within the system if it becomes segmented, as in a fractal grid. In this case, the grid infrastructure is needed to combine the output from multiple distributed resources and transmit this energy to where it is needed. Without a robust transmission and distribution system, the delivery of energy from distributed resources and grid-scale resources to other customers will be hampered, limiting the realization of their resilience value. Microgrids, while an important point solution for critical facilities and smaller groups of customers, do not alone address the larger community needs for reliable clean energy in an increasingly electrified Hawaiʻi.

The Companies' proposed Critical Transmission Line Hardening initiative focuses on hardening existing transmission lines that are critical for system operation and/or restoration following a severe resilience event. The Companies' approach is to incrementally harden critical transmission lines such that the minimum strength of the line would meet or exceed National Electrical Safety Code ("NESC") Extreme Wind Loading criteria. All structures or spans that do not meet or exceed the NESC Extreme Wind Loading criteria will be designed to the stronger of

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[11] *See,* https://www.utilitydive.com/news/ida-knocks-out-all-transmission-lines-into-new-orleans-leaves-1m-without/605754/

[12] *See,* July 2021 report by ACORE: *Transmission Makes the Power System Resilient to Extreme Weather*. https://acore.org/wp-content/uploads/2021/07/GS_Resilient-Transmission_proof.pdf

the Companies' design policy or 100-year extreme wind loading criteria, which exceed NESC Extreme Wind Loading criteria.

On O'ahu, the focus is on ensuring that at least one of the possible paths through the transmission system is hardened to avoid or limit system damage from extreme wind events and support faster restoration following a widespread outage or island-wide blackout. O'ahu's transmission restoration guidelines divide the transmission system into three "target systems." Target System 1 represents the "backbone" of the transmission system used to black start and parallel generation resources needed to restore large load centers. After Target System 1 is energized after a blackout, Target System 2 is energized next. Target System 2 is the first buildout from Target System 1 to nearby transmission substations and allows the Companies to restore the first major load centers and other critical infrastructure such as the Honolulu International Airport, Honolulu Harbor, and Department of Defense facilities. After Target Systems 1 and 2 are energized, Target System 3 can be energized, which allows the Companies to restore the remaining load centers on the island, including Windward O'ahu and East Honolulu. By hardening at least one of the possible transmission restoration paths through Target Systems 1, 2, and 3, the Companies will have a better chance of avoiding wide-spread outages and enabling quicker restoration of service following severe events such as major storms and hurricanes.

The high priority transmission restoration paths may also have synergies with renewable energy zones ("REZ") contemplated in the IGP process. The transmission REZ Study has identified potential transmission system network upgrades that may be needed to increase the capacity of the transmission system to harness electrical power from identified REZs.[13] The Companies will seek to optimize REZ plans as they develop, with the implementation of individual transmission lines as part of this initiative.

The goal of this initiative is to harden one of the possible transmission restoration paths such that the minimum wind speed rating of any component of this path would meet or exceed NESC Extreme Wind Loadings. Any structure or span that is replaced would be designed to the stronger of the Companies' design policy or 100-year extreme wind loading criteria. Based on an analysis of the hardening requirements for the various possible transmission restoration paths, the Companies estimate that the least-cost path to harden would involve upgrading roughly 400 structures across 16 critical transmission lines. For the initial five-year plan proposed in this Application, the Companies intend to harden approximately 81 structures on O'ahu for a total of approximately $54,194,000, as shown in Exhibit A to this Application.

On Hawai'i Island, the major load centers include North Kona and South Kohala on the west side and Hilo and Puna in the east. The east and west sides of the island are connected by four critical cross-island transmission ties. The four cross-island ties are critical for maintaining power transfer capability between the west and east, enabling economic dispatch of resources, independent of their location. Given that the resource mix on the grid is subject to change, these

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[13] *See, Hawaiian Electric Transmission Renewable Energy Zone (REZ) Study*, filed as Exhibit 2 of the Hawaiian Electric Companies' Grid Needs Assessment Methodology Review Point in Docket No. 2018-0165 on November 5, 2021

cross-island ties also enable built-in flexibility for future scenarios, including flexibility for where new renewable generation can be sited (as is contemplated in the REZ study).

More importantly from a resilience planning perspective, the power transfer capability afforded by these lines is especially critical during severe operating scenarios, such as those caused by storms and hurricanes, where generation resources and power lines can be suddenly taken offline. The cross-island ties provide critical flexibility to shift generation based on available resources under these types of scenarios by enabling power transfer from one side of the island to the other. Without the cross-island ties enabling the system to flexibly compensate for these types of sudden changes in system resources, the grid is more vulnerable to wide-spread outages or system-wide blackout. The geographically dispersed utility-scale generation facilities and cross-island ties have been key in facilitating a reliable system with high variable production as well as enabling the system to survive major storms, earthquakes, and lava events.

There have been multiple storms affecting Hawaiʻi Island in the past that caused outages of multiple of the cross-island ties at the same time, resulting in precarious operating scenarios where the grid was saved by the ties that remained energized. For example, during Hurricane Iselle, power was provided to customers in East Hawaiʻi/Hilo from Keahole facilities via the 6200 line (one of the cross-island ties running along Saddle Road) as most of the East Hawaiʻi generation was lost along with the other three cross-island ties. The cross-island ties were also essential for reliable continuity of service during the extended outage of the geothermal plant following the 2018 eruption. Ensuring that there are hardened transmission ties connecting the east and west sides of Hawaiʻi Island is essential for system resilience for the present and future mix of generation resources.

Of the four cross-island ties, the Companies have selected the 6200 line, which runs from Keʻāmuku Switching Station to Kaumana Switching Station along Saddle Road as the most beneficial to harden first. This line is one of the shorter cross-island ties, which results in more resilience benefit per dollar spent on hardening. In addition, a portion of the 6200 line in the upper Kaumana area is located in a critical habitat area. When the line in this area is damaged, gaining access to the line is very challenging for troubleshooting, repairs, and restoration. Poor visibility due to rainy, cloudy, and foggy weather conditions further complicate the already difficult access for troubleshooting and repairs. Hardening and relocating this section of line to the road will greatly improve restoration times if required after a severe event. Furthermore, previous planning studies have indicated that when there is significant generation coming from one side of the island and one of the cross-island ties is lost, there can be potential voltage and overload issues that can be addressed by reconductoring 6200. This type of contingency situation is relevant for both blue-sky reliability (depending on the resource mix on the grid at the time), and for resilience considering severe event scenarios where the loss of generation resources can cause an imbalance of generation between the opposite sides of the island (even if generation were balanced across the island during normal conditions). The 6200 line is also one of the transmission lines that was identified for reconductoring to support the future Renewable Energy Zones needed to interconnect grid-scale renewable energy beyond Stage 1 and 2 procurements. Hardening the 6200 line and upgrading to the standard conductor size will safeguard and improve the resilience value of this critical line for the present and future grid, while also providing synergies with other planning goals (e.g., 100% renewables/decarbonization).

The Companies plan to harden the 6200 line such that the minimum wind speed rating will meet or exceed NESC Extreme Wind Loading criteria. Any structure or span that is replaced would be designed to the stronger of the Companies' design policy or 100-year extreme wind loading criteria. While upgrading the line, the conductor will also be upgraded to current standard (556 kcmil AAC).

The 6200 line is about 50 miles long. The Companies plan to harden and reconductor to current conductor standards approximately 10 miles of line in this initial five-year program, with roughly 178 structures to be upgraded or installed. This includes the relocation of approximately 7 miles of line out of a critical habitat area, which the Companies consider the highest priority segment of this line to address to maximize resilience benefit. The total cost for this initial phase of work is estimated at approximately $12,386,000.

In order to expedite the 6200 line hardening initiative, the Companies are requesting approval for 1) the commitment of funds associated with the Project, and 2) the proposed accounting and ratemaking treatment for the Project, prior to approval of the above-ground 69kV line extension for the sub-section of the 6200 line that is planned to be relocated. Upon completion of any necessary analysis and studies regarding location and construction of the high-voltage electric transmission lines, the Companies will address the elements of HRS § 269-27.6 and will request that the Commission conduct a public hearing under HRS § 269-27.5, as necessary, as part of a subsequent request to be filed with the Commission. Bifurcating the approvals in this way will enable the Companies to begin work sooner on other parts of the 6200 line that will not require relocation, thus expediting the hardening of the 6200 line and accelerating resilience improvement.

For Maui County, the Companies identified the following three transmission paths as most critical to harden:

- Maʻalaea-Puʻunēnē which connects Maʻalaea Power Plant to the major load centers in Central Maui.
- Maʻalaea-Waiinu which also connects Maʻalaea Power Plant to the major load centers in Central Maui.
- Maʻalaea-Kīhei which is the shortest path from Maʻalaea Power Plant to the major load center of Kīhei.

Of these three, the Companies' selected the Maʻalaea-Puʻunēnē line to harden first. In addition to connecting the Maʻalaea Power Plant to loads in Central Maui, the Kuihelani Solar project is interconnecting to Maʻalaea-Puʻunēnē near Kuihelani Switching Station, which increases criticality of the Maʻalaea-Puʻunēnē tie. Furthermore, Maʻalaea-Puʻunēnē was one of the lines identified for reconductoring in the REZ study. While the Companies do not intend to reconductor Maʻalaea-Puʻunēnē as part of this five-year plan, the Companies intend to harden this line (i.e., upgrade/strengthen poles and structures) such that it will meet or exceed NESC Extreme Wind Loading criteria with the larger conductor size contemplated by the REZ study.

Any structure or span that is replaced will be designed to the stronger of the Companies' design policy or 100-year extreme wind loading criteria.

For the majority of the Maʻalaea-Puʻunēnē line, the Companies plan to upgrade poles in-place. However, there are two areas where the Companies are considering alternative options. The portion of the Maʻalaea-Puʻunēnē line heading from Maʻalaea Power Plant to Honoapiʻilani Highway shares structures with the Maʻalaea-Kaheawa 1 line for approximately 1.5 miles. Splitting this double circuit line section into two separate lines may be optimal to improve resilience by reducing the probability of coincident outages of both transmission lines by a single failure event. The Companies are also considering relocating a 2-mile section of the Maʻalaea-Puʻunēnē line near Kuihelani Switching Station where the Companies currently have limited access. Relocating this section of 69kV line to Kuihelani Hwy may be optimal to enable quicker restoration in the event of damage to this line. The Companies will analyze options to address these line sections in 2022 and 2023. To the extent that it is determined that these overhead line projects should move forward and to the extent necessary, the Companies will address the elements of HRS § 269-27.6 and will request that the Commission conduct a public hearing under HRS § 269-27.5 as part of a subsequent request to be filed with the Commission. Bifurcating the approvals in this way will enable the Companies to begin work sooner on the remainder of the Maʻalaea-Puʻunēnē line that will be upgraded in-place, thus expediting the hardening of this critical transmission line and accelerating resilience improvement.

The Companies estimate that about 144 transmission structures will need to be upgraded or installed to harden the Maʻalaea-Puʻunēnē line. This includes approximately 2 miles of line to be relocated near Kuihelani Switching Station, along with splitting 1.5 miles of double-circuit line running from Maʻalaea Power Plant to Honoapiʻilani Highway into two separate lines. The Companies intend to harden the entire line in this five-year program at an estimated cost of $8,433,000.

3.2 Critical Customer Circuit Hardening

Critical customers include those that provide services essential to human health and safety and enable the rest of society to function. Since all critical customer sectors depend on electricity to function, ensuring reliable and resilient power to these customers is crucial to the resilience of the community writ large. The RWG developed a framework for prioritizing customers and infrastructure sectors from the perspective of importance to supporting (1) national security and/or public safety and health and (2) power system recovery. The RWG's critical customer sectors have general alignment and overlap with other national constructs such as FEMA's Community Lifelines[14] construct and the Department of Homeland Security's ("DHS") Critical Infrastructure Sectors.[15]

Like the energy sector, some other critical customer sectors also function as infrastructure networks, where interrelated resources and facilities of varying criticality are located across the community. When critical sites in these networks are disrupted, this increases reliance on the other system components to ensure service continuity. Recently, the Honolulu Board of Water Supply ("BWS") shut down its Hālawa shaft, Hālawa well, and ʻAiea well after water

[14] *See,* https://www.fema.gov/emergency-managers/practitioners/lifelines
[15] *See,* https://www.cisa.gov/critical-infrastructure-sectors

contamination was detected at the Navy's Red Hill shaft. Normally, the Hālawa Shaft supplies 20% of the Honolulu region's drinking water.[16] As of this writing, it is not yet known when the Hālawa Shaft will be brought back in service.[17] The loss of this critical resource in the island's water system further increases the importance of reliable and resilient power to the other wells and pumps on O'ahu to continue to meet demand. This is especially true if a severe event occurs while BWS is operating without the Hālawa shaft. It is therefore of increased importance to minimize energy disruptions to the remaining critical sites and ensure that utility power can be quickly restored when disruptions occur.

Critical Customer Circuit Hardening aims to harden distribution and sub-transmission circuits to benefit communities by strengthening service to critical customers (such as major hospitals, water infrastructure, military facilities, first responders, and other Tier 1 and 2 critical customers in alignment with the framework established by the RWG) by implementing cost-effective solutions (e.g., pole upgrades, storm guying, etc.) that address potential weak points and vulnerabilities along the circuit to increase the overall resilience of the circuit to meet or exceed NESC Extreme Wind Loading criteria.

Critical Customer Circuit Hardening is a complementary or necessary solution to on-site backup generation/battery storage or non-wires alternatives for risk mitigation, such as microgrids, but is not duplicative of them. For example, many critical customers have on-site backup generation. The RWG Report summarizes the existing backup power capabilities in key customer sectors, with some sectors tending to have greater backup power capabilities than others. In any case, on-site backup generation is a stop-gap solution until grid power is restored to the site. In the case of backup diesel generators, critical infrastructure sectors are typically only able to operate at reduced capacity until grid power is restored, prioritizing their most critical facilities and functions. Power supply for backup generators is also limited by on-site fuel stores and the ability to resupply fuel. Backup generator reliability is also an issue, as there are many examples of backup diesel generators for critical facilities failing after being called on following a severe event due to infrequent use or exercising of equipment. On-site renewable DER solutions can also be used to provide backup power to critical facilities, but are themselves vulnerable to severe weather, and are also stop-gap solutions until grid power restoration is achieved. As described in Section 2, a holistic, multi-pronged approach involving both prevention (e.g., system hardening) and mitigation (e.g., microgrid) solutions is needed to improve resilience. Hardening critical customer circuits will help to prevent outages to critical customer facilities and enable quicker restoration after outages occur.

The Critical Customer Circuit Hardening initiative will also help to provide the necessary backbone for future mini-grid and community microgrid solutions. Community microgrids could also be the hybrid microgrid type being discussed in the Microgrid Services Docket No. 2018-0163. Many critical customer circuits may be good candidates for community microgrids

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[16] *See,* https://www.hawaiinewsnow.com/2021/12/13/bws-latest-test-results-Halawa-shaft-show-no-sign-fuel-contamination/
[17] *See,* https://www.staradvertiser.com/2021/12/10/breaking-news/Halawa-shaft-could-be-shut-down-for-years-even-permanently-amid-water-contamination-crisis/

or CCHs in the future.[18] In order to implement a community microgrid, hybrid microgrid or CCH for resilience purposes, the component distribution infrastructure (i.e., wires, poles, switches, etc.) upon which the microgrid operates must remain intact and be hardened to withstand the type of resilience threat the microgrid is intended to mitigate. Therefore, hardening critical customer circuits will complement any future microgrid or CCH implementations in these areas.

Exhibit H (*Critical Customer Circuit Example*) to this Application depicts an area in Kailua, O‘ahu that would likely be considered "no-regrets" for Critical Customer Circuit Hardening. In this area, identified critical customers such as Adventist Health Castle and Fire Station 39 Olomana, as well as other community lifeline[19] facilities, such as an emergency shelter (Kailua High School), correctional centers (Hawai‘i Youth Correctional Facility and Women's Community Correctional Center), and schools (Kailua High School, Olomana School, and Maunawili Elementary), are all fed by two circuits coming from the nearby Pōhākupu Substation. These circuit areas are densely populated with critical customers and community lifeline infrastructure and are located a short distance from the substation, which is implicative of favorable cost-benefit characteristics for hardening.

In addition, this area may be an ideal candidate for a future community microgrid or CCH. In fact, the Companies have been actively pursuing the development of a CCH in this area. Exhibit H shows a high-level overview of the upgrades that would need to be made on the distribution circuitry in order to implement a CCH, including the installation of switches and fuse cutouts to isolate the CCH from the main grid. In 2021 and 2022, the Companies, in partnership with the Hawai‘i State Energy Office (HSEO) and Hawai‘i Emergency Management Agency (HI-EMA), applied through FEMA's Building Resilient Infrastructure & Communities (BRIC) grant program to seek federal cost share for this and two other CCH projects in the Ko‘olaupoko region. Although the Companies' application and no other energy project applications nationwide were funded through the BRIC grant program in 2021, the Companies re-applied to the 2022 BRIC grant program, which has expanded funding. Awardees for this year are slated to be notified in summer 2022.

Developing this CCH for resilience purposes requires the component infrastructure to be hardened. As shown in Exhibit H, the Companies plan to upgrade approximately 28 46/12kV poles, 23 12kV poles, and install anchors for an additional 34 poles, to harden the component distribution circuitry of the CCH to meet or exceed NESC Extreme Wind Loadings as part of the CCH's development.

By identifying and hardening no-regrets critical customer circuits such as the ones shown in Exhibit H, critical customers, including community lifeline facilities, will be less likely to lose power in a severe event and quicker to restore if utility power is lost (minimizing the amount of time these facilities would need to rely on backup generators and fuel, while also reducing total length of restoration and restoration costs). In addition, hardening these circuits complements and facilities potential future mitigation solutions such as microgrids and CCHs to further enhance resilience.

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[18] Critical Customer Hubs are a variant of the microgrid concept that includes mobile generation and/or distribution equipment. This concept came out of the Companies-led Ko‘olaupoko Community Resilience Initiative.
[19] *See,* FEMA Community Lifelines, https://www.fema.gov/emergency-managers/practitioners/lifelines

Upon submitting this Application, the Companies plan to further engage the RWG to resume the work of refining critical customer sector definitions and classifications and identifying critical facilities and community lifelines that provide broader societal benefits. The Companies also plan to seek RWG feedback and input as they develop methods to prioritize critical customer circuits under this Project, as well as methods to evaluate whether a given critical circuit is: 1) "no regrets" to proceed with hardening from substation to identified loads, or 2) requires further evaluation of solution alternatives. For example, some circuits may have characteristics that favor a more mitigation-focused approach, where a microgrid solution combined with hardening within the future microgrid boundary may be more cost effective than hardening from the substation to the critical loads. Hardening would then be executed under the Project, while companion microgrid solutions could be evaluated and sourced through the IGP solution sourcing process. In discussions with the IGP stakeholder council, there was consensus that resilience planning, solution identification, and implementation does not need to happen in a serial sequence with the resource planning and grid needs assessment. Rather, that resilience planning and implementation can occur in parallel to the other parts of the IGP process. Accordingly, the Companies plan on proceeding as such to address the collective agreement that making incremental progress to address resilience and climate adaptation is urgent. In order to meet the aggressive hardening timelines proposed, the Companies will identify, prioritize, and scope specific critical customer circuit hardening projects informed by further RWG discussions and other community and stakeholder input based on the budgeted amounts described below.

On O‘ahu, the Companies plan to harden distribution feeders and laterals directly serving critical customers, as well as select critical sub-transmission lines. The Companies plan to harden approximately 13 circuits over the five-year program for a total of $15,444,000, as shown in Exhibit A.

On Hawai‘i Island, the Companies plan to harden distribution feeders and laterals directly serving critical customers as well as select critical sub-transmission lines. The Companies plan to harden four circuits over the five-year program for a total of $4,502,000.

Similarly, the Companies plan to harden distribution feeders and laterals directly serving critical customers in Maui County as well as select critical sub-transmission lines. The Companies plan to harden four circuits over the five-year program for a total of $4,768,000.

3.3 Critical Pole Hardening

This initiative aims to perform targeted hardening of poles for which failure would have a disproportionate impact on restoration following a severe event, including critical poles at increased risk due to sea level rise. While Critical Transmission Line Hardening is focused on preventing damage to transmission lines that are most critical for system operation in a resilience scenario, and Critical Customer Circuit Hardening is focused on preventing damage to circuits serving critical community lifeline functions and infrastructure, the Critical Pole Hardening & Mitigation initiative views criticality primarily through the lens of reducing the total length of restoration, reducing restoration costs, and minimizing societal impacts of downed poles. Viewed through this lens, "critical" poles are generally poles that would be a high priority to replace, difficult to replace, impede restoration if downed, and/or are especially vulnerable to resilience threats. Some examples of critical poles are:

- Poles adjacent to interstate/major highway crossings
- Poles carrying multiple circuits
- Pole-mounted substations
- Substation getaway poles
- Poles with multiple primary risers

To illustrate with an example, if poles adjacent to major highway overhead crossings were to fail in a storm or hurricane, causing the pole or conductor to fall into a major highway or freeway, this would impede traffic, potentially including emergency vehicles, and would take significant resources, time, and coordination with other emergency response efforts to make the repairs.

Some types of critical pole features are more critical than others, and some poles may have multiple critical features, increasing the criticality rating of the pole.

Any poles targeted for hardening through this initiative will be designed to meet or exceed NESC Extreme Wind Loading requirements. Hardening these poles may include one measure or a combination of measures such as replacing a critical pole with a stronger pole, reducing span length by installing intermediate poles, installing additional guying, or strengthening a critical pole with steel trussing.

The Companies are already beginning to see some of the effects of sea level rise on transmission and distribution infrastructure in certain areas across the Companies' service territories. Coastal erosion and flood water can cause erosion and scour around the base of poles and pole anchors; exposure to salt water can also corrode equipment. The Critical Pole Hardening & Mitigation initiative will also perform upgrades and/or relocations of poles that are either currently being impacted or are imminently at risk of impact due to sea level rise.

As shown in Exhibit A, the Companies propose to harden 170 critical poles for a total of \$16,103,000 on O‘ahu, 130 poles for a total of \$11,809,000 on Hawai‘i Island, and 80 poles for a total of \$7,708,000 in Maui County. These plans are based on the first five years of a longer-term plan to harden the most critical poles in the Companies' service territories.

In order to meet the aggressive hardening timeline proposed and enable the Companies to commence with detailed engineering design upon Commission approval, the Companies will proceed with additional scoping activities beginning in 2022 prior to Commission approval. This will include the identification and prioritization of critical poles for hardening and refining the scope of work for poles to be hardened in the first year of the program.

3.4 Substation Flood Monitoring

Substation flooding can cause significant equipment damage if water reaches control equipment while the substation is still energized. For this initiative, the Companies plan to install flood monitors in substations identified to be at-risk of flooding. Flood monitors improve situational awareness by alerting system operators to substation flooding, allowing them to remotely de-energize a substation to reduce equipment damage. The Companies have begun identifying substations potentially at-risk of flooding using the Companies' GIS asset data in combination with FEMA Flood Insurance Rate Maps, State of Hawaiʻi Sea Level Rise Exposure Area maps, and private climate analytics flood risk models.

The Companies plan to install flood monitors in four substations per Company for a total of roughly $650,000 per Company, as shown in Exhibit A.

In order to meet the aggressive timelines proposed, the Companies will proceed with scoping activities beginning in 2022 prior to Commission approval. This will include identification, prioritization, and scope of work refinement for substation flood monitor installations.

3.5 Distribution Feeder Ties (Maui Only)

Compared to Hawaiʻi Island and Oʻahu, many substation transformers on Maui currently have no circuit ties at the distribution level. When there is an outage at these substations, either for scheduled maintenance or an unplanned outage, the Companies' current practice is to utilize a mobile substation to serve the load, when feasible. However, using a mobile substation is not always feasible (for example, if there is inadequate space at the substation). In situations where a mobile substation can be used, implementing the mobile substation is a time-consuming process that results in customer interruptions, especially in the case of unplanned substation outages, where customers may be out of power for an extended period.

By installing backup ties for isolated substations, customer interruptions can be reduced in the case of planned or unplanned outages of the substation. In addition, distribution feeder ties can often also reduce outage durations caused by faults on the circuit (such as outages caused by vegetation or equipment damage by a storm) by enabling customers to be fed via another circuit. Constructing distribution feeder ties between circuits will greatly reduce outage durations and provide operational and restoration flexibility, which will improve both reliability and resilience.

The goal of this initiative is to construct distribution ties for substation transformer units with no existing ties where it is cost effective and feasible.

The Companies propose to create backup distribution feeder ties for the following circuits:

- Hana 1 & Hana 2 (tie together)
- Keʻanae
- Kula

The total cost for this initiative is $1,033,000. See Exhibit A for further details.

The Companies plan to proceed with refining the scope of work for these projects in 2022 prior to Commission approval so that detailed design can begin once approval is received.

3.6 Lateral Undergrounding (Oʻahu Only)

During severe events, many damage locations typically occur on overhead laterals in forested locations. Converting these overhead laterals from overhead to underground can therefore be a cost-effective way to reduce the amount of damage that needs to be repaired, significantly reducing the total length of restoration. Stakeholders have also repeatedly requested that the Companies consider undergrounding as a solution for resilience, particularly in areas with a high density of vegetation.

Although undergrounding laterals is generally much less costly than undergrounding three-phase mains, costs can still vary widely based on soil condition, customer density, third-party attachments, whether directional boring can be used, and so forth. This initiative will identify four miles of overhead laterals for underground conversion to validate cost assumptions before more aggressively pursuing this resilience strategy.

The four miles of circuit will be identified by ranking all single-phase laterals on O‘ahu based on vegetation-related failures on a failures-per-circuit-mile basis (using five to ten years of historical data). This will identify the overhead laterals that would be likely to have the most damage in a severe event. O‘ahu is initially chosen as it already has the required resources available to perform this work.

The identified laterals will be further prioritized based on cost factors such as customer density, the presence of third-party attachments, and accessibility. The prioritization process will result in the selection of four circuit miles of distribution laterals on O‘ahu for undergrounding to improve storm resilience. Based on lateral undergrounding costs experienced by other utilities, the total cost for this initiative is set at $4,179,000, as shown in Exhibit A to this Application.

In order to meet the aggressive hardening timeline proposed, the Companies will proceed with scoping activities beginning in 2022 prior to Commission approval. This will include analysis and assessments to identify overhead distribution lines for targeted undergrounding along with refining the scope of work for the initial year of implementation.

3.7 Hazard Tree Removal

Hazard trees are trees that are not in the right-of-way that are dead, diseased, or structurally compromised, and are tall enough to fall into power lines. It is common for hazard trees to cause significant damage during severe events. As such, a hazard tree removal program can be very effective at reducing this type of damage. The Companies' current vegetation management programs do not include the removal of trees that are outside of the right-of-way, so this initiative represents an incremental increase in O&M that is not currently embedded in the target revenues approved for the Maui Electric 2018 test year rate case (Docket No. 2017-0150), Hawai‘i Electric Light 2019 test year rate case (Docket No. 2018-0368), or Hawaiian Electric 2020 test year rate case (Docket No. 2019-0085), nor recovered through any recovery mechanism that is currently in effect.

The Companies plan to complete surveys for each Company to identify and prioritize hazard trees for removal. This will also include the identification of invasive tree species that have weak root systems and/or are prone to failure during high winds. In order to begin removing hazard trees as soon as possible following Commission approval, the Companies will proceed with this survey work prior to approval of the Application.

Without the benefit of the survey, the Companies estimate that they will remove 800 hazard trees per Company over the five-year program for approximately $11,000,000 per Company, as shown in Exhibit A. Actual expenses will depend on the survey results as well as various factors such as location, size, and height as well as the method of removing the debris.

3.8 Resilience Modeling

The industry recognizes that grid resilience is an exceptionally difficult concept to measure and evaluate. While there are well-defined and established metrics for grid reliability, there are currently no formal metrics or methods to evaluate resilience in the power industry that have received universal acceptance and adoption. As a result, calculating cost-benefit characteristics and performing options analysis of resilience enhancements is exceedingly difficult to do with precision. Metric development, consequence-based approaches for investment, and cost-benefit analysis applied to resilience are active areas of early-stage research and implementation in the industry. While the Companies believe there are no-regrets preventive actions that can and must be taken now to improve resilience, the Companies also intend to contribute to the development and implementation of cutting-edge methods to better evaluate resilience and assist with options analysis going forward.

The Companies plan to pursue the development of a performance-based model and method through partnership with national labs and/or universities that will support the Companies' efforts to 1) evaluate system resilience, and 2) compare investment options for resilience enhancements in terms of their expected benefits vis-à-vis system damage and recovery under severe event scenarios. Development and implementation of the resilience model will proceed in stages, from requirements gathering and data assessment, to proof-of-concept development, to implementation at scale. The Companies estimate that this initiative will cost approximately $700,000 total across all three Companies, as shown in Exhibit A. Due to the importance of this work, the Companies plan to begin work on scoping and developing the resilience model in 2022 prior to Commission approval of the Project, with full implementation to be completed in two years. The Companies intend to use this model to inform work prioritization both within as well as beyond this initial five-year program.

3.9 Wildfire Prevention & Mitigation

Considering the devastating California wildfires of 2018 and the Companies' own experiences in 2019, the Companies have taken proactive action to address wildfire risks. To this end, the Companies reviewed the San Diego Gas & Electric, Southern California Edison, and Pacific Gas & Electric mandated wildfire mitigation plans to identify best practices that would be appropriate for Hawai‘i's environment and weather conditions. In addition, the Companies performed assessments of potential wildfire areas on O‘ahu, Maui, Lāna‘i, Moloka‘i, and Hawai‘i Island. The Companies' Wildfire Prevention & Mitigation initiative has the following objectives:

1. Minimize the probability of the Companies' facilities becoming the origin or contributing source of ignition for a wildfire
2. Prevent the Companies' facilities from contributing to the severity or breadth of wildfires

3. Identify and implement operational procedures to ensure the Companies can respond effectively to a wildfire without compromising customer and employee safety, while remaining sensitive to customers' need for reliable electricity

Recognizing the importance of addressing wildfire risks, the Companies began wildfire prevention and mitigation activities in 2019. The Companies' ongoing wildfire prevention and mitigation efforts were described in Docket No. 2019-0327 in the Companies' responses to PUC-HECO-IR-105, filed on July 13, 2021. However, these efforts are not routine, business-as-usual, or common historical practice.

The Companies' wildfire prevention and mitigation efforts incorporate a multi-pronged approach including system hardening and situational awareness investments. Some of the system hardening efforts, such as including identified wildfire risk zones in prioritization of pole and shield-wire replacements, will be addressed through the Companies' ongoing asset sustainment programs. Some of the Companies' wildfire prevention and mitigation investments were planned to be implemented under Grid Modernization Project Phase 2 ("GMS Phase 2").[20] This included the deployment of field devices, such as smart reclosers and smart fuses, to minimize the intensity of sparks caused by line contact.

The Companies plan to implement certain system hardening and situational awareness interventions under this Project. Examples of system hardening activities planned under the Project include:

- Proactive pole and hardware upgrades to prevent failures and address clearance issues with overhead conductors in wildfire risk areas. Examples may include pole hardening or changing horizontal conductor configurations to vertical or delta to reduce the probability of swing shorts.
- Proactive replacement of copper conductors with aluminum in wildfire risk areas. Copper conductors tend to become brittle and pose a higher risk of failure compared to aluminum.

Examples of situational awareness investments planned under the Project include:

- Installing weather stations in strategic locations to monitor wind speed and relative humidity. Detection of high-risk conditions will be used to trigger alternative operational procedures to minimize the risk of wildfires and enable expedient response.
- Installing video cameras in strategic locations to help dispatchers respond to fires and provide fire responding authorities with critical information about wildfire situations.

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[20] *See* Companies' response PUC-HECO-IR-105, filed in Docket No. 2019-0327 on July 13, 2021

The Companies used a combination of ignition density maps developed by the Pacific Fire Exchange along with historical experience to identify initial wildfire risk areas.[21] The Companies then conducted Unmanned Aerial System ("UAS" or "drone") and field inspections of the Companies' facilities and surrounding vegetation in these identified areas to evaluate risk and identify potential interventions. The following qualitative criteria were then used to prioritize areas for which to develop prevention and mitigation plans:

- Type of vegetation
- Proximity to residents
- Accessibility issues for fire response
- Other lessons learned from California experiences

The Companies have identified initial wildfire priority areas on O'ahu, Maui, Moloka'i, Lāna'i, and Hawai'i Island. These priority areas are considered a starting point and other areas may be added as circumstances warrant.

The current wildfire priority areas for O'ahu include: West O'ahu (Wai'anae to Kahe Valley), East Honolulu ('Āina Haina to Hawai'i Kai), Kapolei (along railroad track), 'Aikahi/Mōkapu, Central O'ahu (Kunia to Waikele), and Waialua. As shown in Exhibit A, the total estimated program cost for O'ahu is $5,341,000.

In Maui County, the current wildfire priority areas include: West Maui (Lahaina to Kapalua), Ma'alaea, Olowalu, Moloka'i (from west Moloka'i to Kawela), and Lāna'i. The total estimated program cost for Maui County is $6,243,000.

On Hawai'i Island, the current wildfire priority areas include: Waikoloa Village, Na'alehu, Kohala, and Pōhakuloa. The total estimated program cost for Hawai'i Island is $2,517,000.

Due to the urgency of addressing wildfire risk, the Companies plan to continue engineering assessments and scoping for Wildfire Prevention & Mitigation work prior to Commission approval of the Project.

4 Project Implementation Schedule

As shown in Tables 1-3 below, project implementation is anticipated to span just under 5 years, from early to mid-2023 through the end of 2027. This implementation schedule assumes Commission approval of the Application by early to mid-2023. The Companies will commence with detailed scoping and conceptual engineering activities in 2022 prior to Commission approval. Upon Commission approval, the Companies plan to begin detailed engineering design in 2023. Construction activities are planned to begin in 2024. For most initiatives, it is estimated that the first assets will be placed in service in 2024. However, for O'ahu's Critical Transmission Line Hardening initiative, the first assets are scheduled to be placed in service in

[21] The Pacific Fire Exchange is a fire science and information communication program co-led by the Hawai'i Wildfire Management Organization (HWMO) and the University of Hawai'i at Mānoa. https://www.pacificfireexchange.org

2025, since the lead time for upgrading 138kV steel structures is generally around 2 years from design through construction. The implementation schedule includes an execution ramp-up over the duration of the program as the Companies increase execution capacity.

Table 1: Oʻahu Implementation Schedule

Oʻahu		**2023**	**2024**	**2025**	**2026**	**2027**	**Total**
Critical Circuit Hardening	Circuits	0	1	2	4	6	**13**
Critical Pole Hardening & Mitigation	Poles	0	10	30	50	80	**170**
Critical Transmission Line Hardening	Structures	0	0	15	26	40	**81**
Lateral Undergrounding	Circuit Miles	0	1	1	1	1	**4**
Substation Flood Monitoring	Substations	0	1	1	1	1	**4**
Hazard Tree Removal	Trees	0	200	200	200	200	**800**

Table 2: Hawaiʻi Island Implementation Schedule

Hawaiʻi Island		**2023**	**2024**	**2025**	**2026**	**2027**	**Total**
Critical Circuit Hardening	Circuits	0	1	1	1	1	**4**
Critical Pole Hardening & Mitigation	Poles	0	10	20	40	60	**130**
Critical Transmission Line Hardening	Structures	0	10	20	55	93	**178**
	Conductor Miles	0	0.6	1.1	3.1	5.2	**10**
Substation Flood Monitoring	Substations	0	1	1	1	1	**4**
Hazard Tree Removal	Trees	0	200	200	200	200	**800**

Table 3: Maui County Implementation Schedule

Maui County		**2023**	**2024**	**2025**	**2026**	**2027**	**Total**
Critical Circuit Hardening	Circuits	0	1	1	1	1	**4**
Critical Pole Hardening & Mitigation	Poles	0	5	15	25	35	**80**
Critical Transmission Line Hardening	Structures	0	8	20	40	76	**144**
Distribution Feeder Ties	Feeder Ties	0	1	1	1	0	**3**
Substation Flood Monitoring	Substations	0	1	1	1	1	**4**
Hazard Tree Removal	Trees	0	200	200	200	200	**800**

Not shown in the above tables are the implementation schedules for Resilience Modeling and Wildfire Prevention & Mitigation. The resilience model is estimated to take 2 years to develop. Requirements gathering, data assessments, and prototyping will begin in 2022, with full-scale implementation in 2023. The Wildfire Prevention & Mitigation initiative includes projects of varying scope and size, as described in Section 3.9. While near-term projects have been scoped, additional projects will continue to be identified and scoped as the Companies conduct assessments in wildfire risk priority areas over the term of the initiative.

5 Estimated Cost and Bill Impacts

The total estimated Capital and O&M cost of the Project is $189.7M. See Exhibit A (*Project Cost Estimate*) for a breakdown of project costs.

As shown in Exhibit D (*Revenue Requirements and Bill Impact Calculation*) to this Application, the Companies estimate that the average monthly bill impact of the Project for a typical residential customer using 500kWh will be $0.33 for Hawaiian Electric, $0.86 for Hawai‘i Electric Light, and $0.71 for Maui Electric, based on the revenue requirements associated with the cost of the Project.

Although the investments to improve system reliability, resiliency and recovery are substantial, they are reasonable in terms of the Companies' overall capital expenditures as well as the range of investments that other utilities are making to address many of these same issues. For example, assuming an approximate Capital investment of $155 million for the period 2023-2027, this would average approximately $31 million annually. This would be equivalent to a range of approximately 9-15% of the Companies' forecasted annual Capital expenditures.

The Edison Electric Institute recently surveyed member companies on their Adaptation, Hardening and Resilience ("AHR") expenditures. EEI's report demonstrates that investor-owned utilities are spending significant and growing amounts on AHR initiatives (approximately $20 billion per year) which represent 24% of distribution spending and 21% of transmission spending on capital expenditures, respectively.[22] Additionally, and particularly in the face of recent severe events that have resulted in significant outages, northeast utilities such as Consolidated Edison, National Grid and Public Service Enterprise Group are investing billions of dollars to strengthen their systems and incorporate climate change into their planning and operations; and are already seeing dividends from those investments.[23]

6 Project Risks and Uncertainties

6.1 High-Level Plans and Estimates

Given the programmatic nature of the proposed work and the wide variety of potential projects within the component initiatives, the scope and cost estimates provided for the Project are based on relatively high-level plans. For programmatic work composed of numerous smaller projects, it is impracticable to develop detailed estimates for each project composing a 5-year program ahead of implementation. Therefore, estimates are based on unit cost assumptions based on past projects. However, in the case of the proposed Project, many of the component initiatives will be comprised of projects subject to significant scope and cost variation. Critical customer

[22] *EEI 2020 Financial Review: Annual Report of the U.S. Investor-Owned Electric Utility Industry* at 45-46.
[23] *Northeast utilities are spending billions on resilience, and the investments are paying off*, Utility Dive, November 10, 2021.

circuits (see Section 3.2), for example, are likely to vary significantly from one to the next in terms of variables such as the number of poles to upgrade.

In addition, the Companies will continue to incorporate new information, optimization strategies, and lessons learned as they gain experience and capabilities in resilience enhancement. The Companies, along with the industry writ large, have much to gain from developing experience in power system resilience enhancement. To the extent that evolving information and new knowledge influences the prioritization of resilience investments, the Companies will need to exercise flexibility to optimize resilience improvement for the benefit of customers and the community.

For these reasons, the Companies will need flexibility with respect to the allocation of total Project costs to the component parts, with the expectation that total Project costs will not be exceeded.

6.2 Delays or Denial of Regulatory Approval

The aggressive hardening schedule proposed for the Project assumes Commission approval of this Application through issuance of a final decision and order ("D&O") by early to mid-2023. Any delays or denial of Application approval will result in delays to the implementation of the Project.

6.3 Pandemic-Related Risks

As the Covid-19 pandemic continues to evolve, so do the pandemic-driven risks to utility initiatives and operations. The Companies will continue to assess and evaluate the impacts of these risks, such as workforce availability, contractor force majeure, and price increases and supply delays caused by global supply chain disruptions.

6.4 Inflation Risks

At the time of this Application, inflation is on the rise globally, with the United States seeing some of the sharpest increases worldwide. The Companies have included inflationary adjustments into their estimates, as is standard practice. However, future inflationary impacts are difficult to predict. For this reason, the Companies have requested an inflation adjustment mechanism together with a true-up at the end of the 5-year program (see Section XIII.A of the Application).

6.5 Resourcing Risks

The Project presents a large incremental increase in Capital and O&M work for the Companies, which poses a challenge to ensure adequate resourcing to achieve implementation goals. In addition, other utilities in the mainland U.S. are increasingly undertaking large-scale infrastructure hardening projects, which may impact the Companies' ability to secure contractors. High contractor demand combined with worker shortages in the industry (due to the pandemic, voluntary and involuntary retirement and the "great resignation" and reorientation of the workforce) may increase contractor prices. The Companies are developing an execution strategy for the forecasted increase in transmission and distribution work by exploring contracting options for engineering and construction and working to determine the optimal utilization of internal resources. In addition, the Companies' implementation schedule intentionally ramps up over the performance period (see Section 4) to account for resource building and change management.

7 Project Benefits

7.1 Current State of the Industry with Respect to Cost-Benefit Analysis for Power System Resilience

The evaluation of system resilience and quantification of resilience benefits is an eminent challenge in the power industry. A 2020 report developed by the Pacific Northwest National Laboratory ("PNNL") under the U.S. DOE's Grid Modernization Laboratory Consortium ("GMLC") notes that "no consensus exists at present on how to define or quantify resilience."[24]

Part of the challenge with measuring resilience has to do with the high level of uncertainty concerning the frequency of severe events and the damage they cause. No one can predict with precision the expected frequency with which hurricanes or other severe events will impact Hawai'i's grid looking into the future, nor which areas will be affected or to what extent. In addition to the paucity of historical data, there is also uncertainty concerning the impacts of climate change on the frequency and severity of severe events to be expected in the future, which means that historical probabilities may not be accurate predictors of future probabilities.

Predicting the impacts of major disruptions on the system is another area of high uncertainty. Such analysis usually requires significant data along with complex modeling and technology capabilities that are still in early stages of development in the industry.

As a result, the industry currently lacks sufficient means to precisely quantify resilience benefits, including the ability to quantitatively distinguish the benefit characteristics of one type of resilience enhancement activity from another. A report by the Electric Power Research Institute ("EPRI") describes these challenges:

> *A central characteristic of extreme events is the fact that their impacts are uncertain and incompletely understood. In conventional cost-benefit analysis, prospective investments can be evaluated by comparing the costs and benefits expressed in present-value terms, which make comparisons straightforward. Resiliency investments are considered to avert the consequences of events characterized by low probability, uncertain timing, and high severity (while the costs are certain and large) … [T]here is no unifying perspective or framework for cost-benefit analysis of resiliency efforts, though there is much interest in advancing the state of the art. Despite growing concern over the critical need for enhanced resiliency, there is no standardized framework for assessing resiliency levels or evaluating investment options.*[25]

Recognizing these uncertainties and the need for additional capabilities to evaluate resilience and support options analysis of resilience enhancements, the Companies are pursuing the

[24] Petit, Vargas, et al. (2020, April). *Grid Modernization: Metrics Analysis (GMLC1.1) – Resilience*. Prepared for U.S. Department of Energy by Pacific Northwest National Laboratory.
[25] Electric Power Research Institute. (2016, February). *Electric Power System Resiliency: Challenges and Opportunities* at 45-46.

development of performance-based resilience modeling capabilities, as discussed in Section 3.8, through partnerships with national labs and/or universities that will help to advance the state of the art and support further refinement of the Companies' proposed resilience improvements beyond initial no-regrets initiatives.

The Companies' position is that there are foundational, well-established, no-regrets resilience enhancements that can and should begin now. For the current Application, the Companies have performed two different types of analyses to quantify a portion of the potential benefits of the proposed Project. However, these analyses are not intended to be comprehensive depictions of the cost-benefit characteristics of the proposed resilience enhancements and are subject to significant uncertainty.

7.2 Description of Benefits of Resilience Investment

The benefits of a more resilient system are many for utility systems in areas prone to severe events. This is why system hardening has been aggressively pursued in Florida, Texas, Virginia, and New York. Some of the major benefits of a more resilient system include the following:

- Critical customer facilities and community lifelines are less likely to be interrupted.
- If critical customer facilities and community lifelines are interrupted, they can be restored much more quickly.
- The total length of restoration can be dramatically reduced, resulting in far fewer customers being out of power for extended periods of time.
- The local economy returns to normal much more quickly, minimizing the loss of GDP due to businesses being without power.
- Storm restoration costs are dramatically reduced.
- Storm inventory levels can be reduced, which lessens storm preparation costs that are passed on to customers.
- Day-to-day reliability is typically improved.

Of course, these benefits come with a cost, as system hardening can be expensive and take many years to implement. Accordingly, the next section presents a benefit-to-cost analysis of the proposed hardening investments.

7.3 Benefit-Cost Analysis

This section develops a statistical model for the probability of hurricanes of different categories making landfall on one of the Hawaiian Islands. This statistical model is based on historical hurricanes that tracked near the Hawaiian Islands. This data has been maintained since 1950 (70 years of data). Tropical storms are included in this analysis and are also referred to as Category Zero storms. Table 4 shows the hurricane tracking frequency in the area surrounding the Hawaiian Islands.

Table 4: Hurricane Frequency

Category	#	Freq. (/yr)	Period (yr)
0	14	0.20	5.0
1	10	0.14	7.0
2	4	0.06	17.5
3	11	0.16	6.4
4	28	0.40	2.5
5	3	0.04	23.3

Table 5 shows the historical probability of a formed hurricane making landfall on one-or-more or the Hawaiian Islands. Of the 70 hurricanes that formed, 11 made landfall, corresponding to 15.7%. The islands are then divided into four geographic areas: Kaua‘i, O‘ahu, Maui/Moloka‘i/Lāna‘i, and Hawai‘i Island. It is assumed that a hurricane making landfall will affect one of these geographic areas with equal probability, with only one of the island groups being affected at a time. This is a conservative assumption since some of the historical hurricanes made landfall in more than one geographic area. With this assumption, the probability of a formed hurricane making landfall on one of the island groups is 25% of 15.7%, which is equal to 3.9%.

Table 5: Probability of Landfall

Total	70
Landfall Anywhere	11
% Landfall Anywhere	15.7%
% Landfall on a Particular Island Group	3.9%

Hurricanes are categorized based on their strongest wind speeds. However, hurricanes do not necessarily make landfall at their strongest speed. Table 6 shows the number of hurricanes of each category making landfall, and what the strength was at landfall. For example, there were three category 0 storms that made landfall, and all three made landfall at category 0 strength (necessarily, since a reduction in strength would mean that it was no longer a tropical storm). In contrast, there were five category 4 storms that made landfall, with four making landfall at category 0 strength and one making landfall at full category 4 strength. Based on this, five out of 11 hurricanes that made landfall landed at full strength, corresponding to 45%. Similarly, six out of 11 hurricanes that made landfall landed at category 0 strength, corresponding to 55%.

Table 6: Strength of Hurricanes Making Landfall

Category (Max Strength)	**Category at Landfall**					
	0	**1**	**2**	**3**	**4**	**5**
0	3					
1		1				
2						
3	2					
4	4				1	
5						

Table 7 shows the probability of hurricanes making landfall on a particular island group at both full strength and at a reduced strength (conservatively assumed to be category 0). This is based on the probability of a hurricane tracking in the Hawaiian Islands area, the probability of making landfall on O‘ahu, and the probability of making landfall at full or reduced strength.

Table 7: Probability of Hurricanes Making Landfall on a Particular Island Group

Cat	Landfall Freq. On O‘ahu		Years Between Landfall on O‘ahu	
	Cat 0	Full Strength	Cat 0	Full Strength
0	0.0079	0.0000	127	0
1	0.0031	0.0026	327	392
2	0.0012	0.0010	817	980
3	0.0034	0.0028	297	356
4	0.0086	0.0071	117	140
5	0.0009	0.0008	1089	1307
Total			40	70

Table 8: Probability of Hurricanes Making Landfall on a Particular Island Group

Cat	Landfall Freq. On O‘ahu	Years Between Landfall
0	0.0250	40
1	0.0026	392
2	0.0010	980
3	0.0028	356
4	0.0071	140
5	0.0008	1307
Total		**25**

Table 8 consolidates all of the category 0 events of Table 7 into a single probability of category 0 winds making landfall on O‘ahu. The results of Table 8 will be used as an input to the benefit-to-cost analysis. For example, it can be expected (based on historical data) that an island group will experience category 0 winds once every 40 years.

To perform a benefit-to-cost analysis (BCA), it is necessary to compare the cost of hardening to the economic benefits of hardening. The cost of hardening has been calculated as a net-present-value (NPV) for each of the operating companies. This NPV has been converted to an annualized cost (assuming a discount rate of 7%) so that annualized costs can be compared to expected annual benefits. Hardening costs are shown in Table 9.

Table 9: Expected Hardening Costs

Revenue Requirement	HECO	MECO	HELCO
NPV ($)	101,042,673	38,163,089	40,246,108
Annualized ($/yr at 7%)	7,072,987	2,671,416	2,817,228

To calculate benefits, the expected TLR for the unhardened systems was taken from the Hawaiian Electric Electrical Service Restoration Plan. The percentage of customers expected to be interrupted for each category storm was then estimated. A “GDP Factor” of 25% was then assumed, which corresponds to the percent of daily GDP savings achieved for a one-day reduction in TLR (e.g., a 4-day reduction in TLR with a GDP factor of 25% corresponds to 4 x 0.25 = 1 day of GDP savings).

Annualized GDP impact for each of the operating companies is shown in Table 10. For each category of storm, this is equal to daily GDP x TLR x GDP Factor x % of Customers Affected. This is then compared to the annualized revenue requirements required for the proposed hardening initiatives.

Table 10: Required TLR Reduction for Break Even BCA

	Cat 0	Cat 1	Cat 2	Cat 3	Cat 4	Cat 5	Total
ETR Before Mitigation – Total System (Days)	15	20	40	60	150	180	
% of customers affected	20%	35%	50%	75%	90%	100%	
Years between events	40	392	980	356	140	1307	
GDP Factor	0.25	0.25	0.25	0.25	0.25	0.25	
Oahu County							
Annual GDP Impact ($M)	3.14	0.75	0.85	5.28	40.35	5.76	56.14
Annualized Revenue Requirement ($M)							7.1
Required TLR Reduction for BCA=1							13%
Maui County							
Annual GDP Impact ($M)	0.48	0.11	0.13	0.81	6.16	0.88	8.57
Annualized Revenue Requirement ($M)							2.7
Required TLR Reduction for BCA=1							31%
Hawaiʻi Island							
Annual GDP Impact ($M)	0.42	0.10	0.11	0.71	5.43	0.78	7.55
Annualized Revenue Requirement ($M)							2.8
Required TLR Reduction for BCA=1							37%

As show above, the calculated break-even values for TLR reduction are 13% for Oʻahu, 31% for Maui County, and 37% for Hawaiʻi Island. The lower value for Oʻahu is primarily based on much higher customer density, which allows hardening costs to be spread across a higher number of customers.

It should be noted that hurricanes are anticipated to become more frequent and severe in the future due to climate change. If hurricanes are more frequent and/or severe than this analysis assumed (based on historical data), this would increase the relative value of the proposed resilience investments.

In addition to expected GDP benefits, significant customer value will be realized through other benefits, which were not quantified:

1. Reduced storm restoration costs
2. Reduced customer interruption costs
3. Reduced food spoilage
4. Societal benefits of reduced interruptions and restoration times for hardened critical customer circuits, enabling quicker stabilization of community lifeline functions

5. Benefits related to other events such as prevention and/or mitigation of wildfires

It should be noted that for some of the proposed initiatives, a reduction in TLR is secondary to the primary intended benefits of the initiative, which were not quantified. For example, enabling continued electric service and quicker restoration for community lifeline facilities (as in Critical Customer Circuit Hardening) has societal benefits that are not adequately captured by quantifying benefits solely in terms of reduced TLR of the whole system.

Based on the above, it is likely that the customer benefits of the proposed hardening projects will exceed the amount of rate increases to customers.

Another way of examining the benefits and costs is to identify a single extreme event that would result in full economic cost recovery. Table 11 shows the expected total GDP loss for each category of hurricane. It then calculates the expected GDP savings using the assumption that the resilience investments will result in a 20% reduction in TLR. These GDP benefits are then compared to the NPV of investment costs to identify the severity of storm that would result in GDP savings exceeding the investment amount. Under these assumptions, the benefits from this level of TLR reduction for a single Category 2 hurricane making landfall on O‘ahu would exceed costs for the O‘ahu resilience investments, while the benefits from this level of TLR reduction for a single Category 3 hurricane would exceed costs for the respective Maui County and Hawai‘i Island investments. As in the previous analysis, only GDP benefits were considered, and a comprehensive consideration of all benefits (if it were feasible) would be expected to yield even more favorable cost-benefit characteristics.

Table 11: Single Event Benefit-To-Cost

	Cat 0	Cat 1	Cat 2	Cat 3	Cat 4	Cat 5
Expected GDP Loss						
Oahu County	125.5	292.9	836.9	1883.0	5649.1	7532.1
Maui County	19.2	44.7	127.8	287.4	862.3	1149.8
Hawai‘i Island	16.9	39.4	112.6	253.4	760.1	1013.4
GDP Savings (20% faster restoration)						
Oahu County	25.1	58.6	167.4	376.6	1129.8	1506.4
Maui County	3.8	8.9	25.6	57.5	172.5	230.0
Hawai‘i Island	3.4	7.9	22.5	50.7	152.0	202.7
Single Event Benefit-to-Cost						
Oahu County	25%	58%	**166%**	373%	1118%	1491%
Maui County	10%	23%	67%	**151%**	452%	603%
Hawai‘i Island	8%	20%	56%	**126%**	378%	504%

In summary, the proposed resilience plans are estimated to have favorable benefit-to-cost characteristics when considering GDP benefits alone. In addition, only a single major hurricane would be required for GDP benefits to exceed investment costs. Furthermore, since benefits were quantified only in terms of estimated GDP savings due to reduced TLR after a storm, the actual benefits of these investments are likely to be much higher. While it is not feasible at this time to quantify the full scope of the benefits of the Project with precision, it is likely that the Project’s comprehensive benefits are significantly greater than the estimated benefits attributed to GDP savings alone.

8 Operational Impacts

At this time, the Companies are continuing to evaluate the operational impacts as a result of this Project. Some of the known or likely impacts to operational procedures are described below.

Implementation of substation flood monitors in flood-prone substations (see Section 3.4), as well as weather stations and video cameras in wildfire risk areas (see Section 3.9), will facilitate situational awareness, enabling the Companies to detect and appropriately respond to real-time threats.

System hardening is expected to result in more efficient restoration by reducing the total damage on the system as well as reducing damage in critical areas most impactful to the restoration process.

REVENUE REQUIREMENT

Recovery of all of the costs for which the Companies are requesting recovery through the EPRM will follow the EPRM guidelines in effect at the time of recovery. The various revenue requirement components and the vehicles to address cost recovery are discussed below.

1. Capital Revenue Requirements would be based on the following parameters (see Exhibit D):
   a) Depreciation parameters (EPRM Guidelines Section III.C.2.ii) – The revenue requirements of the Transmission assets will be accounted for in FERC plant account 355, "Transmission Plant – Poles and Fixtures" which has an average service life of 58 years. The Distribution assets will be accounted for in FERC plant account 364, "Distribution Plant – Poles, Towers and Fixtures" which has an average service life of 45 years, FERC plant account 365, "Distribution Plant – Overhead Conductors and Devices" which has an average service life of 53 years, FERC plant account 366, "Distribution Plant – Underground Conduit" which has an average service life of 60 years, FERC plant account 367, "Distribution Plant – Underground Conductors and Devices" which has an average service life of 55 years, FERC plant account 368, "Distribution Plant – Line Transformers" which has an average service life of 30 years, and FERC plant account 362, "Distribution Plant – Station Equipment – Substation" which has an average service life of 55 years.
   b) Rate of return (EPRM Guidelines Section III.C.2.b.(i)) – The proposed return on rate base for this Project is the composite cost of capital (7.37%) from the Hawaiian Electric 2020 test year rate case Decision and Order No. 37387 in Docket No. 2019 0085; (7.52%) from the Hawai‘i Electric Light 2019 test year rate case Decision and Order No. 37237 in Docket No. 2018-0368; (7.43%) from the Maui Electric 2018 test year rate case Decision and Order No. 36219 in Docket No. 2017-0150. The cost of capital will be based on the weights and rates in effect for rates at the time of the EPRM filing.
   c) Net of tax average annual undepreciated investment or unamortized balance of the deferred cost in allowed Major Projects or Deferred Cost Projects (essentially a rate base calculation with capital investment, accumulated depreciation, accumulated deferred income taxes, and unamortized state investment tax credit) (EPRM Guidelines Sections III.C.2.b.(i) and III.C.3.c) – Depreciation and taxes will be based on approved rates and regulations in place at the time of filing (and when the program is installed in January in the years following).

The Companies propose to recover the capital revenue requirements through the EPRM until new rates for the next MRP become effective that provide cost recovery for the Project and for recovery through the EPRM of Project capital and O&M costs for the Project's investments that go into service during the next MRP. In the annual EPRM filing (i.e., Companies' Spring

Revenue Report as part of the PBR Annual Review Cycle), the revenue requirements will follow the EPRM guidelines approved at that time and based on the lesser of authorized or actual costs incurred and detailed classification of the costs in the depreciation and tax calculations.

Resilience Project/Program
Consolidated Summary

		Consolidated								
Year		Capital - Transmission Revenue Requirement	Capital - Dist - Poles Revenue Requirement	Capital - Dist - OH Cond Revenue Requirement	Capital - Dist - Station Revenue Requirement	Capital - Dist - UG Conduit Revenue Requirement	Capital - Dist - UG Con Revenue Requirement	Capital - Dist - Line Trans Revenue Requirement	O&M Revenue Requirement	**Total Revenue Requirement**
1	2023	-	-	-	-	-	-	-	-	**-**
2	2024	-	-	-	-	-	-	-	1,169,608	**1,169,608**
3	2025	253,670	687,827	254,930	77,994	71,132	36,101	13,848	8,408,759	**9,804,261**
4	2026	1,592,477	1,903,992	645,240	137,472	135,738	68,866	26,334	8,667,711	**13,177,831**
5	2027	4,072,502	3,942,881	1,265,169	198,198	200,931	101,904	38,847	8,914,051	**18,734,482**
6	2028	8,138,862	6,934,153	1,584,055	249,625	266,981	135,353	51,433	9,176,269	**26,536,731**
7	2029	7,896,094	6,744,088	1,543,409	243,336	260,450	131,939	49,791	-	**16,869,107**
8	2030	7,669,784	6,561,800	1,504,558	237,329	254,224	128,677	48,199	-	**16,404,570**
9	2031	7,457,674	6,386,704	1,467,365	231,580	248,281	125,557	46,655	-	**15,963,817**
10	2032	7,256,479	6,218,047	1,431,625	226,047	242,577	122,556	45,151	-	**15,542,482**
11	2033	7,061,375	6,054,698	1,397,000	220,661	237,043	119,640	43,675	-	**15,134,093**
12	2034	6,867,881	5,895,094	1,363,031	215,362	231,612	116,776	42,216	-	**14,731,973**
13	2035	6,683,942	5,761,941	1,338,805	213,022	228,950	115,297	41,219	-	**14,383,176**
14	2036	6,541,230	5,647,032	1,319,250	209,857	225,917	113,632	40,160	-	**14,097,080**
15	2037	6,439,984	5,559,886	1,307,514	206,630	222,787	111,918	39,085	-	**13,887,804**
16	2038	6,395,270	5,503,802	1,283,444	202,937	219,562	110,157	37,994	-	**13,753,166**
17	2039	6,179,861	5,327,589	1,245,325	196,973	213,420	106,937	36,416	-	**13,306,521**
18	2040	5,970,943	5,151,375	1,207,206	191,009	207,277	103,717	34,839	-	**12,866,366**
19	2041	5,781,197	4,975,161	1,169,087	185,045	201,135	100,497	33,261	-	**12,445,383**
20	2042	5,628,538	4,798,948	1,130,968	179,081	194,992	97,277	31,684	-	**12,061,488**
21	2043	5,514,086	4,622,734	1,092,848	173,117	188,850	94,057	30,107	-	**11,715,800**
22	2044	5,414,290	4,448,246	1,055,389	167,357	182,895	90,932	28,561	-	**11,387,670**
23	2045	5,314,494	4,280,309	1,020,279	162,164	177,493	88,082	27,107	-	**11,069,926**
24	2046	5,214,698	4,125,540	989,534	157,662	172,811	85,592	25,773	-	**10,771,610**
25	2047	5,114,902	3,992,136	964,027	153,804	168,855	83,466	24,560	-	**10,501,750**
26	2048	5,015,106	3,879,525	941,993	150,408	165,456	81,617	23,440	-	**10,257,546**
27	2049	4,915,310	3,774,690	920,870	147,159	162,245	79,863	22,351	-	**10,022,488**
28	2050	4,815,514	3,669,854	899,748	143,910	159,034	78,109	21,262	-	**9,787,431**
29	2051	4,715,718	3,565,019	878,625	140,661	155,823	76,355	20,173	-	**9,552,374**
30	2052	4,615,922	3,460,183	857,502	137,411	152,612	74,601	19,085	-	**9,317,317**
31	2053	4,516,126	3,355,347	836,379	134,162	149,402	72,847	17,996	-	**9,082,259**
32	2054	4,416,330	3,250,512	815,257	130,913	146,191	71,093	12,988	-	**8,843,283**
33	2055	4,316,534	3,145,676	794,134	127,664	142,980	69,339	8,520	-	**8,604,846**
34	2056	4,216,738	3,040,841	773,011	124,415	139,769	67,584	4,192	-	**8,366,550**
35	2057	4,116,942	2,936,005	751,888	121,166	136,558	65,830	0	-	**8,128,390**
36	2058	4,017,146	2,831,170	730,766	117,917	133,347	64,076	0	-	**7,894,421**
37	2059	3,917,350	2,726,334	709,643	114,668	130,136	62,322	0	-	**7,660,453**
38	2060	3,817,554	2,621,499	688,520	111,419	126,925	60,568	0	-	**7,426,485**
39	2061	3,717,758	2,516,663	667,397	108,170	123,714	58,814	0	-	**7,192,516**
40	2062	3,617,962	2,411,828	646,275	104,921	120,503	57,060	0	-	**6,958,548**
41	2063	3,518,166	2,306,992	625,152	101,672	117,292	55,305	0	-	**6,724,579**
42	2064	3,418,370	2,202,157	604,029	98,423	114,081	53,551	0	-	**6,490,611**
43	2065	3,318,574	2,097,321	582,906	95,174	110,870	51,797	0	-	**6,256,642**
44	2066	3,218,778	1,992,486	561,784	91,925	107,659	50,043	0	-	**6,022,674**
45	2067	3,118,982	1,887,650	540,661	88,676	104,448	48,289	0	-	**5,788,706**
46	2068	3,019,186	1,782,815	519,538	85,427	101,237	46,535	0	-	**5,554,737**
47	2069	2,919,390	1,536,944	498,415	82,178	98,026	44,781	0	-	**5,179,734**
48	2070	2,819,593	1,188,623	477,293	78,929	94,815	43,026	0	-	**4,702,280**
49	2071	2,719,797	682,556	456,170	75,680	91,604	41,272	0	-	**4,067,079**
50	2072	2,620,001	(0)	435,047	72,431	88,393	39,518	0	-	**3,255,391**
51	2073	2,520,205	(0)	413,924	69,182	85,182	37,764	0	-	**3,126,258**
52	2074	2,420,409	(0)	392,801	65,933	81,971	36,010	0	-	**2,997,125**
53	2075	2,320,613	(0)	371,679	62,684	78,760	34,256	0	-	**2,867,992**
54	2076	2,220,817	(0)	350,556	59,435	75,549	32,502	0	-	**2,738,859**
55	2077	2,121,021	(0)	283,640	56,186	72,338	30,747	0	-	**2,563,933**
56	2078	2,021,225	(0)	194,387	52,937	69,127	28,993	0	-	**2,366,670**
57	2079	1,921,429	(0)	67,546	36,141	65,916	20,925	0	-	**2,111,958**
58	2080	1,821,633	(0)	(0)	23,183	62,705	13,726	0	-	**1,921,247**
59	2081	1,721,837	(0)	(0)	10,514	59,495	6,754	0	-	**1,798,599**
60	2082	1,579,916	(0)	(0)	0	56,284	0	0	-	**1,636,200**
61	2083	1,257,169	(0)	(0)	0	53,073	0	0	-	**1,310,242**
62	2084	752,560	(0)	(0)	0	38,303	0	0	-	**790,863**
63	2085	(0)	(0)	(0)	0	25,125	0	0	-	**25,125**
64	2086	(0)	(0)	(0)	0	12,363	0	0	-	**12,363**
Total		252,577,912	178,386,673	46,867,594	7,657,942	8,763,225	4,144,804	986,920	36,336,398	**535,721,468**

Resilience Project/Program
HE Summary

Year		Hawaiian Electric Capital - Transmission Revenue Requirement	Capital - Dist - Poles Revenue Requirement	Capital - Dist - OH Cond Revenue Requirement	Capital - Dist - Station Revenue Requirement	Capital - Dist - UG Conduit Revenue Requirement	Capital - Dist - UG Con Revenue Requirement	Capital - Dist - Line Trans Revenue Requirement	O&M Revenue Requirement	**Total Revenue Requirement**	Sale Forecast[1] (MWh)	Rate Impact cents per kWh	**Bill Impact 500 kWh[2]**
1	2023	-	-	-	-	-	-	-	-	**-**	6,273,200	-	-
2	2024	-	-	-	-	-	-	-	437,912	**437,912**	6,331,100	0.0069	0.03
3	2025	-	241,379	118,105	20,050	71,132	36,101	13,848	2,735,750	**3,236,365**	6,406,700	0.0505	0.25
4	2026	1,085,934	821,878	350,392	36,613	135,738	68,866	26,334	2,822,865	**5,348,620**	6,482,200	0.0825	0.41
5	2027	2,939,376	1,897,800	463,679	53,680	200,931	101,904	38,847	2,903,061	**8,599,278**	6,492,700	0.1324	0.66
6	2028	5,868,571	3,598,732	579,081	71,516	266,981	135,353	51,433	2,988,424	**13,560,091**	6,524,000	0.2078	1.04
7	2029	5,693,363	3,500,044	564,302	69,712	260,450	131,939	49,791		**10,269,600**	6,560,400	0.1565	0.78
8	2030	5,530,109	3,405,408	550,170	67,989	254,224	128,677	48,199		**9,984,778**	6,631,900	0.1506	0.75
9	2031	5,377,264	3,314,523	536,638	66,341	248,281	125,557	46,655		**9,715,260**	6,665,700	0.1458	0.73
10	2032	5,232,406	3,227,031	523,621	64,756	242,577	122,556	45,151		**9,458,098**	6,702,400	0.1411	0.71
11	2033	5,091,959	3,142,403	510,959	63,215	237,043	119,640	43,675		**9,208,893**	6,758,800	0.1363	0.68
12	2034	4,952,669	3,059,843	498,486	61,701	231,612	116,776	42,216		**8,963,304**	6,805,400	0.1317	0.66
13	2035	4,813,344	2,986,968	490,518	60,955	228,950	115,297	41,219		**8,737,251**	6,863,400	0.1273	0.64
14	2036	4,715,661	2,926,153	486,644	60,045	225,917	113,632	40,160		**8,568,212**	6,948,600	0.1233	0.62
15	2037	4,645,717	2,882,399	477,902	59,124	222,787	111,918	39,085		**8,438,932**	7,006,100	0.1205	0.60
16	2038	4,613,996	2,859,583	469,016	58,199	219,562	110,157	37,994		**8,368,507**	7,085,100	0.1181	0.59
17	2039	4,458,291	2,768,522	455,011	56,497	213,420	106,937	36,416		**8,095,094**	7,189,700	0.1126	0.56
18	2040	4,306,384	2,677,461	441,005	54,795	207,277	103,717	34,839		**7,825,479**	7,340,100	0.1066	0.53
19	2041	4,168,682	2,586,401	426,999	53,094	201,135	100,497	33,261		**7,570,069**	7,426,500	0.1019	0.51
20	2042	4,058,548	2,495,340	412,993	51,392	194,992	97,277	31,684		**7,342,227**	7,557,300	0.0972	0.49
21	2043	3,976,155	2,404,280	398,987	49,690	188,850	94,057	30,107		**7,142,126**	7,702,500	0.0927	0.46
22	2044	3,904,316	2,313,824	385,287	48,040	182,895	90,932	28,561		**6,953,855**	7,876,200	0.0883	0.44
23	2045	3,832,476	2,226,049	372,807	46,540	177,493	88,082	27,107		**6,770,553**	8,016,200	0.0845	0.42
24	2046	3,760,637	2,144,574	362,168	45,227	172,811	85,592	25,773		**6,596,782**	8,178,800	0.0807	0.40
25	2047	3,688,797	2,074,469	353,102	44,103	168,855	83,466	24,560		**6,437,351**	8,342,700	0.0772	0.39
26	2048	3,616,958	2,015,901	345,011	43,126	165,456	81,617	23,440		**6,291,509**	8,524,300	0.0738	0.37
27	2049	3,545,118	1,961,725	337,250	42,199	162,245	79,863	22,351		**6,150,752**	8,650,300	0.0711	0.36
28	2050	3,473,279	1,907,550	329,489	41,271	159,034	78,109	21,262		**6,009,996**	8,780,500	0.0684	0.34
29	2051	3,401,439	1,853,375	321,728	40,344	155,823	76,355	20,173		**5,869,239**	8,780,500	0.0668	0.33
30	2052	3,329,600	1,799,200	313,967	39,417	152,612	74,601	19,085		**5,728,482**	8,780,500	0.0652	0.33
31	2053	3,257,760	1,745,025	306,206	38,490	149,402	72,847	17,996		**5,587,726**	8,780,500	0.0636	0.32
32	2054	3,185,921	1,690,850	298,445	37,563	146,191	71,093	12,988		**5,443,050**	8,780,500	0.0620	0.31
33	2055	3,114,081	1,636,675	290,684	36,636	142,980	69,339	8,520		**5,298,914**	8,780,500	0.0603	0.30
34	2056	3,042,242	1,582,500	282,923	35,709	139,769	67,584	4,192		**5,154,919**	8,780,500	0.0587	0.29
35	2057	2,970,402	1,528,325	275,162	34,781	136,558	65,830	0		**5,011,059**	8,780,500	0.0571	0.29
36	2058	2,898,563	1,474,150	267,401	33,854	133,347	64,076	0		**4,871,391**	8,780,500	0.0555	0.28
37	2059	2,826,723	1,419,975	259,640	32,927	130,136	62,322	0		**4,731,723**	8,780,500	0.0539	0.27
38	2060	2,754,884	1,365,800	251,879	32,000	126,925	60,568	0		**4,592,056**	8,780,500	0.0523	0.26
39	2061	2,683,044	1,311,625	244,118	31,073	123,714	58,814	0		**4,452,388**	8,780,500	0.0507	0.25
40	2062	2,611,205	1,257,450	236,358	30,146	120,503	57,060	0		**4,312,720**	8,780,500	0.0491	0.25
41	2063	2,539,365	1,203,275	228,597	29,218	117,292	55,305	0		**4,173,052**	8,780,500	0.0475	0.24
42	2064	2,467,526	1,149,100	220,836	28,291	114,081	53,551	0		**4,033,384**	8,780,500	0.0459	0.23
43	2065	2,395,686	1,094,925	213,075	27,364	110,870	51,797	0		**3,893,717**	8,780,500	0.0443	0.22
44	2066	2,323,846	1,040,750	205,314	26,437	107,659	50,043	0		**3,754,049**	8,780,500	0.0428	0.21
45	2067	2,252,007	986,575	197,553	25,510	104,448	48,289	0		**3,614,381**	8,780,500	0.0412	0.21
46	2068	2,180,167	932,400	189,792	24,583	101,237	46,535	0		**3,474,713**	8,780,500	0.0396	0.20
47	2069	2,108,328	828,391	182,031	23,656	98,026	44,781	0		**3,285,212**	8,780,500	0.0374	0.19
48	2070	2,036,488	656,542	174,270	22,728	94,815	43,026	0		**3,027,870**	8,780,500	0.0345	0.17
49	2071	1,964,649	387,750	166,509	21,801	91,604	41,272	0		**2,673,585**	8,780,500	0.0304	0.15
50	2072	1,892,809	(0)	158,748	20,874	88,393	39,518	0		**2,200,343**	8,780,500	0.0251	0.13
51	2073	1,820,970	(0)	150,987	19,947	85,182	37,764	0		**2,114,850**	8,780,500	0.0241	0.12
52	2074	1,749,130	(0)	143,226	19,020	81,971	36,010	0		**2,029,357**	8,780,500	0.0231	0.12
53	2075	1,677,291	(0)	135,465	18,093	78,760	34,256	0		**1,943,865**	8,780,500	0.0221	0.11
54	2076	1,605,451	(0)	127,704	17,166	75,549	32,502	0		**1,858,372**	8,780,500	0.0212	0.11
55	2077	1,533,612	(0)	98,634	16,238	72,338	30,747	0		**1,751,570**	8,780,500	0.0199	0.10
56	2078	1,461,772	(0)	49,923	15,311	69,127	28,993	0		**1,625,127**	8,780,500	0.0185	0.09
57	2079	1,389,933	(0)	24,618	10,877	65,916	20,925	0		**1,512,269**	8,780,500	0.0172	0.09
58	2080	1,318,093	(0)	(0)	7,212	62,705	13,726	0		**1,401,737**	8,780,500	0.0160	0.08
59	2081	1,246,254	(0)	(0)	3,598	59,495	6,754	0		**1,316,100**	8,780,500	0.0150	0.07
60	2082	1,174,414	(0)	(0)	0	56,284	0	0		**1,230,698**	8,780,500	0.0140	0.07
61	2083	919,932	(0)	(0)	0	53,073	0	0		**973,005**	8,780,500	0.0111	0.06
62	2084	543,787	(0)	(0)	0	38,303	0	0		**582,090**	8,780,500	0.0066	0.03
63	2085	(0)	(0)	(0)	0	25,125	0	0		**25,125**	8,780,500	0.0003	0.00
64	2086	(0)	(0)	(0)	0	12,363	0	0		**12,363**	8,780,500	0.0001	0.00
Total		182,027,386	92,384,898	17,255,414	2,190,734	8,763,225	4,144,804	986,920	11,888,011	**319,641,394**		*Average*	0.33
NPV @	6.88%	50,703,374	30,504,806	5,440,575	672,835	2,545,021	1,271,696	421,666	9,482,700	**101,042,673**		*Highest 5-year Average*	0.80

Notes:
1. Sales Forecast developed in August 2021 for IGP obtained from Forecasting Division. Using 2050 forecasted sales for years thereafter
2. Hawaiian Electric typical residential energy consumption, per month.

Resilience Project/Program
HL Summary

		Hawaii Electric Light								
Year		Capital - Transmission Revenue Requirement	Capital - Dist - Poles Revenue Requirement	Capital - Dist - OH Cond Revenue Requirement	Capital - Dist - Station Revenue Requirement	O&M Revenue Requirement	**Total Revenue Requirement**	Sale Forecast[1] (MWh)	Rate Impact cents per kWh	**Bill Impact 500 kWh[2]**
1	2023	-	-	-	-	-	**-**	985,809	-	-
2	2024	-	-	-	-	408,456	**408,456**	987,578	0.0414	0.21
3	2025	182,444	234,712	27,458	19,846	2,759,011	**3,223,470**	985,740	0.3270	1.64
4	2026	315,167	565,335	46,533	35,908	2,842,706	**3,805,649**	979,703	0.3884	1.94
5	2027	695,472	1,110,146	163,908	52,334	2,923,510	**4,945,370**	974,267	0.5076	2.54
6	2028	1,353,272	1,876,526	282,203	69,259	3,009,522	**6,590,782**	976,052	0.6752	3.38
7	2029	1,313,050	1,825,043	274,878	67,508		**3,480,479**	969,467	0.3590	1.80
8	2030	1,275,493	1,775,660	267,882	65,836		**3,384,872**	966,704	0.3501	1.75
9	2031	1,240,165	1,728,221	261,190	64,237		**3,293,813**	964,273	0.3416	1.71
10	2032	1,206,551	1,682,506	254,770	62,698		**3,206,525**	964,623	0.3324	1.66
11	2033	1,173,918	1,638,192	248,585	61,202		**3,121,896**	961,027	0.3248	1.62
12	2034	1,141,546	1,594,854	242,568	59,731		**3,038,700**	962,705	0.3156	1.58
13	2035	1,116,058	1,560,344	237,636	59,010		**2,973,048**	969,771	0.3066	1.53
14	2036	1,088,403	1,528,948	232,356	58,115		**2,907,822**	979,370	0.2969	1.48
15	2037	1,069,867	1,504,672	230,675	57,204		**2,862,419**	985,212	0.2905	1.45
16	2038	1,061,172	1,487,412	228,824	56,280		**2,833,688**	994,060	0.2851	1.43
17	2039	1,025,625	1,439,537	222,111	54,627		**2,741,901**	1,004,937	0.2728	1.36
18	2040	991,845	1,391,662	215,399	52,975		**2,651,880**	1,020,345	0.2599	1.30
19	2041	961,040	1,343,788	208,687	51,322		**2,564,836**	1,030,993	0.2488	1.24
20	2042	935,836	1,295,913	201,974	49,669		**2,483,392**	1,047,968	0.2370	1.18
21	2043	916,762	1,248,038	195,262	48,016		**2,408,078**	1,067,693	0.2255	1.13
22	2044	900,066	1,200,754	188,621	46,415		**2,335,855**	1,090,134	0.2143	1.07
23	2045	883,370	1,155,496	182,173	44,960		**2,266,000**	1,110,199	0.2041	1.02
24	2046	866,675	1,113,930	176,208	43,690		**2,200,503**	1,133,859	0.1941	0.97
25	2047	849,979	1,078,032	171,227	42,601		**2,141,839**	1,160,394	0.1846	0.92
26	2048	833,283	1,047,547	167,189	41,653		**2,089,672**	1,189,843	0.1756	0.88
27	2049	816,588	1,019,064	163,470	40,753		**2,039,875**	1,214,221	0.1680	0.84
28	2050	799,892	990,582	159,750	39,852		**1,990,077**	1,243,569	0.1600	0.80
29	2051	783,196	962,100	156,031	38,952		**1,940,279**	1,243,569	0.1560	0.78
30	2052	766,501	933,618	152,311	38,051		**1,890,481**	1,243,569	0.1520	0.76
31	2053	749,805	905,135	148,592	37,151		**1,840,683**	1,243,569	0.1480	0.74
32	2054	733,109	876,653	144,873	36,250		**1,790,885**	1,243,569	0.1440	0.72
33	2055	716,414	848,171	141,153	35,350		**1,741,087**	1,243,569	0.1400	0.70
34	2056	699,718	819,689	137,434	34,449		**1,691,289**	1,243,569	0.1360	0.68
35	2057	683,022	791,206	133,714	33,549		**1,641,492**	1,243,569	0.1320	0.66
36	2058	666,327	762,724	129,995	32,648		**1,591,694**	1,243,569	0.1280	0.64
37	2059	649,631	734,242	126,275	31,748		**1,541,896**	1,243,569	0.1240	0.62
38	2060	632,935	705,760	122,556	30,847		**1,492,098**	1,243,569	0.1200	0.60
39	2061	616,240	677,277	118,836	29,947		**1,442,300**	1,243,569	0.1160	0.58
40	2062	599,544	648,795	115,117	29,046		**1,392,502**	1,243,569	0.1120	0.56
41	2063	582,848	620,313	111,397	28,146		**1,342,704**	1,243,569	0.1080	0.54
42	2064	566,153	591,831	107,678	27,245		**1,292,907**	1,243,569	0.1040	0.52
43	2065	549,457	563,348	103,958	26,345		**1,243,109**	1,243,569	0.1000	0.50
44	2066	532,761	534,866	100,239	25,444		**1,193,311**	1,243,569	0.0960	0.48
45	2067	516,066	506,384	96,520	24,544		**1,143,513**	1,243,569	0.0920	0.46
46	2068	499,370	477,902	92,800	23,643		**1,093,715**	1,243,569	0.0879	0.44
47	2069	482,674	401,656	89,081	22,743		**996,154**	1,243,569	0.0801	0.40
48	2070	465,979	308,030	85,361	21,842		**881,212**	1,243,569	0.0709	0.35
49	2071	449,283	173,942	81,642	20,942		**725,809**	1,243,569	0.0584	0.29
50	2072	432,587	(0)	77,922	20,041		**530,551**	1,243,569	0.0427	0.21
51	2073	415,892	(0)	74,203	19,141		**509,235**	1,243,569	0.0409	0.20
52	2074	399,196	(0)	70,483	18,240		**487,920**	1,243,569	0.0392	0.20
53	2075	382,500	(0)	66,764	17,340		**466,604**	1,243,569	0.0375	0.19
54	2076	365,805	(0)	63,044	16,439		**445,289**	1,243,569	0.0358	0.18
55	2077	349,109	(0)	54,444	15,539		**419,092**	1,243,569	0.0337	0.17
56	2078	332,413	(0)	47,559	14,638		**394,611**	1,243,569	0.0317	0.16
57	2079	315,718	(0)	23,370	10,318		**349,406**	1,243,569	0.0281	0.14
58	2080	299,022	(0)	(0)	6,809		**305,831**	1,243,569	0.0246	0.12
59	2081	282,326	(0)	(0)	3,374		**285,701**	1,243,569	0.0230	0.11
60	2082	235,406	(0)	(0)	0		**235,406**	1,243,569	0.0189	0.09
61	2083	197,987	(0)	(0)	0		**197,987**	1,243,569	0.0159	0.08
62	2084	120,575	(0)	(0)	0		**120,575**	1,243,569	0.0097	0.05
63	2085	(0)	(0)	(0)	0		**(0)**	1,243,569	(0.0000)	(0.00)
64	2086	(0)	(0)	(0)	0		**(0)**	1,243,569	(0.0000)	(0.00)
Total		42,083,113	48,280,557	8,224,888	2,116,465	11,943,205	**112,648,228**		*Average*	0.86
NPV @	7.00%	11,729,586	15,950,712	2,435,395	642,541	9,487,874	**40,246,108**		*Highest 5-year Average*	2.28

Notes:
1. Sales Forecast developed in August 2021 for IGP obtained from Forecasting Division. Using 2050 forecasted sales for years thereafter.
2. Hawaii Electric Light typical residential energy consumption, per month.

Resilience Project/Program
ME Summary

		Maui Electric								
Year		Capital - Transmission Revenue Requirement	Capital - Distribution Revenue Requirement	Capital - Dist - OH Cond Revenue Requirement	Capital - Dist - Station Revenue Requirement	O&M Revenue Requirement	**Total Revenue Requirement**	Sale Forecast[1] (MWh)	Rate Impact cents per kWh	**Bill Impact 500 kWh[2]**
1	2023	-	-	-	-	-	**-**	976,322	-	-
2	2024	-	-	-	-	323,240	**323,240**	979,363	0.0330	0.17
3	2025	71,226	211,736	109,368	38,098	2,913,998	**3,344,425**	981,821	0.3406	1.70
4	2026	191,376	516,779	248,315	64,951	3,002,140	**4,023,562**	989,168	0.4068	2.03
5	2027	437,654	934,935	637,582	92,183	3,087,480	**5,189,834**	996,591	0.5208	2.60
6	2028	917,018	1,458,895	722,771	108,850	3,178,323	**6,385,858**	1,002,783	0.6368	3.18
7	2029	889,681	1,419,002	704,229	106,116		**3,119,028**	1,004,108	0.3106	1.55
8	2030	864,181	1,380,731	686,505	103,503		**3,034,920**	1,009,866	0.3005	1.50
9	2031	840,245	1,343,960	669,537	101,002		**2,954,744**	1,017,121	0.2905	1.45
10	2032	817,522	1,308,509	653,234	98,593		**2,877,859**	1,031,550	0.2790	1.39
11	2033	795,499	1,274,103	637,457	96,245		**2,803,304**	1,047,358	0.2677	1.34
12	2034	773,666	1,240,397	621,976	93,930		**2,729,969**	1,064,533	0.2564	1.28
13	2035	754,540	1,214,630	610,651	93,056		**2,672,877**	1,083,505	0.2467	1.23
14	2036	737,166	1,191,932	600,250	91,697		**2,621,045**	1,107,380	0.2367	1.18
15	2037	724,399	1,172,815	598,937	90,302		**2,586,453**	1,125,609	0.2298	1.15
16	2038	720,102	1,156,808	585,604	88,457		**2,550,972**	1,149,043	0.2220	1.11
17	2039	695,944	1,119,530	568,203	85,848		**2,469,526**	1,172,701	0.2106	1.05
18	2040	672,714	1,082,251	550,802	83,239		**2,389,007**	1,199,822	0.1991	1.00
19	2041	651,474	1,044,973	533,401	80,630		**2,310,478**	1,219,619	0.1894	0.95
20	2042	634,154	1,007,694	516,000	78,021		**2,235,869**	1,244,543	0.1797	0.90
21	2043	621,169	970,416	498,599	75,412		**2,165,596**	1,269,614	0.1706	0.85
22	2044	609,908	933,669	481,482	72,902		**2,097,961**	1,295,594	0.1619	0.81
23	2045	598,647	898,764	465,298	70,664		**2,033,373**	1,316,106	0.1545	0.77
24	2046	587,386	867,035	451,158	68,745		**1,974,325**	1,339,353	0.1474	0.74
25	2047	576,126	839,635	439,699	67,100		**1,922,560**	1,362,540	0.1411	0.71
26	2048	564,865	816,078	429,793	65,629		**1,876,364**	1,389,429	0.1350	0.68
27	2049	553,604	793,900	420,151	64,207		**1,831,862**	1,409,077	0.1300	0.65
28	2050	542,343	771,721	410,508	62,786		**1,787,359**	1,433,122	0.1247	0.62
29	2051	531,082	749,543	400,866	61,365		**1,742,856**	1,433,122	0.1216	0.61
30	2052	519,821	727,365	391,224	59,943		**1,698,353**	1,433,122	0.1185	0.59
31	2053	508,561	705,187	381,581	58,522		**1,653,851**	1,433,122	0.1154	0.58
32	2054	497,300	683,009	371,939	57,101		**1,609,348**	1,433,122	0.1123	0.56
33	2055	486,039	660,830	362,297	55,679		**1,564,845**	1,433,122	0.1092	0.55
34	2056	474,778	638,652	352,654	54,258		**1,520,342**	1,433,122	0.1061	0.53
35	2057	463,517	616,474	343,012	52,836		**1,475,839**	1,433,122	0.1030	0.51
36	2058	452,256	594,296	333,370	51,415		**1,431,337**	1,433,122	0.0999	0.50
37	2059	440,996	572,117	323,727	49,994		**1,386,834**	1,433,122	0.0968	0.48
38	2060	429,735	549,939	314,085	48,572		**1,342,331**	1,433,122	0.0937	0.47
39	2061	418,474	527,761	304,443	47,151		**1,297,828**	1,433,122	0.0906	0.45
40	2062	407,213	505,583	294,800	45,729		**1,253,325**	1,433,122	0.0875	0.44
41	2063	395,952	483,405	285,158	44,308		**1,208,823**	1,433,122	0.0843	0.42
42	2064	384,691	461,226	275,516	42,887		**1,164,320**	1,433,122	0.0812	0.41
43	2065	373,430	439,048	265,873	41,465		**1,119,817**	1,433,122	0.0781	0.39
44	2066	362,170	416,870	256,231	40,044		**1,075,314**	1,433,122	0.0750	0.38
45	2067	350,909	394,692	246,589	38,622		**1,030,812**	1,433,122	0.0719	0.36
46	2068	339,648	372,513	236,946	37,201		**986,309**	1,433,122	0.0688	0.34
47	2069	328,387	306,897	227,304	35,780		**898,367**	1,433,122	0.0627	0.31
48	2070	317,126	224,052	217,662	34,358		**793,198**	1,433,122	0.0553	0.28
49	2071	305,865	120,863	208,019	32,937		**667,685**	1,433,122	0.0466	0.23
50	2072	294,605	(0)	198,377	31,516		**524,497**	1,433,122	0.0366	0.18
51	2073	283,344	(0)	188,735	30,094		**502,172**	1,433,122	0.0350	0.18
52	2074	272,083	(0)	179,092	28,673		**479,848**	1,433,122	0.0335	0.17
53	2075	260,822	(0)	169,450	27,251		**457,523**	1,433,122	0.0319	0.16
54	2076	249,561	(0)	159,808	25,830		**435,199**	1,433,122	0.0304	0.15
55	2077	238,300	(0)	130,561	24,409		**393,270**	1,433,122	0.0274	0.14
56	2078	227,040	(0)	96,905	22,987		**346,931**	1,433,122	0.0242	0.12
57	2079	215,779	(0)	19,559	14,946		**250,283**	1,433,122	0.0175	0.09
58	2080	204,518	(0)	(0)	9,161		**213,679**	1,433,122	0.0149	0.07
59	2081	193,257	(0)	(0)	3,541		**196,798**	1,433,122	0.0137	0.07
60	2082	170,096	(0)	(0)	0		**170,096**	1,433,122	0.0119	0.06
61	2083	139,250	(0)	(0)	0		**139,250**	1,433,122	0.0097	0.05
62	2084	88,197	(0)	(0)	0		**88,197**	1,433,122	0.0062	0.03
63	2085						**-**	1,433,122	-	-
64	2086						**-**	1,433,122	-	-
Total		28,467,412	37,721,218	21,387,291	3,350,743	12,505,182	**103,431,847**		*Average*	0.71
NPV @	6.94%	7,929,875	12,651,702	6,602,305	1,039,443	9,939,765	**38,163,089**		*Highest 5-year Average*	2.22

Notes:
1. Sales Forecast developed in August 2021 for IGP obtained from Forecasting Division. Using 2050 forecasted sales for years thereafter.
2. Maui Electric typical residential energy consumption, per month.

Resilience Project/Program
Tax Depreciation Factors

Manual input

Tax Depreciation Rates (Straight Line)

Years	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
-																														
3	16.670%	33.330%	33.330%	16.670%																										
5	10.000%	20.000%	20.000%	20.000%	20.000%	10.000%																								
7	7.140%	14.290%	14.290%	14.280%	14.290%	14.280%	14.290%	7.140%																						
10	5.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	5.000%																			
15	3.330%	6.670%	6.670%	6.670%	6.670%	6.670%	6.670%	6.660%	6.670%	6.660%	6.670%	6.660%	6.670%	6.660%	6.670%	3.330%														
20	2.500%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	2.500%									
25	2.000%	4.000%	4.000%	4.000%	4.000%	4.000%	4.000%	4.000%	4.000%	4.000%	4.000%	4.000%	4.000%	4.000%	4.000%	4.000%	4.000%	4.000%	4.000%	4.000%	4.000%	4.000%	4.000%	4.000%	4.000%	2.000%				
28	1.786%	3.571%	3.571%	3.571%	3.571%	3.571%	3.572%	3.571%	3.572%	3.571%	3.572%	3.571%	3.572%	3.571%	3.572%	3.571%	3.572%	3.571%	3.572%	3.571%	3.572%	3.571%	3.572%	3.571%	3.572%	3.571%	3.572%	3.571%	1.786%	
30	1.667%	3.333%	3.333%	3.333%	3.333%	3.333%	3.333%	3.333%	3.333%	3.333%	3.333%	3.333%	3.334%	3.333%	3.334%	3.333%	3.334%	3.333%	3.334%	3.333%	3.334%	3.333%	3.334%	3.333%	3.334%	3.333%	3.334%	3.333%	3.334%	3.333%
35	1.429%	2.857%	2.857%	2.857%	2.857%	2.857%	2.857%	2.857%	2.857%	2.857%	2.857%	2.857%	2.857%	2.857%	2.857%	2.857%	2.857%	2.857%	2.857%	2.857%	2.857%	2.857%	2.857%	2.857%	2.857%	2.857%	2.857%	2.858%	2.857%	2.858%
50	1.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%

Source: IRS Publication 946, Table A-8

Tax Depreciation Rates (MACRS)

Years	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
-																					
3	33.330%	44.450%	14.810%	7.410%																	
5	20.000%	32.000%	19.200%	11.520%	11.520%	5.760%															
7	14.290%	24.490%	17.490%	12.490%	8.930%	8.920%	8.930%	4.460%													
10	10.000%	18.000%	14.400%	11.520%	9.220%	7.370%	6.550%	6.550%	6.560%	6.550%	3.280%										
15	5.000%	9.500%	8.550%	7.700%	6.930%	6.230%	5.900%	5.900%	5.910%	5.900%	5.910%	5.900%	5.910%	5.900%	5.910%	2.950%					
20	3.750%	7.219%	6.677%	6.177%	5.713%	5.285%	4.888%	4.522%	4.462%	4.461%	4.462%	4.461%	4.462%	4.461%	4.462%	4.461%	4.462%	4.461%	4.462%	4.461%	2.231%

Source: IRS Publication 946, Table A-1

Resilience Project/Program
Tax Depreciation Factors

Manual input	Years	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	Total
Tax Depreciation Rate																																
	-																															
	3																															100.000%
	5																															100.000%
	7																															100.000%
	10																															100.000%
	15																															100.000%
	20																															100.000%
	25																															100.000%
	28																															100.000%
	30	1.667%																														100.000%
	35	2.857%	2.858%	2.857%	2.858%	2.857%	1.429%																									100.000%
	50	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	2.000%	1.000%										100.000%

Source: IRS Publication 946, T

Tax Depreciation Rate																																
	-																															
	3																															100.000%
	5																															100.000%
	7																															100.000%
	10																															100.000%
	15																															100.000%
	20																															100.000%

Source: IRS Publication 946, T

Resilience Project/Program
HE Capital Revenue Requirements

			HE Transmission						
			1	2	3	4	5		
			2023	2024	2025	2026	2027	**Total**	**Check**
		Capital Investment	$0	$0	$9,823,804	$17,068,128	$27,302,074	**$54,194,006**	-
		RR Factor							
1	2023	-	-	-	-	-	-	-	
2	2024	0.111	-	-	-	-	-	-	
3	2025	0.107	-	-	-	-	-	-	
4	2026	0.104	-	-	1,085,934	-	-	1,085,934	
5	2027	0.101	-	-	1,052,646	1,886,730	-	2,939,376	
6	2028	0.098	-	-	1,021,675	1,828,894	3,018,002	5,868,571	
7	2029	0.096	-	-	992,790	1,775,085	2,925,488	5,693,363	
8	2030	0.093	-	-	965,796	1,724,898	2,839,415	5,530,109	
9	2031	0.091	-	-	940,129	1,677,999	2,759,136	5,377,264	
10	2032	0.088	-	-	914,886	1,633,403	2,684,117	5,232,406	
11	2033	0.085	-	-	889,630	1,589,546	2,612,782	5,091,959	
12	2034	0.087	-	-	864,375	1,545,666	2,542,628	4,952,669	
13	2035	0.084	-	-	839,119	1,501,786	2,472,438	4,813,344	
14	2036	0.081	-	-	855,506	1,457,907	2,402,248	4,715,661	
15	2037	0.078	-	-	827,281	1,486,378	2,332,059	4,645,717	
16	2038	0.076	-	-	799,056	1,437,339	2,377,601	4,613,996	
17	2039	0.074	-	-	770,832	1,388,301	2,299,159	4,458,291	
18	2040	0.073	-	-	746,404	1,339,262	2,220,718	4,306,384	
19	2041	0.072	-	-	729,584	1,296,822	2,142,276	4,168,682	
20	2042	0.070	-	-	716,562	1,267,598	2,074,388	4,058,548	
21	2043	0.069	-	-	703,540	1,244,973	2,027,643	3,976,155	
22	2044	0.068	-	-	690,517	1,222,348	1,991,451	3,904,316	
23	2045	0.066	-	-	677,495	1,199,722	1,955,260	3,832,476	
24	2046	0.065	-	-	664,472	1,177,097	1,919,068	3,760,637	
25	2047	0.064	-	-	651,450	1,154,471	1,882,876	3,688,797	
26	2048	0.062	-	-	638,427	1,131,846	1,846,685	3,616,958	
27	2049	0.061	-	-	625,405	1,109,220	1,810,493	3,545,118	
28	2050	0.060	-	-	612,383	1,086,595	1,774,302	3,473,279	
29	2051	0.058	-	-	599,360	1,063,969	1,738,110	3,401,439	
30	2052	0.057	-	-	586,338	1,041,344	1,701,918	3,329,600	
31	2053	0.056	-	-	573,315	1,018,718	1,665,727	3,257,760	
32	2054	0.054	-	-	560,293	996,093	1,629,535	3,185,921	
33	2055	0.053	-	-	547,270	973,467	1,593,344	3,114,081	
34	2056	0.052	-	-	534,248	950,842	1,557,152	3,042,242	
35	2057	0.050	-	-	521,226	928,216	1,520,960	2,970,402	
36	2058	0.049	-	-	508,203	905,591	1,484,769	2,898,563	
37	2059	0.048	-	-	495,181	882,965	1,448,577	2,826,723	
38	2060	0.046	-	-	482,158	860,340	1,412,386	2,754,884	
39	2061	0.045	-	-	469,136	837,714	1,376,194	2,683,044	
40	2062	0.044	-	-	456,113	815,089	1,340,002	2,611,205	
41	2063	0.042	-	-	443,091	792,463	1,303,811	2,539,365	
42	2064	0.041	-	-	430,069	769,838	1,267,619	2,467,526	
43	2065	0.040	-	-	417,046	747,212	1,231,428	2,395,686	
44	2066	0.038	-	-	404,024	724,587	1,195,236	2,323,846	
45	2067	0.037	-	-	391,001	701,961	1,159,044	2,252,007	
46	2068	0.036	-	-	377,979	679,336	1,122,853	2,180,167	
47	2069	0.034	-	-	364,956	656,710	1,086,661	2,108,328	
48	2070	0.033	-	-	351,934	634,085	1,050,470	2,036,488	
49	2071	0.032	-	-	338,912	611,459	1,014,278	1,964,649	
50	2072	0.031	-	-	325,889	588,834	978,086	1,892,809	
51	2073	0.029	-	-	312,867	566,208	941,895	1,820,970	
52	2074	0.028	-	-	299,844	543,583	905,703	1,749,130	
53	2075	0.027	-	-	286,822	520,957	869,512	1,677,291	
54	2076	0.025	-	-	273,800	498,332	833,320	1,605,451	
55	2077	0.024	-	-	260,777	475,706	797,128	1,533,612	
56	2078	0.023	-	-	247,755	453,081	760,937	1,461,772	
57	2079	0.021	-	-	234,732	430,455	724,745	1,389,933	
58	2080	0.020	-	-	221,710	407,830	688,554	1,318,093	
59	2081	(0.000)	-	-	208,687	385,204	652,362	1,246,254	
60	2082	(0.000)	-	-	195,665	362,579	616,170	1,174,414	
61	2083	-	-	-	(0)	339,953	579,979	919,932	
62	2084	-	-	-	(0)	(0)	543,787	543,787	
63	2085	-	-	-	-	(0)	(0)	(0)	
64	2086	-	-	-	-	-	(0)	(0)	
Total			-	-	32,996,295	57,328,604	91,702,487	182,027,386	
NPV @	6.88%		-	-	9,378,336	15,244,632	22,814,537	47,437,505	

			HE Distribution - Poles, Towers, and Fixtures						
			1	2	3	4	5		
			2023	2024	2025	2026	2027	**Total**	**Check**
		Capital Investment	$0	$2,069,067	$5,033,360	$9,417,244	$15,027,829	**$31,547,500**	-
		RR Factor							
1	2023	-	-	-	-	-	-	-	
2	2024	0.117	-	-	-	-	-	-	
3	2025	0.113	-	241,379	-	-	-	241,379	
4	2026	0.110	-	234,683	587,195	-	-	821,878	
5	2027	0.107	-	228,271	570,908	1,098,622	-	1,897,800	
6	2028	0.104	-	222,119	555,308	1,068,149	1,753,156	3,598,732	
7	2029	0.102	-	216,210	540,344	1,038,962	1,704,528	3,500,044	
8	2030	0.099	-	210,524	525,968	1,010,964	1,657,952	3,405,408	
9	2031	0.097	-	205,045	512,136	984,068	1,613,275	3,314,523	
10	2032	0.094	-	199,682	498,807	958,189	1,570,353	3,227,031	
11	2033	0.091	-	194,335	485,760	933,252	1,529,057	3,142,403	
12	2034	0.093	-	188,988	472,753	908,840	1,489,262	3,059,843	
13	2035	0.090	-	192,412	459,745	884,504	1,450,307	2,986,968	
14	2036	0.087	-	186,439	468,074	860,168	1,411,472	2,926,153	
15	2037	0.084	-	180,467	453,545	875,750	1,372,636	2,882,399	
16	2038	0.081	-	174,495	439,017	848,568	1,397,503	2,859,583	
17	2039	0.079	-	168,522	424,488	821,385	1,354,126	2,768,522	
18	2040	0.076	-	162,550	409,960	794,203	1,310,749	2,677,461	
19	2041	0.073	-	156,578	395,431	767,020	1,267,371	2,586,401	
20	2042	0.070	-	150,606	380,902	739,838	1,223,994	2,495,340	
21	2043	0.067	-	144,633	366,374	712,655	1,180,617	2,404,280	
22	2044	0.065	-	139,266	351,845	685,473	1,137,240	2,313,824	
23	2045	0.064	-	135,108	338,788	658,290	1,093,863	2,226,049	
24	2046	0.062	-	131,555	328,673	633,861	1,050,485	2,144,574	
25	2047	0.060	-	128,002	320,030	614,936	1,011,501	2,074,469	
26	2048	0.058	-	124,449	311,386	598,764	981,302	2,015,901	
27	2049	0.057	-	120,895	302,742	582,593	955,495	1,961,725	
28	2050	0.055	-	117,342	294,099	566,421	929,688	1,907,550	
29	2051	0.053	-	113,789	285,455	550,249	903,882	1,853,375	
30	2052	0.052	-	110,236	276,812	534,077	878,075	1,799,200	
31	2053	0.050	-	106,683	268,168	517,905	852,269	1,745,025	
32	2054	0.048	-	103,130	259,525	501,734	826,462	1,690,850	
33	2055	0.046	-	99,577	250,881	485,562	800,655	1,636,675	
34	2056	0.045	-	96,024	242,238	469,390	774,849	1,582,500	
35	2057	0.043	-	92,471	233,594	453,218	749,042	1,528,325	
36	2058	0.041	-	88,917	224,950	437,046	723,236	1,474,150	
37	2059	0.040	-	85,364	216,307	420,875	697,429	1,419,975	
38	2060	0.038	-	81,811	207,663	404,703	671,622	1,365,800	
39	2061	0.036	-	78,258	199,020	388,531	645,816	1,311,625	
40	2062	0.034	-	74,705	190,376	372,359	620,009	1,257,450	
41	2063	0.033	-	71,152	181,733	356,188	594,203	1,203,275	
42	2064	0.031	-	67,599	173,089	340,016	568,396	1,149,100	
43	2065	0.029	-	64,046	164,446	323,844	542,590	1,094,925	
44	2066	0.028	-	60,493	155,802	307,672	516,783	1,040,750	
45	2067	0.026	-	56,939	147,159	291,500	490,976	986,575	
46	2068	(0.000)	-	53,386	138,515	275,329	465,170	932,400	
47	2069	(0.000)	-	(0)	129,871	259,157	439,363	828,391	
48	2070	(0.000)	-	(0)	(0)	242,985	413,557	656,542	
49	2071	(0.000)	-	(0)	(0)	(0)	387,750	387,750	
50	2072	(0.000)	-	(0)	(0)	(0)	(0)	(0)	
51	2073	(0.000)	-	(0)	(0)	(0)	(0)	(0)	
52	2074	(0.000)	-	(0)	(0)	(0)	(0)	(0)	
53	2075	(0.000)	-	(0)	(0)	(0)	(0)	(0)	
54	2076	(0.000)	-	(0)	(0)	(0)	(0)	(0)	
55	2077	(0.000)	-	(0)	(0)	(0)	(0)	(0)	
56	2078	(0.000)	-	(0)	(0)	(0)	(0)	(0)	
57	2079	(0.000)	-	(0)	(0)	(0)	(0)	(0)	
58	2080	(0.000)	-	(0)	(0)	(0)	(0)	(0)	
59	2081	(0.000)	-	(0)	(0)	(0)	(0)	(0)	
60	2082	(0.000)	-	(0)	(0)	(0)	(0)	(0)	
61	2083	-	-	(0)	(0)	(0)	(0)	(0)	
62	2084	-	-	-	(0)	(0)	(0)	(0)	
63	2085	-	-	-	-	(0)	(0)	(0)	
64	2086	-	-	-	-	-	(0)	(0)	
Total			-	6,059,134	14,739,882	27,577,816	44,008,066	92,384,898	
NPV @	6.88%		-	2,160,799	4,917,934	8,608,621	12,852,599	28,539,953	

HE Distribution - Overhead Conductors and Devices

		1	2	3	4	5		
		2023	2024	2025	2026	2027	**Total**	**Check**
Capital Investment		$0	$1,045,588	$2,083,959	$1,084,010	$1,127,562	**$5,341,118**	-
	RR Factor							
2023	-	-	-	-	-	-	**-**	
2024	0.113	-	-	-	-	-	**-**	
2025	0.110	-	118,105	-	-	-	**118,105**	
2026	0.107	-	114,998	235,394	-	-	**350,392**	
2027	0.104	-	112,033	229,201	122,445	-	**463,679**	
2028	0.102	-	109,201	223,293	119,223	127,364	**579,081**	
2029	0.099	-	106,491	217,648	116,150	124,013	**564,302**	
2030	0.097	-	103,894	212,247	113,214	120,817	**550,170**	
2031	0.095	-	101,401	207,070	110,404	117,762	**536,638**	
2032	0.092	-	98,967	202,103	107,711	114,840	**523,621**	
2033	0.090	-	96,541	197,251	105,127	112,039	**510,959**	
2034	0.092	-	94,115	192,416	102,604	109,351	**498,486**	
2035	0.089	-	96,122	187,581	100,089	106,726	**490,518**	
2036	0.087	-	93,380	191,580	97,574	104,110	**486,644**	
2037	0.084	-	90,638	186,116	99,654	101,494	**477,902**	
2038	0.081	-	87,896	180,651	96,811	103,658	**469,016**	
2039	0.079	-	85,155	175,186	93,969	100,701	**455,011**	
2040	0.076	-	82,413	169,721	91,126	97,744	**441,005**	
2041	0.074	-	79,671	164,257	88,284	94,787	**426,999**	
2042	0.071	-	76,929	158,792	85,441	91,831	**412,993**	
2043	0.069	-	74,187	153,327	82,599	88,874	**398,987**	
2044	0.067	-	71,751	147,863	79,756	85,917	**385,287**	
2045	0.065	-	69,926	143,007	76,913	82,960	**372,807**	
2046	0.064	-	68,407	139,370	74,388	80,004	**362,168**	
2047	0.063	-	66,888	136,342	72,496	77,376	**353,102**	
2048	0.061	-	65,368	133,314	70,921	75,408	**345,011**	
2049	0.060	-	63,849	130,285	69,346	73,770	**337,250**	
2050	0.058	-	62,330	127,257	67,770	72,132	**329,489**	
2051	0.057	-	60,810	124,229	66,195	70,493	**321,728**	
2052	0.055	-	59,291	121,201	64,620	68,855	**313,967**	
2053	0.054	-	57,772	118,173	63,045	67,216	**306,206**	
2054	0.052	-	56,253	115,145	61,470	65,578	**298,445**	
2055	0.051	-	54,733	112,117	59,895	63,940	**290,684**	
2056	0.049	-	53,214	109,089	58,320	62,301	**282,923**	
2057	0.048	-	51,695	106,061	56,744	60,663	**275,162**	
2058	0.047	-	50,175	103,032	55,169	59,024	**267,401**	
2059	0.045	-	48,656	100,004	53,594	57,386	**259,640**	
2060	0.044	-	47,137	96,976	52,019	55,747	**251,879**	
2061	0.042	-	45,617	93,948	50,444	54,109	**244,118**	
2062	0.041	-	44,098	90,920	48,869	52,471	**236,358**	
2063	0.039	-	42,579	87,892	47,294	50,832	**228,597**	
2064	0.038	-	41,059	84,864	45,719	49,194	**220,836**	
2065	0.036	-	39,540	81,836	44,143	47,555	**213,075**	
2066	0.035	-	38,021	78,807	42,568	45,917	**205,314**	
2067	0.033	-	36,502	75,779	40,993	44,279	**197,553**	
2068	0.032	-	34,982	72,751	39,418	42,640	**189,792**	
2069	0.031	-	33,463	69,723	37,843	41,002	**182,031**	
2070	0.029	-	31,944	66,695	36,268	39,363	**174,270**	
2071	0.028	-	30,424	63,667	34,693	37,725	**166,509**	
2072	0.026	-	28,905	60,639	33,118	36,086	**158,748**	
2073	0.025	-	27,386	57,611	31,542	34,448	**150,987**	
2074	0.023	-	25,866	54,583	29,967	32,810	**143,226**	
2075	0.022	-	24,347	51,554	28,392	31,171	**135,465**	
2076	(0.000)	-	22,828	48,526	26,817	29,533	**127,704**	
2077	(0.000)	-	(0)	45,498	25,242	27,894	**98,634**	
2078	(0.000)	-	(0)	(0)	23,667	26,256	**49,923**	
2079	(0.000)	-	(0)	(0)	(0)	24,618	**24,618**	
2080	(0.000)	-	(0)	(0)	(0)	(0)	**(0)**	
2081	(0.000)	-	(0)	(0)	(0)	(0)	**(0)**	
2082	(0.000)	-	(0)	(0)	(0)	(0)	**(0)**	
2083	-	-	(0)	(0)	(0)	(0)	**(0)**	
2084	-	-	-	(0)	(0)	(0)	**(0)**	
2085	-	-	-	-	(0)	(0)	**(0)**	
2086	-	-	-	-	-	(0)	**(0)**	
		-	3,377,954	6,732,593	3,502,083	3,642,785	**17,255,414**	
		-	1,093,393	2,038,872	992,245	965,631	**5,090,140**	

HE Distribution - Station Equipment - Substations

		1	2	3	4	5		
		2023	2024	2025	2026	2027	**Total**	**Check**
Capital Investment		$0	$178,700	$152,266	$160,500	$171,141	**$662,607**	-
	RR Factor							
2023	-	-	-	-	-	-	**-**	
2024	0.112	-	-	-	-	-	**-**	
2025	0.109	-	20,050	-	-	-	**20,050**	
2026	0.107	-	19,529	17,084	-	-	**36,613**	
2027	0.104	-	19,032	16,640	18,008	-	**53,680**	
2028	0.101	-	18,557	16,216	17,540	19,202	**71,516**	
2029	0.099	-	18,104	15,812	17,093	18,703	**69,712**	
2030	0.097	-	17,670	15,426	16,667	18,227	**67,989**	
2031	0.094	-	17,253	15,056	16,260	17,772	**66,341**	
2032	0.092	-	16,847	14,701	15,870	17,338	**64,756**	
2033	0.090	-	16,442	14,355	15,496	16,922	**63,215**	
2034	0.092	-	16,037	14,010	15,131	16,523	**61,701**	
2035	0.089	-	16,389	13,665	14,767	16,134	**60,955**	
2036	0.087	-	15,930	13,965	14,403	15,746	**60,045**	
2037	0.084	-	15,471	13,574	14,720	15,358	**59,124**	
2038	0.081	-	15,012	13,183	14,308	15,696	**58,199**	
2039	0.079	-	14,553	12,792	13,896	15,257	**56,497**	
2040	0.076	-	14,094	12,401	13,483	14,817	**54,795**	
2041	0.074	-	13,635	12,010	13,071	14,377	**53,094**	
2042	0.071	-	13,176	11,618	12,659	13,938	**51,392**	
2043	0.069	-	12,718	11,227	12,247	13,498	**49,690**	
2044	0.067	-	12,311	10,836	11,834	13,059	**48,040**	
2045	0.066	-	12,008	10,490	11,422	12,619	**46,540**	
2046	0.064	-	11,758	10,232	11,057	12,180	**45,227**	
2047	0.063	-	11,508	10,019	10,785	11,790	**44,103**	
2048	0.062	-	11,258	9,806	10,561	11,501	**43,126**	
2049	0.060	-	11,008	9,593	10,336	11,261	**42,199**	
2050	0.059	-	10,758	9,380	10,112	11,022	**41,271**	
2051	0.057	-	10,508	9,167	9,887	10,782	**40,344**	
2052	0.056	-	10,258	8,954	9,663	10,543	**39,417**	
2053	0.055	-	10,008	8,741	9,438	10,303	**38,490**	
2054	0.053	-	9,758	8,528	9,213	10,064	**37,563**	
2055	0.052	-	9,508	8,315	8,989	9,824	**36,636**	
2056	0.050	-	9,258	8,102	8,764	9,585	**35,709**	
2057	0.049	-	9,008	7,888	8,540	9,345	**34,781**	
2058	0.048	-	8,758	7,675	8,315	9,106	**33,854**	
2059	0.046	-	8,508	7,462	8,090	8,866	**32,927**	
2060	0.045	-	8,258	7,249	7,866	8,627	**32,000**	
2061	0.043	-	8,008	7,036	7,641	8,387	**31,073**	
2062	0.042	-	7,758	6,823	7,417	8,148	**30,146**	
2063	0.041	-	7,508	6,610	7,192	7,909	**29,218**	
2064	0.039	-	7,258	6,397	6,968	7,669	**28,291**	
2065	0.038	-	7,008	6,184	6,743	7,430	**27,364**	
2066	0.036	-	6,758	5,971	6,518	7,190	**26,437**	
2067	0.035	-	6,507	5,758	6,294	6,951	**25,510**	
2068	0.034	-	6,257	5,545	6,069	6,711	**24,583**	
2069	0.032	-	6,007	5,332	5,845	6,472	**23,656**	
2070	0.031	-	5,757	5,119	5,620	6,232	**22,728**	
2071	0.029	-	5,507	4,906	5,396	5,993	**21,801**	
2072	0.028	-	5,257	4,693	5,171	5,753	**20,874**	
2073	0.027	-	5,007	4,480	4,946	5,514	**19,947**	
2074	0.025	-	4,757	4,267	4,722	5,274	**19,020**	
2075	0.024	-	4,507	4,053	4,497	5,035	**18,093**	
2076	0.022	-	4,257	3,840	4,273	4,795	**17,166**	
2077	0.021	-	4,007	3,627	4,048	4,556	**16,238**	
2078	0.000	-	3,757	3,414	3,823	4,316	**15,311**	
2079	0.000	-	0	3,201	3,599	4,077	**10,877**	
2080	0.000	-	0	0	3,374	3,838	**7,212**	
2081	0.000	-	0	0	0	3,598	**3,598**	
2082	0.000	-	0	0	0	0	**0**	
2083	-	-	0	0	0	0	**0**	
2084	-	-	-	0	0	0	**0**	
2085	-	-	-	-	0	0	**0**	
2086	-	-	-	-	-	0	**0**	
		-	590,825	503,426	530,649	565,833	**2,190,734**	
		-	186,924	149,014	146,955	146,605	**629,497**	

	HE Distribution - Underground Condui						
		1	2	3	4	5		
		2023	2024	2025	2026	2027	Total	Check
Capital Investment		$0	$643,513	$600,769	$620,497	$642,487	$2,507,266	-
	RR Factor							
2023	-	-	-	-	-	-	**-**	
2024	0.111	-	-	-	-	-	**-**	
2025	0.108	-	71,132	-	-	-	**71,132**	
2026	0.105	-	69,331	66,407	-	-	**135,738**	
2027	0.103	-	67,617	64,726	68,588	-	**200,931**	
2028	0.100	-	65,985	63,126	66,851	71,019	**266,981**	
2029	0.098	-	64,428	61,602	65,199	69,220	**260,450**	
2030	0.096	-	62,941	60,149	63,625	67,510	**254,224**	
2031	0.093	-	61,518	58,760	62,124	65,880	**248,281**	
2032	0.091	-	60,130	57,431	60,690	64,325	**242,577**	
2033	0.089	-	58,748	56,136	59,317	62,840	**237,043**	
2034	0.091	-	57,366	54,846	57,980	61,420	**231,612**	
2035	0.089	-	58,712	53,556	56,647	60,035	**228,950**	
2036	0.086	-	57,136	54,812	55,315	58,655	**225,917**	
2037	0.084	-	55,559	53,341	56,612	57,275	**222,787**	
2038	0.081	-	53,983	51,869	55,092	58,619	**219,562**	
2039	0.079	-	52,406	50,397	53,572	57,045	**213,420**	
2040	0.077	-	50,830	48,925	52,052	55,471	**207,277**	
2041	0.074	-	49,253	47,453	50,532	53,897	**201,135**	
2042	0.072	-	47,677	45,981	49,012	52,323	**194,992**	
2043	0.069	-	46,100	44,510	47,491	50,749	**188,850**	
2044	0.068	-	44,712	43,038	45,971	49,175	**182,895**	
2045	0.067	-	43,699	41,742	44,451	47,600	**177,493**	
2046	0.065	-	42,875	40,797	43,112	46,026	**172,811**	
2047	0.064	-	42,051	40,027	42,136	44,640	**168,855**	
2048	0.063	-	41,227	39,258	41,342	43,630	**165,456**	
2049	0.062	-	40,403	38,489	40,547	42,807	**162,245**	
2050	0.060	-	39,579	37,719	39,752	41,984	**159,034**	
2051	0.059	-	38,755	36,950	38,958	41,161	**155,823**	
2052	0.058	-	37,930	36,180	38,163	40,338	**152,612**	
2053	0.056	-	37,106	35,411	37,369	39,516	**149,402**	
2054	0.055	-	36,282	34,642	36,574	38,693	**146,191**	
2055	0.054	-	35,458	33,872	35,779	37,870	**142,980**	
2056	0.053	-	34,634	33,103	34,985	37,047	**139,769**	
2057	0.051	-	33,810	32,333	34,190	36,224	**136,558**	
2058	0.050	-	32,986	31,564	33,395	35,402	**133,347**	
2059	0.049	-	32,162	30,795	32,601	34,579	**130,136**	
2060	0.047	-	31,338	30,025	31,806	33,756	**126,925**	
2061	0.046	-	30,513	29,256	31,011	32,933	**123,714**	
2062	0.045	-	29,689	28,487	30,217	32,110	**120,503**	
2063	0.044	-	28,865	27,717	29,422	31,288	**117,292**	
2064	0.042	-	28,041	26,948	28,627	30,465	**114,081**	
2065	0.041	-	27,217	26,178	27,833	29,642	**110,870**	
2066	0.040	-	26,393	25,409	27,038	28,819	**107,659**	
2067	0.038	-	25,569	24,640	26,243	27,996	**104,448**	
2068	0.037	-	24,745	23,870	25,449	27,173	**101,237**	
2069	0.036	-	23,920	23,101	24,654	26,351	**98,026**	
2070	0.035	-	23,096	22,332	23,859	25,528	**94,815**	
2071	0.033	-	22,272	21,562	23,065	24,705	**91,604**	
2072	0.032	-	21,448	20,793	22,270	23,882	**88,393**	
2073	0.031	-	20,624	20,023	21,476	23,059	**85,182**	
2074	0.029	-	19,800	19,254	20,681	22,237	**81,971**	
2075	0.028	-	18,976	18,485	19,886	21,414	**78,760**	
2076	0.027	-	18,152	17,715	19,092	20,591	**75,549**	
2077	0.026	-	17,327	16,946	18,297	19,768	**72,338**	
2078	0.024	-	16,503	16,176	17,502	18,945	**69,127**	
2079	0.023	-	15,679	15,407	16,708	18,123	**65,916**	
2080	0.022	-	14,855	14,638	15,913	17,300	**62,705**	
2081	0.021	-	14,031	13,868	15,118	16,477	**59,495**	
2082	0.019	-	13,207	13,099	14,324	15,654	**56,284**	
2083	-	-	12,383	12,330	13,529	14,831	**53,073**	
2084	-	-	-	11,560	12,734	14,009	**38,303**	
2085	-	-	-	-	11,940	13,186	**25,125**	
2086	-	-	-	-	-	12,363	**12,363**	
		-	2,249,163	2,099,766	2,168,720	2,245,576	**8,763,225**	
		-	673,557	588,314	568,495	550,727	**2,381,093**	

	HE Distribution - Underground Conductors and Device						
		1	2	3	4	5		
		2023	2024	2025	2026	2027	Total	Check
Capital Investment		$0	$321,757	$300,384	$310,249	$321,243	$1,253,633	-
	RR Factor							
2023	-	-	-	-	-	-	**-**	
2024	0.112	-	-	-	-	-	**-**	
2025	0.109	-	36,101	-	-	-	**36,101**	
2026	0.107	-	35,162	33,703	-	-	**68,866**	
2027	0.104	-	34,268	32,827	34,810	-	**101,904**	
2028	0.101	-	33,413	31,991	33,905	36,044	**135,353**	
2029	0.099	-	32,597	31,194	33,042	35,106	**131,939**	
2030	0.097	-	31,815	30,431	32,218	34,213	**128,677**	
2031	0.094	-	31,065	29,701	31,431	33,360	**125,557**	
2032	0.092	-	30,333	29,002	30,677	32,545	**122,556**	
2033	0.090	-	29,604	28,318	29,954	31,764	**119,640**	
2034	0.092	-	28,875	27,638	29,248	31,015	**116,776**	
2035	0.089	-	29,510	26,957	28,545	30,285	**115,297**	
2036	0.087	-	28,683	27,550	27,842	29,557	**113,632**	
2037	0.084	-	27,857	26,778	28,454	28,829	**111,918**	
2038	0.081	-	27,030	26,006	27,657	29,463	**110,157**	
2039	0.079	-	26,204	25,235	26,861	28,638	**106,937**	
2040	0.076	-	25,378	24,463	26,064	27,812	**103,717**	
2041	0.074	-	24,551	23,692	25,267	26,987	**100,497**	
2042	0.071	-	23,725	22,920	24,470	26,162	**97,277**	
2043	0.069	-	22,898	22,149	23,673	25,337	**94,057**	
2044	0.067	-	22,166	21,377	22,876	24,512	**90,932**	
2045	0.066	-	21,622	20,694	22,079	23,687	**88,082**	
2046	0.064	-	21,172	20,186	21,373	22,862	**85,592**	
2047	0.063	-	20,721	19,765	20,848	22,131	**83,466**	
2048	0.062	-	20,271	19,345	20,414	21,587	**81,617**	
2049	0.060	-	19,821	18,925	19,980	21,138	**79,863**	
2050	0.059	-	19,371	18,504	19,546	20,688	**78,109**	
2051	0.057	-	18,920	18,084	19,112	20,239	**76,355**	
2052	0.056	-	18,470	17,664	18,678	19,789	**74,601**	
2053	0.055	-	18,020	17,243	18,244	19,340	**72,847**	
2054	0.053	-	17,570	16,823	17,810	18,890	**71,093**	
2055	0.052	-	17,120	16,403	17,375	18,441	**69,339**	
2056	0.050	-	16,669	15,982	16,941	17,991	**67,584**	
2057	0.049	-	16,219	15,562	16,507	17,542	**65,830**	
2058	0.048	-	15,769	15,142	16,073	17,092	**64,076**	
2059	0.046	-	15,319	14,721	15,639	16,643	**62,322**	
2060	0.045	-	14,868	14,301	15,205	16,193	**60,568**	
2061	0.043	-	14,418	13,881	14,771	15,744	**58,814**	
2062	0.042	-	13,968	13,461	14,337	15,294	**57,060**	
2063	0.041	-	13,518	13,040	13,903	14,845	**55,305**	
2064	0.039	-	13,068	12,620	13,468	14,395	**53,551**	
2065	0.038	-	12,617	12,200	13,034	13,946	**51,797**	
2066	0.036	-	12,167	11,779	12,600	13,496	**50,043**	
2067	0.035	-	11,717	11,359	12,166	13,047	**48,289**	
2068	0.034	-	11,267	10,939	11,732	12,597	**46,535**	
2069	0.032	-	10,817	10,518	11,298	12,148	**44,781**	
2070	0.031	-	10,366	10,098	10,864	11,698	**43,026**	
2071	0.029	-	9,916	9,678	10,430	11,249	**41,272**	
2072	0.028	-	9,466	9,257	9,996	10,799	**39,518**	
2073	0.027	-	9,016	8,837	9,561	10,350	**37,764**	
2074	0.025	-	8,565	8,417	9,127	9,900	**36,010**	
2075	0.024	-	8,115	7,997	8,693	9,451	**34,256**	
2076	0.022	-	7,665	7,576	8,259	9,001	**32,502**	
2077	0.021	-	7,215	7,156	7,825	8,552	**30,747**	
2078	0.000	-	6,765	6,736	7,391	8,102	**28,993**	
2079	0.000	-	0	6,315	6,957	7,653	**20,925**	
2080	0.000	-	0	0	6,523	7,203	**13,726**	
2081	0.000	-	0	0	0	6,754	**6,754**	
2082	0.000	-	0	0	0	0	**0**	
2083	-	-	0	0	0	0	**0**	
2084	-	-	-	0	0	0	**0**	
2085	-	-	-	-	0	0	**0**	
2086	-	-	-	-	-	0	**0**	
		-	1,063,803	993,141	1,025,754	1,062,106	**4,144,804**	
		-	336,563	293,969	284,066	275,187	**1,189,785**	

	HE Distribution - Line Transformers						
		1	2	3	4	5		
		2023	2024	2025	2026	2027	Total	Check
Capital Investment		$0	$107,252	$100,128	$103,416	$107,081	$417,878	-
	RR Factor							
2023	-	-	-	-	-	-	**-**	
2024	0.129	-	-	-	-	-	**-**	
2025	0.125	-	13,848	-	-	-	**13,848**	
2026	0.121	-	13,406	12,928	-	-	**26,334**	
2027	0.117	-	12,978	12,515	13,353	-	**38,847**	
2028	0.113	-	12,564	12,116	12,926	13,826	**51,433**	
2029	0.110	-	12,163	11,730	12,514	13,385	**49,791**	
2030	0.106	-	11,773	11,355	12,115	12,958	**48,199**	
2031	0.103	-	11,393	10,991	11,728	12,544	**46,655**	
2032	0.099	-	11,020	10,636	11,351	12,143	**45,151**	
2033	0.096	-	10,648	10,288	10,986	11,754	**43,675**	
2034	0.097	-	10,275	9,940	10,626	11,375	**42,216**	
2035	0.093	-	10,357	9,593	10,267	11,002	**41,219**	
2036	0.089	-	9,952	9,669	9,908	10,631	**40,160**	
2037	0.085	-	9,548	9,291	9,987	10,259	**39,085**	
2038	0.081	-	9,143	8,913	9,597	10,341	**37,994**	
2039	0.078	-	8,738	8,535	9,206	9,937	**36,416**	
2040	0.074	-	8,333	8,158	8,816	9,532	**34,839**	
2041	0.070	-	7,928	7,780	8,425	9,128	**33,261**	
2042	0.066	-	7,523	7,402	8,035	8,724	**31,684**	
2043	0.063	-	7,119	7,024	7,645	8,320	**30,107**	
2044	0.060	-	6,745	6,646	7,254	7,916	**28,561**	
2045	0.057	-	6,434	6,297	6,864	7,511	**27,107**	
2046	0.055	-	6,155	6,007	6,504	7,107	**25,773**	
2047	0.052	-	5,875	5,746	6,204	6,734	**24,560**	
2048	0.050	-	5,596	5,485	5,935	6,424	**23,440**	
2049	0.047	-	5,316	5,224	5,665	6,145	**22,351**	
2050	0.044	-	5,037	4,963	5,396	5,866	**21,262**	
2051	0.042	-	4,758	4,702	5,126	5,587	**20,173**	
2052	0.039	-	4,478	4,442	4,857	5,308	**19,085**	
2053	0.000	-	4,199	4,181	4,587	5,029	**17,996**	
2054	0.000	-	0	3,920	4,318	4,750	**12,988**	
2055	0.000	-	0	0	4,049	4,471	**8,520**	
2056	0.000	-	0	0	0	4,192	**4,192**	
2057	0.000	-	0	0	0	0	**0**	
2058	0.000	-	0	0	0	0	**0**	
2059	0.000	-	0	0	0	0	**0**	
2060	0.000	-	0	0	0	0	**0**	
2061	0.000	-	0	0	0	0	**0**	
2062	0.000	-	0	0	0	0	**0**	
2063	0.000	-	0	0	0	0	**0**	
2064	0.000	-	0	0	0	0	**0**	
2065	0.000	-	0	0	0	0	**0**	
2066	0.000	-	0	0	0	0	**0**	
2067	0.000	-	0	0	0	0	**0**	
2068	0.000	-	0	0	0	0	**0**	
2069	0.000	-	0	0	0	0	**0**	
2070	0.000	-	0	0	0	0	**0**	
2071	0.000	-	0	0	0	0	**0**	
2072	0.000	-	0	0	0	0	**0**	
2073	0.000	-	0	0	0	0	**0**	
2074	0.000	-	0	0	0	0	**0**	
2075	0.000	-	0	0	0	0	**0**	
2076	0.000	-	0	0	0	0	**0**	
2077	0.000	-	0	0	0	0	**0**	
2078	0.000	-	0	0	0	0	**0**	
2079	0.000	-	0	0	0	0	**0**	
2080	0.000	-	0	0	0	0	**0**	
2081	0.000	-	0	0	0	0	**0**	
2082	0.000	-	0	0	0	0	**0**	
2083	-	-	0	0	0	0	**0**	
2084	-	-	-	0	0	0	**0**	
2085	-	-	-	-	0	0	**0**	
2086	-	-	-	-	-	0	**0**	
		-	253,302	236,477	244,243	252,898	**986,920**	
		-	111,597	97,473	94,190	91,246	**394,506**	

Resilience Project/Program
HL Capital Revenue Requirements

						HL Transmission			
			1	2	3	4	5		
			2023	2024	2025	2026	2027	**Total**	**Check**
		Capital Investment	$0	$1,626,675	$1,233,342	$3,475,197	$6,050,349	**$12,385,563**	-
		RR Factor							
1	2023	-	-	-	-	-	-	**-**	
2	2024	0.112	-	-	-	-	-	**-**	
3	2025	0.109	-	182,444	-	-	-	**182,444**	
4	2026	0.106	-	176,839	138,329	-	-	**315,167**	
5	2027	0.103	-	171,624	134,079	389,769	-	**695,472**	
6	2028	0.100	-	166,760	130,125	377,795	678,592	**1,353,272**	
7	2029	0.097	-	162,215	126,437	366,654	657,744	**1,313,050**	
8	2030	0.094	-	157,893	122,991	356,263	638,347	**1,275,493**	
9	2031	0.092	-	153,642	119,714	346,552	620,256	**1,240,165**	
10	2032	0.089	-	149,390	116,491	337,319	603,351	**1,206,551**	
11	2033	0.087	-	145,137	113,267	328,238	587,275	**1,173,918**	
12	2034	0.088	-	140,884	110,043	319,153	571,466	**1,141,546**	
13	2035	0.085	-	143,523	106,818	310,068	555,649	**1,116,058**	
14	2036	0.082	-	138,771	108,819	300,983	539,831	**1,088,403**	
15	2037	0.079	-	134,018	105,216	306,620	524,014	**1,069,867**	
16	2038	0.077	-	129,265	101,612	296,467	533,828	**1,061,172**	
17	2039	0.075	-	125,152	98,009	286,313	516,151	**1,025,625**	
18	2040	0.074	-	122,320	94,890	276,160	498,474	**991,845**	
19	2041	0.073	-	120,127	92,743	267,373	480,797	**961,040**	
20	2042	0.071	-	117,935	91,080	261,322	465,499	**935,836**	
21	2043	0.070	-	115,742	89,418	256,638	454,964	**916,762**	
22	2044	0.068	-	113,549	87,755	251,953	446,809	**900,066**	
23	2045	0.067	-	111,356	86,093	247,269	438,653	**883,370**	
24	2046	0.066	-	109,164	84,430	242,584	430,497	**866,675**	
25	2047	0.064	-	106,971	82,768	237,900	422,341	**849,979**	
26	2048	0.063	-	104,778	81,105	233,215	414,185	**833,283**	
27	2049	0.062	-	102,585	79,443	228,530	406,029	**816,588**	
28	2050	0.060	-	100,393	77,780	223,846	397,874	**799,892**	
29	2051	0.059	-	98,200	76,117	219,161	389,718	**783,196**	
30	2052	0.058	-	96,007	74,455	214,477	381,562	**766,501**	
31	2053	0.056	-	93,814	72,792	209,792	373,406	**749,805**	
32	2054	0.055	-	91,622	71,130	205,108	365,250	**733,109**	
33	2055	0.054	-	89,429	69,467	200,423	357,094	**716,414**	
34	2056	0.052	-	87,236	67,805	195,739	348,939	**699,718**	
35	2057	0.051	-	85,043	66,142	191,054	340,783	**683,022**	
36	2058	0.050	-	82,851	64,480	186,370	332,627	**666,327**	
37	2059	0.048	-	80,658	62,817	181,685	324,471	**649,631**	
38	2060	0.047	-	78,465	61,155	177,000	316,315	**632,935**	
39	2061	0.046	-	76,272	59,492	172,316	308,159	**616,240**	
40	2062	0.044	-	74,080	57,830	167,631	300,004	**599,544**	
41	2063	0.043	-	71,887	56,167	162,947	291,848	**582,848**	
42	2064	0.041	-	69,694	54,505	158,262	283,692	**566,153**	
43	2065	0.040	-	67,501	52,842	153,578	275,536	**549,457**	
44	2066	0.039	-	65,309	51,179	148,893	267,380	**532,761**	
45	2067	0.037	-	63,116	49,517	144,209	259,224	**516,066**	
46	2068	0.036	-	60,923	47,854	139,524	251,069	**499,370**	
47	2069	0.035	-	58,730	46,192	134,840	242,913	**482,674**	
48	2070	0.033	-	56,538	44,529	130,155	234,757	**465,979**	
49	2071	0.032	-	54,345	42,867	125,470	226,601	**449,283**	
50	2072	0.031	-	52,152	41,204	120,786	218,445	**432,587**	
51	2073	0.029	-	49,959	39,542	116,101	210,289	**415,892**	
52	2074	0.028	-	47,767	37,879	111,417	202,134	**399,196**	
53	2075	0.027	-	45,574	36,217	106,732	193,978	**382,500**	
54	2076	0.025	-	43,381	34,554	102,048	185,822	**365,805**	
55	2077	0.024	-	41,188	32,892	97,363	177,666	**349,109**	
56	2078	0.023	-	38,996	31,229	92,679	169,510	**332,413**	
57	2079	0.021	-	36,803	29,566	87,994	161,354	**315,718**	
58	2080	0.020	-	34,610	27,904	83,310	153,199	**299,022**	
59	2081	(0.000)	-	32,417	26,241	78,625	145,043	**282,326**	
60	2082	(0.000)	-	(0)	24,579	73,940	136,887	**235,406**	
61	2083	-	-	(0)	(0)	69,256	128,731	**197,987**	
62	2084	-	-	-	(0)	(0)	120,575	**120,575**	
63	2085	-	-	-	-	(0)	(0)	**(0)**	
64	2086	-	-	-	-	-	(0)	**(0)**	
Total			-	5,527,045	4,190,594	11,807,869	20,557,605	**42,083,113**	
NPV @	7.00%		-	1,658,250	1,175,020	3,094,239	5,034,630	**10,962,139**	

					HL Distribution - Poles, Towers, and Fixtures			
		1	2	3	4	5		
		2023	2024	2025	2026	2027	**Total**	**Check**
	Capital Investment	$0	$1,984,305	$2,850,354	$4,738,110	$6,737,612	**$16,310,380**	-
	RR Factor							
2023	-	-	-	-	-	-	**-**	
2024	0.118	-	-	-	-	-	**-**	
2025	0.115	-	234,712	-	-	-	**234,712**	
2026	0.112	-	228,183	337,152	-	-	**565,335**	
2027	0.109	-	221,929	327,773	560,444	-	**1,110,146**	
2028	0.106	-	215,930	318,790	544,853	796,954	**1,876,526**	
2029	0.103	-	210,167	310,172	529,920	774,784	**1,825,043**	
2030	0.100	-	204,622	301,894	515,596	753,549	**1,775,660**	
2031	0.098	-	199,278	293,929	501,835	733,179	**1,728,221**	
2032	0.095	-	194,048	286,253	488,594	713,611	**1,682,506**	
2033	0.093	-	188,833	278,740	475,836	694,783	**1,638,192**	
2034	0.094	-	183,619	271,249	463,346	676,640	**1,594,854**	
2035	0.091	-	186,810	263,759	450,895	658,880	**1,560,344**	
2036	0.088	-	180,986	268,344	438,444	641,174	**1,528,948**	
2037	0.085	-	175,162	259,977	446,065	623,468	**1,504,672**	
2038	0.082	-	169,337	251,611	432,157	634,306	**1,487,412**	
2039	0.079	-	163,513	243,245	418,250	614,530	**1,439,537**	
2040	0.077	-	157,689	234,878	404,343	594,753	**1,391,662**	
2041	0.074	-	151,864	226,512	390,435	574,977	**1,343,788**	
2042	0.071	-	146,040	218,145	376,528	555,200	**1,295,913**	
2043	0.068	-	140,215	209,779	362,620	535,424	**1,248,038**	
2044	0.066	-	134,981	201,412	348,713	515,647	**1,200,754**	
2045	0.064	-	130,926	193,893	334,805	495,871	**1,155,496**	
2046	0.062	-	127,461	188,068	322,307	476,095	**1,113,930**	
2047	0.061	-	123,996	183,091	312,624	458,321	**1,078,032**	
2048	0.059	-	120,531	178,114	304,350	444,553	**1,047,547**	
2049	0.057	-	117,065	173,136	296,076	432,787	**1,019,064**	
2050	0.056	-	113,600	168,159	287,802	421,021	**990,582**	
2051	0.054	-	110,135	163,181	279,528	409,256	**962,100**	
2052	0.052	-	106,670	158,204	271,254	397,490	**933,618**	
2053	0.050	-	103,205	153,226	262,980	385,724	**905,135**	
2054	0.049	-	99,740	148,249	254,706	373,959	**876,653**	
2055	0.047	-	96,275	143,271	246,432	362,193	**848,171**	
2056	0.045	-	92,810	138,294	238,158	350,427	**819,689**	
2057	0.043	-	89,344	133,316	229,884	338,662	**791,206**	
2058	0.042	-	85,879	128,339	221,610	326,896	**762,724**	
2059	0.040	-	82,414	123,361	213,336	315,130	**734,242**	
2060	0.038	-	78,949	118,384	205,062	303,365	**705,760**	
2061	0.036	-	75,484	113,406	196,788	291,599	**677,277**	
2062	0.035	-	72,019	108,429	188,514	279,833	**648,795**	
2063	0.033	-	68,554	103,451	180,240	268,068	**620,313**	
2064	0.031	-	65,089	98,474	171,966	256,302	**591,831**	
2065	0.029	-	61,623	93,496	163,692	244,536	**563,348**	
2066	0.028	-	58,158	88,519	155,418	232,771	**534,866**	
2067	0.026	-	54,693	83,541	147,144	221,005	**506,384**	
2068	(0.000)	-	51,228	78,564	138,870	209,239	**477,902**	
2069	(0.000)	-	(0)	73,587	130,596	197,474	**401,656**	
2070	(0.000)	-	(0)	(0)	122,322	185,708	**308,030**	
2071	(0.000)	-	(0)	(0)	(0)	173,942	**173,942**	
2072	(0.000)	-	(0)	(0)	(0)	(0)	**(0)**	
2073	(0.000)	-	(0)	(0)	(0)	(0)	**(0)**	
2074	(0.000)	-	(0)	(0)	(0)	(0)	**(0)**	
2075	(0.000)	-	(0)	(0)	(0)	(0)	**(0)**	
2076	(0.000)	-	(0)	(0)	(0)	(0)	**(0)**	
2077	(0.000)	-	(0)	(0)	(0)	(0)	**(0)**	
2078	(0.000)	-	(0)	(0)	(0)	(0)	**(0)**	
2079	(0.000)	-	(0)	(0)	(0)	(0)	**(0)**	
2080	(0.000)	-	(0)	(0)	(0)	(0)	**(0)**	
2081	(0.000)	-	(0)	(0)	(0)	(0)	**(0)**	
2082	(0.000)	-	(0)	(0)	(0)	(0)	**(0)**	
2083	-	-	(0)	(0)	(0)	(0)	**(0)**	
2084	-	-	-	(0)	(0)	(0)	**(0)**	
2085	-	-	-	-	(0)	(0)	**(0)**	
2086	-	-	-	-	-	(0)	**(0)**	
		-	5,873,765	8,437,367	14,025,338	19,944,086	**48,280,557**	
		-	2,070,528	2,779,612	4,318,204	5,738,741	**14,907,085**	

HL Distribution - Overhead Conductors and Devices

		1	2	3	4	5		
		2023	2024	2025	2026	2027	**Total**	**Check**
Capital Investment		$0	$239,634	$172,798	$1,034,968	$1,069,816	**$2,517,215**	-
	RR Factor							
2023	-	-	-	-	-	-	**-**	
2024	0.115	-	-	-	-	-	**-**	
2025	0.112	-	27,458	-	-	-	**27,458**	
2026	0.109	-	26,733	19,799	-	-	**46,533**	
2027	0.106	-	26,043	19,277	118,588	-	**163,908**	
2028	0.103	-	25,382	18,779	115,460	122,581	**282,203**	
2029	0.101	-	24,751	18,303	112,476	119,348	**274,878**	
2030	0.098	-	24,146	17,848	109,626	116,264	**267,882**	
2031	0.096	-	23,565	17,411	106,898	113,317	**261,190**	
2032	0.094	-	22,997	16,992	104,284	110,497	**254,770**	
2033	0.091	-	22,432	16,583	101,775	107,795	**248,585**	
2034	0.093	-	21,867	16,176	99,325	105,202	**242,568**	
2035	0.090	-	22,316	15,768	96,883	102,669	**237,636**	
2036	0.088	-	21,677	16,092	94,441	100,145	**232,356**	
2037	0.085	-	21,038	15,631	96,384	97,621	**230,675**	
2038	0.082	-	20,399	15,171	93,624	99,629	**228,824**	
2039	0.080	-	19,760	14,710	90,864	96,776	**222,111**	
2040	0.077	-	19,121	14,249	88,104	93,924	**215,399**	
2041	0.074	-	18,482	13,788	85,345	91,071	**208,687**	
2042	0.072	-	17,843	13,328	82,585	88,218	**201,974**	
2043	0.069	-	17,204	12,867	79,825	85,366	**195,262**	
2044	0.068	-	16,637	12,406	77,065	82,513	**188,621**	
2045	0.066	-	16,211	11,997	74,305	79,660	**182,173**	
2046	0.065	-	15,857	11,690	71,853	76,807	**176,208**	
2047	0.063	-	15,503	11,435	70,016	74,273	**171,227**	
2048	0.062	-	15,149	11,179	68,487	72,374	**167,189**	
2049	0.060	-	14,795	10,924	66,958	70,793	**163,470**	
2050	0.059	-	14,441	10,669	65,428	69,212	**159,750**	
2051	0.057	-	14,087	10,413	63,899	67,632	**156,031**	
2052	0.056	-	13,733	10,158	62,370	66,051	**152,311**	
2053	0.054	-	13,379	9,903	60,841	64,470	**148,592**	
2054	0.053	-	13,025	9,647	59,311	62,889	**144,873**	
2055	0.051	-	12,671	9,392	57,782	61,308	**141,153**	
2056	0.050	-	12,316	9,137	56,253	59,728	**137,434**	
2057	0.048	-	11,962	8,881	54,724	58,147	**133,714**	
2058	0.047	-	11,608	8,626	53,194	56,566	**129,995**	
2059	0.045	-	11,254	8,371	51,665	54,985	**126,275**	
2060	0.044	-	10,900	8,115	50,136	53,405	**122,556**	
2061	0.043	-	10,546	7,860	48,606	51,824	**118,836**	
2062	0.041	-	10,192	7,605	47,077	50,243	**115,117**	
2063	0.040	-	9,838	7,349	45,548	48,662	**111,397**	
2064	0.038	-	9,484	7,094	44,019	47,082	**107,678**	
2065	0.037	-	9,130	6,839	42,489	45,501	**103,958**	
2066	0.035	-	8,776	6,583	40,960	43,920	**100,239**	
2067	0.034	-	8,422	6,328	39,431	42,339	**96,520**	
2068	0.032	-	8,067	6,073	37,901	40,758	**92,800**	
2069	0.031	-	7,713	5,817	36,372	39,178	**89,081**	
2070	0.029	-	7,359	5,562	34,843	37,597	**85,361**	
2071	0.028	-	7,005	5,307	33,314	36,016	**81,642**	
2072	0.026	-	6,651	5,051	31,784	34,435	**77,922**	
2073	0.025	-	6,297	4,796	30,255	32,855	**74,203**	
2074	0.023	-	5,943	4,541	28,726	31,274	**70,483**	
2075	0.022	-	5,589	4,285	27,197	29,693	**66,764**	
2076	(0.000)	-	5,235	4,030	25,667	28,112	**63,044**	
2077	(0.000)	-	(0)	3,775	24,138	26,531	**54,444**	
2078	(0.000)	-	(0)	(0)	22,609	24,951	**47,559**	
2079	(0.000)	-	(0)	(0)	(0)	23,370	**23,370**	
2080	(0.000)	-	(0)	(0)	(0)	(0)	**(0)**	
2081	(0.000)	-	(0)	(0)	(0)	(0)	**(0)**	
2082	(0.000)	-	(0)	(0)	(0)	(0)	**(0)**	
2083	-	-	(0)	(0)	(0)	(0)	**(0)**	
2084	-	-	-	(0)	(0)	(0)	**(0)**	
2085	-	-	-	-	(0)	(0)	**(0)**	
2086	-	-	-	-	-	(0)	**(0)**	
		-	782,993	564,610	3,381,711	3,495,575	**8,224,888**	
		-	250,381	168,734	944,506	912,430	**2,276,051**	

HL Distribution - Station Equipment - Substations

		1	2	3	4	5		
		2023	2024	2025	2026	2027	**Total**	**Check**
Capital Investment		$0	$174,351	$145,655	$152,441	$160,412	**$632,859**	-
	RR Factor							
2023	-	-	-	-	-	-	**-**	
2024	0.114	-	-	-	-	-	**-**	
2025	0.111	-	19,846	-	-	-	**19,846**	
2026	0.108	-	19,328	16,579	-	-	**35,908**	
2027	0.105	-	18,835	16,147	17,352	-	**52,334**	
2028	0.103	-	18,365	15,735	16,900	18,259	**69,259**	
2029	0.100	-	17,915	15,342	16,468	17,783	**67,508**	
2030	0.098	-	17,484	14,966	16,057	17,330	**65,836**	
2031	0.096	-	17,071	14,606	15,663	16,896	**64,237**	
2032	0.093	-	16,667	14,261	15,287	16,482	**62,698**	
2033	0.091	-	16,266	13,924	14,926	16,086	**61,202**	
2034	0.093	-	15,864	13,589	14,573	15,706	**59,731**	
2035	0.090	-	16,201	13,253	14,222	15,335	**59,010**	
2036	0.088	-	15,745	13,534	13,870	14,965	**58,115**	
2037	0.085	-	15,290	13,154	14,165	14,596	**57,204**	
2038	0.082	-	14,835	12,773	13,767	14,906	**56,280**	
2039	0.080	-	14,379	12,393	13,369	14,487	**54,627**	
2040	0.077	-	13,924	12,013	12,970	14,068	**52,975**	
2041	0.075	-	13,468	11,632	12,572	13,649	**51,322**	
2042	0.072	-	13,013	11,252	12,174	13,230	**49,669**	
2043	0.070	-	12,558	10,871	11,776	12,811	**48,016**	
2044	0.068	-	12,154	10,491	11,378	12,392	**46,415**	
2045	0.067	-	11,854	10,154	10,980	11,973	**44,960**	
2046	0.065	-	11,606	9,903	10,627	11,554	**43,690**	
2047	0.064	-	11,358	9,696	10,365	11,183	**42,601**	
2048	0.062	-	11,110	9,489	10,148	10,907	**41,653**	
2049	0.061	-	10,862	9,281	9,931	10,678	**40,753**	
2050	0.059	-	10,614	9,074	9,714	10,450	**39,852**	
2051	0.058	-	10,366	8,867	9,497	10,222	**38,952**	
2052	0.057	-	10,118	8,660	9,280	9,994	**38,051**	
2053	0.055	-	9,870	8,452	9,063	9,765	**37,151**	
2054	0.054	-	9,622	8,245	8,846	9,537	**36,250**	
2055	0.052	-	9,373	8,038	8,629	9,309	**35,350**	
2056	0.051	-	9,125	7,831	8,412	9,081	**34,449**	
2057	0.049	-	8,877	7,623	8,196	8,852	**33,549**	
2058	0.048	-	8,629	7,416	7,979	8,624	**32,648**	
2059	0.047	-	8,381	7,209	7,762	8,396	**31,748**	
2060	0.045	-	8,133	7,002	7,545	8,168	**30,847**	
2061	0.044	-	7,885	6,794	7,328	7,939	**29,947**	
2062	0.042	-	7,637	6,587	7,111	7,711	**29,046**	
2063	0.041	-	7,389	6,380	6,894	7,483	**28,146**	
2064	0.040	-	7,141	6,173	6,677	7,255	**27,245**	
2065	0.038	-	6,893	5,965	6,460	7,026	**26,345**	
2066	0.037	-	6,645	5,758	6,243	6,798	**25,444**	
2067	0.035	-	6,396	5,551	6,026	6,570	**24,544**	
2068	0.034	-	6,148	5,344	5,810	6,342	**23,643**	
2069	0.032	-	5,900	5,136	5,593	6,113	**22,743**	
2070	0.031	-	5,652	4,929	5,376	5,885	**21,842**	
2071	0.030	-	5,404	4,722	5,159	5,657	**20,942**	
2072	0.028	-	5,156	4,515	4,942	5,429	**20,041**	
2073	0.027	-	4,908	4,307	4,725	5,200	**19,141**	
2074	0.025	-	4,660	4,100	4,508	4,972	**18,240**	
2075	0.024	-	4,412	3,893	4,291	4,744	**17,340**	
2076	0.022	-	4,164	3,686	4,074	4,516	**16,439**	
2077	0.021	-	3,916	3,478	3,857	4,287	**15,539**	
2078	0.000	-	3,668	3,271	3,641	4,059	**14,638**	
2079	0.000	-	0	3,064	3,424	3,831	**10,318**	
2080	0.000	-	0	0	3,207	3,603	**6,809**	
2081	0.000	-	0	0	0	3,374	**3,374**	
2082	0.000	-	0	0	0	0	**0**	
2083	-	-	0	0	0	0	**0**	
2084	-	-	-	0	0	0	**0**	
2085	-	-	-	-	0	0	**0**	
2086	-	-	-	-	-	0	**0**	
		-	583,079	487,112	509,807	536,466	**2,116,465**	
		-	182,222	142,270	139,157	136,852	**600,501**	

Resilience Project/Program

ME Capital Revenue Requirements

			ME Transmission							
			1	2	3	4	5		
			2023	2024	2025	2026	2027	**Total**	**Check**
		Capital Investment	$0	$640,262	$1,099,690	$2,265,855	$4,427,055	**$8,432,862**	-
		RR Factor							
1	2023	-	-	-	-	-	-	**-**	
2	2024	0.111	-	-	-	-	-	**-**	
3	2025	0.108	-	71,226	-	-	-	**71,226**	
4	2026	0.105	-	69,040	122,335	-	-	**191,376**	
5	2027	0.102	-	67,007	118,581	252,065	-	**437,654**	
6	2028	0.099	-	65,111	115,089	244,331	492,488	**917,018**	
7	2029	0.096	-	63,338	111,832	237,135	477,377	**889,681**	
8	2030	0.094	-	61,653	108,788	230,423	463,317	**864,181**	
9	2031	0.091	-	59,996	105,893	224,152	450,204	**840,245**	
10	2032	0.089	-	58,338	103,047	218,188	437,950	**817,522**	
11	2033	0.086	-	56,680	100,199	212,323	426,298	**795,499**	
12	2034	0.088	-	55,022	97,351	206,455	414,839	**773,666**	
13	2035	0.085	-	56,077	94,503	200,587	403,374	**754,540**	
14	2036	0.082	-	54,224	96,315	194,719	391,908	**737,166**	
15	2037	0.079	-	52,371	93,133	198,453	380,443	**724,399**	
16	2038	0.076	-	50,518	89,950	191,895	387,739	**720,102**	
17	2039	0.075	-	48,914	86,767	185,337	374,926	**695,944**	
18	2040	0.073	-	47,809	84,012	178,779	362,114	**672,714**	
19	2041	0.072	-	46,954	82,116	173,103	349,301	**651,474**	
20	2042	0.071	-	46,100	80,647	169,195	338,211	**634,154**	
21	2043	0.069	-	45,245	79,179	166,170	330,576	**621,169**	
22	2044	0.068	-	44,390	77,710	163,144	324,664	**609,908**	
23	2045	0.067	-	43,535	76,242	160,118	318,753	**598,647**	
24	2046	0.065	-	42,680	74,773	157,093	312,841	**587,386**	
25	2047	0.064	-	41,825	73,305	154,067	306,929	**576,126**	
26	2048	0.063	-	40,970	71,836	151,041	301,018	**564,865**	
27	2049	0.061	-	40,115	70,368	148,015	295,106	**553,604**	
28	2050	0.060	-	39,260	68,900	144,990	289,194	**542,343**	
29	2051	0.059	-	38,405	67,431	141,964	283,283	**531,082**	
30	2052	0.057	-	37,550	65,963	138,938	277,371	**519,821**	
31	2053	0.056	-	36,695	64,494	135,913	271,459	**508,561**	
32	2054	0.055	-	35,840	63,026	132,887	265,547	**497,300**	
33	2055	0.053	-	34,985	61,557	129,861	259,636	**486,039**	
34	2056	0.052	-	34,130	60,089	126,835	253,724	**474,778**	
35	2057	0.051	-	33,275	58,620	123,810	247,812	**463,517**	
36	2058	0.049	-	32,420	57,152	120,784	241,901	**452,256**	
37	2059	0.048	-	31,565	55,683	117,758	235,989	**440,996**	
38	2060	0.047	-	30,710	54,215	114,733	230,077	**429,735**	
39	2061	0.045	-	29,855	52,746	111,707	224,166	**418,474**	
40	2062	0.044	-	29,000	51,278	108,681	218,254	**407,213**	
41	2063	0.043	-	28,145	49,809	105,655	212,342	**395,952**	
42	2064	0.041	-	27,290	48,341	102,630	206,431	**384,691**	
43	2065	0.040	-	26,435	46,872	99,604	200,519	**373,430**	
44	2066	0.039	-	25,580	45,404	96,578	194,607	**362,170**	
45	2067	0.037	-	24,725	43,935	93,553	188,696	**350,909**	
46	2068	0.036	-	23,870	42,467	90,527	182,784	**339,648**	
47	2069	0.035	-	23,015	40,999	87,501	176,872	**328,387**	
48	2070	0.033	-	22,160	39,530	84,475	170,961	**317,126**	
49	2071	0.032	-	21,305	38,062	81,450	165,049	**305,865**	
50	2072	0.031	-	20,450	36,593	78,424	159,137	**294,605**	
51	2073	0.029	-	19,595	35,125	75,398	153,226	**283,344**	
52	2074	0.028	-	18,740	33,656	72,373	147,314	**272,083**	
53	2075	0.027	-	17,885	32,188	69,347	141,402	**260,822**	
54	2076	0.025	-	17,030	30,719	66,321	135,491	**249,561**	
55	2077	0.024	-	16,175	29,251	63,295	129,579	**238,300**	
56	2078	0.023	-	15,320	27,782	60,270	123,667	**227,040**	
57	2079	0.021	-	14,465	26,314	57,244	117,756	**215,779**	
58	2080	0.020	-	13,610	24,845	54,218	111,844	**204,518**	
59	2081	(0.000)	-	12,755	23,377	51,193	105,932	**193,257**	
60	2082	(0.000)	-	(0)	21,908	48,167	100,021	**170,096**	
61	2083	-	-	(0)	(0)	45,141	94,109	**139,250**	
62	2084	-	-	-	(0)	(0)	88,197	**88,197**	
63	2085	-	-	-	-	(0)	(0)	**(0)**	
64	2086	-	-	-	-	-	(0)	**(0)**	
	Total		-	2,161,377	3,712,302	7,649,010	14,944,724	**28,467,412**	
NPV @	6.88%		-	657,116	1,055,942	2,035,574	3,720,956	**7,469,588**	

		ME Distribution - Poles, Towers, and Fixtures						
		1	2	3	4	5		
		2023	2024	2025	2026	2027	**Total**	**Check**
	Capital Investment	$0	$1,804,038	$2,649,141	$3,684,348	$4,683,084	**$12,820,612**	-
	RR Factor							
2023	-	-	-	-	-	-	**-**	
2024	0.117	-	-	-	-	-	**-**	
2025	0.114	-	211,736	-	-	-	**211,736**	
2026	0.111	-	205,855	310,924	-	-	**516,779**	
2027	0.108	-	200,223	302,288	432,424	-	**934,935**	
2028	0.105	-	194,820	294,018	420,414	549,643	**1,458,895**	
2029	0.102	-	189,630	286,084	408,911	534,378	**1,419,002**	
2030	0.100	-	184,636	278,462	397,877	519,757	**1,380,731**	
2031	0.097	-	179,823	271,128	387,276	505,731	**1,343,960**	
2032	0.094	-	175,112	264,062	377,077	492,258	**1,308,509**	
2033	0.092	-	170,416	257,144	367,249	479,294	**1,274,103**	
2034	0.093	-	165,720	250,248	357,628	466,801	**1,240,397**	
2035	0.091	-	168,669	243,351	348,037	454,573	**1,214,630**	
2036	0.088	-	163,423	247,682	338,446	442,381	**1,191,932**	
2037	0.085	-	158,177	239,979	344,468	430,190	**1,172,815**	
2038	0.082	-	152,932	232,276	333,755	437,845	**1,156,808**	
2039	0.079	-	147,686	224,573	323,042	424,228	**1,119,530**	
2040	0.076	-	142,441	216,870	312,329	410,611	**1,082,251**	
2041	0.073	-	137,195	209,167	301,616	396,994	**1,044,973**	
2042	0.070	-	131,949	201,464	290,903	383,377	**1,007,694**	
2043	0.068	-	126,704	193,761	280,190	369,760	**970,416**	
2044	0.066	-	121,990	186,058	269,478	356,143	**933,669**	
2045	0.064	-	118,337	179,136	258,765	342,526	**898,764**	
2046	0.062	-	115,217	173,773	249,137	328,909	**867,035**	
2047	0.060	-	112,096	169,190	241,678	316,671	**839,635**	
2048	0.059	-	108,975	164,607	235,305	307,191	**816,078**	
2049	0.057	-	105,854	160,025	228,931	299,090	**793,900**	
2050	0.055	-	102,734	155,442	222,558	290,989	**771,721**	
2051	0.053	-	99,613	150,859	216,184	282,887	**749,543**	
2052	0.052	-	96,492	146,276	209,811	274,786	**727,365**	
2053	0.050	-	93,371	141,694	203,437	266,685	**705,187**	
2054	0.048	-	90,250	137,111	197,063	258,584	**683,009**	
2055	0.047	-	87,130	132,528	190,690	250,482	**660,830**	
2056	0.045	-	84,009	127,946	184,316	242,381	**638,652**	
2057	0.043	-	80,888	123,363	177,943	234,280	**616,474**	
2058	0.041	-	77,767	118,780	171,569	226,179	**594,296**	
2059	0.040	-	74,646	114,197	165,196	218,078	**572,117**	
2060	0.038	-	71,526	109,615	158,822	209,976	**549,939**	
2061	0.036	-	68,405	105,032	152,449	201,875	**527,761**	
2062	0.034	-	65,284	100,449	146,075	193,774	**505,583**	
2063	0.033	-	62,163	95,867	139,702	185,673	**483,405**	
2064	0.031	-	59,043	91,284	133,328	177,572	**461,226**	
2065	0.029	-	55,922	86,701	126,955	169,470	**439,048**	
2066	0.028	-	52,801	82,118	120,581	161,369	**416,870**	
2067	0.026	-	49,680	77,536	114,208	153,268	**394,692**	
2068	(0.000)	-	46,559	72,953	107,834	145,167	**372,513**	
2069	(0.000)	-	(0)	68,370	101,461	137,066	**306,897**	
2070	(0.000)	-	(0)	(0)	95,087	128,964	**224,052**	
2071	(0.000)	-	(0)	(0)	(0)	120,863	**120,863**	
2072	(0.000)	-	(0)	(0)	(0)	(0)	**(0)**	
2073	(0.000)	-	(0)	(0)	(0)	(0)	**(0)**	
2074	(0.000)	-	(0)	(0)	(0)	(0)	**(0)**	
2075	(0.000)	-	(0)	(0)	(0)	(0)	**(0)**	
2076	(0.000)	-	(0)	(0)	(0)	(0)	**(0)**	
2077	(0.000)	-	(0)	(0)	(0)	(0)	**(0)**	
2078	(0.000)	-	(0)	(0)	(0)	(0)	**(0)**	
2079	(0.000)	-	(0)	(0)	(0)	(0)	**(0)**	
2080	(0.000)	-	(0)	(0)	(0)	(0)	**(0)**	
2081	(0.000)	-	(0)	(0)	(0)	(0)	**(0)**	
2082	(0.000)	-	(0)	(0)	(0)	(0)	**(0)**	
2083	-	-	(0)	(0)	(0)	(0)	**(0)**	
2084	-	-	-	(0)	(0)	(0)	**(0)**	
2085	-	-	-	-	(0)	(0)	**(0)**	
2086	-	-	-	-	-	(0)	**(0)**	
Total		-	5,307,900	7,794,389	10,840,209	13,778,720	**37,721,218**	
NPV		-	1,894,258	2,602,456	3,386,288	4,026,986	**11,909,988**	

	ME Distribution - Overhead Conductors and Devices							
		1	2	3	4	5		
		2023	2024	2025	2026	2027	**Total**	**Check**
Capital Investment		$0	$962,207	$1,247,790	$3,481,773	$895,639	**$6,587,409**	-
	RR Factor							
2023	-	-	-	-	-	-	**-**	
2024	0.114	-	-	-	-	-	**-**	
2025	0.111	-	109,368	-	-	-	**109,368**	
2026	0.108	-	106,487	141,828	-	-	**248,315**	
2027	0.105	-	103,739	138,093	395,750	-	**637,582**	
2028	0.102	-	101,114	134,529	385,327	101,801	**722,771**	
2029	0.100	-	98,601	131,124	375,383	99,120	**704,229**	
2030	0.098	-	96,194	127,866	365,882	96,562	**686,505**	
2031	0.095	-	93,883	124,744	356,792	94,118	**669,537**	
2032	0.093	-	91,627	121,748	348,080	91,780	**653,234**	
2033	0.091	-	89,378	118,821	339,719	89,539	**637,457**	
2034	0.092	-	87,129	115,905	331,554	87,388	**621,976**	
2035	0.090	-	88,958	112,989	323,416	85,288	**610,651**	
2036	0.087	-	86,416	115,361	315,279	83,194	**600,250**	
2037	0.085	-	83,875	112,065	321,897	81,101	**598,937**	
2038	0.082	-	81,333	108,768	312,700	82,804	**585,604**	
2039	0.079	-	78,791	105,472	303,502	80,438	**568,203**	
2040	0.077	-	76,249	102,176	294,305	78,072	**550,802**	
2041	0.074	-	73,708	98,880	285,108	75,706	**533,401**	
2042	0.071	-	71,166	95,584	275,910	73,340	**516,000**	
2043	0.069	-	68,624	92,288	266,713	70,974	**498,599**	
2044	0.067	-	66,366	88,992	257,516	68,608	**481,482**	
2045	0.066	-	64,674	86,063	248,318	66,242	**465,298**	
2046	0.064	-	63,266	83,869	240,146	63,877	**451,158**	
2047	0.063	-	61,857	82,043	234,025	61,774	**439,699**	
2048	0.061	-	60,449	80,216	228,928	60,200	**429,793**	
2049	0.060	-	59,040	78,390	223,832	58,889	**420,151**	
2050	0.058	-	57,632	76,563	218,735	57,578	**410,508**	
2051	0.057	-	56,223	74,737	213,639	56,267	**400,866**	
2052	0.056	-	54,815	72,910	208,542	54,956	**391,224**	
2053	0.054	-	53,407	71,084	203,446	53,645	**381,581**	
2054	0.053	-	51,998	69,258	198,349	52,334	**371,939**	
2055	0.051	-	50,590	67,431	193,253	51,023	**362,297**	
2056	0.050	-	49,181	65,605	188,157	49,712	**352,654**	
2057	0.048	-	47,773	63,778	183,060	48,401	**343,012**	
2058	0.047	-	46,364	61,952	177,964	47,090	**333,370**	
2059	0.045	-	44,956	60,125	172,867	45,779	**323,727**	
2060	0.044	-	43,548	58,299	167,771	44,468	**314,085**	
2061	0.042	-	42,139	56,472	162,674	43,157	**304,443**	
2062	0.041	-	40,731	54,646	157,578	41,846	**294,800**	
2063	0.039	-	39,322	52,819	152,481	40,535	**285,158**	
2064	0.038	-	37,914	50,993	147,385	39,224	**275,516**	
2065	0.036	-	36,505	49,167	142,289	37,913	**265,873**	
2066	0.035	-	35,097	47,340	137,192	36,602	**256,231**	
2067	0.034	-	33,688	45,514	132,096	35,291	**246,589**	
2068	0.032	-	32,280	43,687	126,999	33,980	**236,946**	
2069	0.031	-	30,872	41,861	121,903	32,669	**227,304**	
2070	0.029	-	29,463	40,034	116,806	31,358	**217,662**	
2071	0.028	-	28,055	38,208	111,710	30,047	**208,019**	
2072	0.026	-	26,646	36,381	106,613	28,736	**198,377**	
2073	0.025	-	25,238	34,555	101,517	27,425	**188,735**	
2074	0.023	-	23,829	32,728	96,420	26,114	**179,092**	
2075	0.022	-	22,421	30,902	91,324	24,803	**169,450**	
2076	(0.000)	-	21,013	29,076	86,228	23,492	**159,808**	
2077	(0.000)	-	(0)	27,249	81,131	22,181	**130,561**	
2078	(0.000)	-	(0)	(0)	76,035	20,870	**96,905**	
2079	(0.000)	-	(0)	(0)	(0)	19,559	**19,559**	
2080	(0.000)	-	(0)	(0)	(0)	(0)	**(0)**	
2081	(0.000)	-	(0)	(0)	(0)	(0)	**(0)**	
2082	(0.000)	-	(0)	(0)	(0)	(0)	**(0)**	
2083	-	-	(0)	(0)	(0)	(0)	**(0)**	
2084	-	-	-	(0)	(0)	(0)	**(0)**	
2085	-	-	-	-	(0)	(0)	**(0)**	
2086	-	-	-	-	-	(0)	**(0)**	
		-	3,123,992	4,051,189	11,304,246	2,907,865	**21,387,291**	
		-	1,011,956	1,227,776	3,205,259	771,402	**6,216,392**	

	ME Distribution - Station Equipment - Substations							
		1	2	3	4	5		
		2023	2024	2025	2026	2027	**Total**	**Check**
Capital Investment		$0	$337,422	$246,618	$255,977	$168,390	**$1,008,407**	-
	RR Factor							
2023	-	-	-	-	-	-	**-**	
2024	0.113	-	-	-	-	-	**-**	
2025	0.110	-	38,098	-	-	-	**38,098**	
2026	0.107	-	37,106	27,845	-	-	**64,951**	
2027	0.104	-	36,161	27,120	28,902	-	**92,183**	
2028	0.102	-	35,258	26,430	28,150	19,013	**108,850**	
2029	0.099	-	34,396	25,770	27,432	18,518	**106,116**	
2030	0.097	-	33,570	25,139	26,748	18,046	**103,503**	
2031	0.095	-	32,778	24,536	26,093	17,596	**101,002**	
2032	0.093	-	32,005	23,957	25,467	17,165	**98,593**	
2033	0.090	-	31,234	23,392	24,866	16,753	**96,245**	
2034	0.092	-	30,464	22,829	24,280	16,358	**93,930**	
2035	0.090	-	31,124	22,266	23,695	15,972	**93,056**	
2036	0.087	-	30,251	22,748	23,111	15,587	**91,697**	
2037	0.084	-	29,378	22,110	23,611	15,203	**90,302**	
2038	0.082	-	28,505	21,472	22,949	15,532	**88,457**	
2039	0.079	-	27,632	20,834	22,287	15,097	**85,848**	
2040	0.077	-	26,759	20,196	21,624	14,661	**83,239**	
2041	0.074	-	25,885	19,558	20,962	14,225	**80,630**	
2042	0.072	-	25,012	18,919	20,300	13,789	**78,021**	
2043	0.069	-	24,139	18,281	19,637	13,354	**75,412**	
2044	0.068	-	23,366	17,643	18,975	12,918	**72,902**	
2045	0.066	-	22,791	17,078	18,313	12,482	**70,664**	
2046	0.065	-	22,315	16,658	17,726	12,047	**68,745**	
2047	0.063	-	21,840	16,310	17,290	11,661	**67,100**	
2048	0.062	-	21,364	15,962	16,929	11,374	**65,629**	
2049	0.060	-	20,888	15,615	16,568	11,136	**64,207**	
2050	0.059	-	20,413	15,267	16,207	10,899	**62,786**	
2051	0.058	-	19,937	14,919	15,846	10,662	**61,365**	
2052	0.056	-	19,462	14,572	15,486	10,424	**59,943**	
2053	0.055	-	18,986	14,224	15,125	10,187	**58,522**	
2054	0.053	-	18,510	13,877	14,764	9,950	**57,101**	
2055	0.052	-	18,035	13,529	14,403	9,712	**55,679**	
2056	0.051	-	17,559	13,181	14,042	9,475	**54,258**	
2057	0.049	-	17,083	12,834	13,682	9,238	**52,836**	
2058	0.048	-	16,608	12,486	13,321	9,000	**51,415**	
2059	0.046	-	16,132	12,139	12,960	8,763	**49,994**	
2060	0.045	-	15,657	11,791	12,599	8,525	**48,572**	
2061	0.044	-	15,181	11,443	12,238	8,288	**47,151**	
2062	0.042	-	14,705	11,096	11,878	8,051	**45,729**	
2063	0.041	-	14,230	10,748	11,517	7,813	**44,308**	
2064	0.039	-	13,754	10,400	11,156	7,576	**42,887**	
2065	0.038	-	13,279	10,053	10,795	7,339	**41,465**	
2066	0.037	-	12,803	9,705	10,434	7,101	**40,044**	
2067	0.035	-	12,327	9,358	10,073	6,864	**38,622**	
2068	0.034	-	11,852	9,010	9,713	6,627	**37,201**	
2069	0.032	-	11,376	8,662	9,352	6,389	**35,780**	
2070	0.031	-	10,901	8,315	8,991	6,152	**34,358**	
2071	0.029	-	10,425	7,967	8,630	5,915	**32,937**	
2072	0.028	-	9,949	7,619	8,269	5,677	**31,516**	
2073	0.027	-	9,474	7,272	7,909	5,440	**30,094**	
2074	0.025	-	8,998	6,924	7,548	5,203	**28,673**	
2075	0.024	-	8,523	6,577	7,187	4,965	**27,251**	
2076	0.022	-	8,047	6,229	6,826	4,728	**25,830**	
2077	0.021	-	7,571	5,881	6,465	4,490	**24,409**	
2078	0.000	-	7,096	5,534	6,105	4,253	**22,987**	
2079	0.000	-	0	5,186	5,744	4,016	**14,946**	
2080	0.000	-	0	0	5,383	3,778	**9,161**	
2081	0.000	-	0	0	0	3,541	**3,541**	
2082	0.000	-	0	0	0	0	**0**	
2083	-	-	0	0	0	0	**0**	
2084	-	-	-	0	0	0	**0**	
2085	-	-	-	-	0	0	**0**	
2086	-	-	-	-	-	0	**0**	
		-	1,121,189	819,465	850,562	559,527	**3,350,743**	
		-	354,990	242,746	235,729	145,082	**978,547**	

Resilience Project/Program
O&M Revenue Requirements

	Year	Escalation		HE O&M Expense[1]	HE O&M Rev Req		HL O&M Expense[1]	HL O&M Rev Req		ME O&M Expense[1]	ME O&M Rev Req
				Hazard Tree Removal (O&M)							
					1.0975			1.0975			1.0975
1	2024	-		399,004	437,912		372,164	408,456		294,520	323,240
2	2025	-		2,492,679	2,735,750		2,513,873	2,759,011		2,655,089	2,913,998
3	2026	-		2,572,053	2,822,865		2,590,132	2,842,706		2,735,400	3,002,140
4	2027	-		2,645,124	2,903,061		2,663,756	2,923,510		2,813,158	3,087,480
5	2028	-		2,722,902	2,988,424		2,742,126	3,009,522		2,895,929	3,178,323
	Total			10,831,761	11,888,011		10,882,051	11,943,205		11,394,097	12,505,182
	NPV		6.88%		9,482,700	7.00%		9,487,874	6.94%		9,939,765

Notes:
1. Hazard tree removal O&M recovery will be based on actuals. Recovery will be in the following year based on a lookback of the actuals of the prior year.

Resilience Project/Program
Revenue Requirements Model
Assumptions

Manual input
HECO TY2020 Rate Case Dkt 2019-0085 Final D&O 37387

Cost of Capital Assumptions	Weight	Rate	Weighted Average	After-Tax Weighted Average	Weighted Average Revenue Requirement	Weighted Average Gross-up for Income Taxes
Short Term Debt	0.58%	2.50%	0.01%	0.01%	0.016%	0.01%
Long Term Debt (Taxable Debt)	41.42%	4.55%	1.88%	1.40%	2.068%	1.88%
Hybrids	0.00%	0.00%	0.00%	0.00%	0.000%	0.00%
Preferred Stock	0.85%	5.33%	0.05%	0.05%	0.067%	0.06%
Common Stock	57.15%	9.50%	5.43%	5.43%	8.026%	7.31%
	100.00%		7.37%	6.885%	10.177%	9.272%

Tax Assumptions		Effective
Federal Income Tax Rate	21.00%	19.74%
State Income Tax Rate	6.40%	6.02%
		25.75%

State Investment Tax Credit (ITC)	4.00%	
Accelerated State ITC Amortization Period[1]	10	
Public Service Company Tax	5.885%	
PUC Fee	0.500%	
Franchise Tax	2.500%	
Composite Revenue Tax Rate	8.885%	1.09751

Project Assumptions

Hawaiian Electric

Input for RR Calc: 1,000

Transmission - Poles and Fixtures					
Capital Investment[2, 6]	$ -	$ -	$ 9,823,804	$ 17,068,128	$ 27,302,074
Placed In-Service Date	2023	2024	2025	2026	2027
Pro-rated Initial Year	0%	0%	0%	0%	0%
Recovery Mechanism[7]	EPRM	EPRM	EPRM	EPRM	EPRM

Distribution - Poles, Towers, and Fixtures					
Capital Investment[2, 6]	$ -	$ 2,069,067	$ 5,033,360	$ 9,417,244	$ 15,027,829
Placed In-Service Date	2023	2024	2025	2026	2027
Pro-rated Initial Year	0%	0%	0%	0%	0%
Recovery Mechanism[7]	EPRM	EPRM	EPRM	EPRM	EPRM

Distribution - Overhead Conductors and Devices					
Capital Investment[2, 6]	$ -	$ 1,045,588	$ 2,083,959	$ 1,084,010	$ 1,127,562
Placed In-Service Date	2023	2024	2025	2026	2027
Pro-rated Initial Year	0%	0%	0%	0%	0%
Recovery Mechanism[7]	EPRM	EPRM	EPRM	EPRM	EPRM

Distribution - Station Equipment - Substations					
Capital Investment[2, 6]	$ -	$ 178,700	$ 152,266	$ 160,500	$ 171,141
Placed In-Service Date	2023	2024	2025	2026	2027
Pro-rated Initial Year	0%	0%	0%	0%	0%
Recovery Mechanism[7]	EPRM	EPRM	EPRM	EPRM	EPRM

Distribution - Underground Conduit					
Capital Investment[2, 6]	$ -	$ 643,513	$ 600,769	$ 620,497	$ 642,487
Placed In-Service Date	2023	2024	2025	2026	2027
Pro-rated Initial Year	0%	0%	0%	0%	0%
Recovery Mechanism[7]	EPRM	EPRM	EPRM	EPRM	EPRM

Distribution - Underground Conductors and Devices					
Capital Investment[2, 6]	$ -	$ 321,757	$ 300,384	$ 310,249	$ 321,243
Placed In-Service Date	2023	2024	2025	2026	2027
Pro-rated Initial Year	0%	0%	0%	0%	0%
Recovery Mechanism[7]	EPRM	EPRM	EPRM	EPRM	EPRM

Distribution - Line Transformers					
Capital Investment[2, 6]	$ -	$ 107,252	$ 100,128	$ 103,416	$ 107,081
Placed In-Service Date	2023	2024	2025	2026	2027
Pro-rated Initial Year	0%	0%	0%	0%	0%
Recovery Mechanism[7]	EPRM	EPRM	EPRM	EPRM	EPRM

Depreciation

Hawaiian Electric

	Transmission - Poles	Distribution - Poles	Distribution - Overhead Conductors	Distribution - Station Equip/Underground Conductors	Distribution - Underground Conduit	Distribution - Line Transformers	
Expected Useful Life [3]	58	45	53	55	60	30	
MACRS Tax Life ("Tax Life") [4]	15	20	20	20	20	20	half-year conv
Tax Class Life ("Class Life")	20	20	20	20	20	20	half-year conv

O&M

Hawaiian Electric

	Hazard Tree Removal (O&M)				
	2023	2024	2025	2026	2027
O&M[2, 5]	$ 399,004	$ 2,492,679	$ 2,572,053	$ 2,645,124	$ 2,722,902

Escalation Rate 2.0%

Notes:
1. Per HECO 2020 TY Rate Case Parties' Stipulated Settlement Letter in Docket No. 2019-0085, State ITC Amortization accelerated over a ten-year period.
2. Capital and O&M amounts are from the Reliability & Resilience Department per file "**Pivots_220526.xlsx**".
3. Expected useful life are from the Reliability & Resilience Department.
4. MACRS Tax life are per the HEI Tax Department.
5. Recovery of the incremental O&M will start in the following year based on a lookback of the actuals of the prior year.
6. Per the Reliability & Resilience Dept, plant-adds will be throughout the year. As these are assumed to be primarily programs, capital costs will be grouped and recovery will start in tl
7. Disallowed overheads have been removed from project costs in EPRM filings.

Manual input

HELCO TY2019 Rate Case Dkt 2018-0368 PUC Final D&O 37237

Cost of Capital Assumptions	Weight	Rate	Weighted Average	After-Tax Weighted Average	Weighted Average Revenue Requirement	Weighted Average Gross-up for Income Taxes
Short Term Debt	0.61%	3.75%	0.02%	0.02%	0.025%	0.02%
Long Term Debt (Taxable Debt)	40.59%	4.79%	1.94%	1.44%	2.134%	1.94%
Hybrids	0.80%	7.83%	0.06%	0.05%	0.069%	0.06%
Preferred Stock	1.17%	8.12%	0.09%	0.09%	0.140%	0.13%
Common Stock	56.83%	9.50%	5.40%	5.40%	7.980%	7.27%
	100.00%		7.52%	7.001%	10.349%	9.429%

Manual input

MECO TY2018 Rate Case Dkt 2017-0150 Final D&O No. 36219

Cost of Capital Assumptions	Weight	Rate	Weighted Average	After-Tax Weighted Average	Weighted Average Revenue Requirement	Weighted Average Gross-up for Income Taxes
Short Term Debt	1.37%	3.00%	0.04%	0.03%	0.045%	0.04%
Long Term Debt (Taxable Debt)	38.68%	4.54%	1.76%	1.30%	1.928%	1.76%
Hybrids	1.96%	7.16%	0.14%	0.10%	0.154%	0.14%
Preferred Stock	0.98%	8.15%	0.08%	0.08%	0.118%	0.11%
Common Stock	57.02%	9.50%	5.42%	5.42%	8.007%	7.30%
	100.00%		7.43%	6.935%	10.251%	9.341%

Hawaii Electric Light

Transmission - Poles and Fixtures				
$ -	$ 1,626,675	$ 1,233,342	$ 3,475,197	$ 6,050,349
2023	2024	2025	2026	2027
0%	0%	0%	0%	0%
EPRM	EPRM	EPRM	EPRM	EPRM

Distribution - Poles, Towers, and Fixtures				
$ -	$ 1,984,305	$ 2,850,354	$ 4,738,110	$ 6,737,612
2023	2024	2025	2026	2027
0%	0%	0%	0%	0%
EPRM	EPRM	EPRM	EPRM	EPRM

Distribution - Overhead Conductors and Devices				
$ -	$ 239,634	$ 172,798	$ 1,034,968	$ 1,069,816
2023	2024	2025	2026	2027
0%	0%	0%	0%	0%
EPRM	EPRM	EPRM	EPRM	EPRM

Distribution - Station Equipment - Substations				
$ -	$ 174,351	$ 145,655	$ 152,441	$ 160,412
2023	2024	2025	2026	2027
0%	0%	0%	0%	0%
EPRM	EPRM	EPRM	EPRM	EPRM

Maui Electric

Transmission - Poles and Fixtures				
$ -	$ 640,262	$ 1,099,690	$ 2,265,855	$ 4,427,055
2023	2024	2025	2026	2027
0%	0%	0%	0%	0%
EPRM	EPRM	EPRM	EPRM	EPRM

Distribution - Poles, Towers, and Fixtures				
$ -	$ 1,804,038	$ 2,649,141	$ 3,684,348	$ 4,683,084
2023	2024	2025	2026	2027
0%	0%	0%	0%	0%
EPRM	EPRM	EPRM	EPRM	EPRM

Distribution - Overhead Conductors and Devices				
$ -	$ 962,207	$ 1,247,790	$ 3,481,773	$ 895,639
2023	2024	2025	2026	2027
0%	0%	0%	0%	0%
EPRM	EPRM	EPRM	EPRM	EPRM

Distribution - Station Equipment - Substations				
$ -	$ 337,422	$ 246,618	$ 255,977	$ 168,390
2023	2024	2025	2026	2027
0%	0%	0%	0%	0%
EPRM	EPRM	EPRM	EPRM	EPRM

Hawaii Electric Light

Transmission - Poles	Distribution - Poles	Distribution - Overhead Conductors	Distribution - Station Equipment	
58	45	53	55	
15	20	20	20	half-year convention, table A-1
20	20	20	20	half-year convention, table A-8

Maui Electric

Transmission - Poles	Distribution - Poles	Distribution - Overhead Conductors	Distribution - Station Equipment	
58	45	53	55	
15	20	20	20	half-year convention, table A-1
20	20	20	20	half-year convention, table A-8

Hawaii Electric Light

Hazard Tree Removal (O&M)				
2023	2024	2025	2026	2027
$ 372,164	$ 2,513,873	$ 2,590,132	$ 2,663,756	$ 2,742,126

Maui Electric

Hazard Tree Removal (O&M)				
2023	2024	2025	2026	2027
$ 294,520	$ 2,655,089	$ 2,735,400	$ 2,813,158	$ 2,895,929

he following year.

Resilience Project/Program
Revenue Requirements Model - Calculations HE Transmission
Transmission - Poles and Fixtures

Manual input		1	2	3	4	5	6	7	8	9	10	11	12
O&M													
Escalation Rate		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24
O&M		-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates		0.000%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%
Depreciation Expense		-	18	18	18	18	18	18	18	18	18	18	18
Accumulated Depreciation		-	18	35	53	70	88	105	123	140	158	175	193
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	**20**	2.500%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%
Tax Basis (S/L)	0.0%	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	**15**	5.000%	9.500%	8.550%	7.700%	6.930%	6.230%	5.900%	5.900%	5.910%	5.900%	5.910%	5.900%
NonRB Financed Tax Basis (MACRS)	100.0%	50	95	86	77	69	62	59	59	59	59	59	59
Tax Depreciation		50	95	86	77	69	62	59	59	59	59	59	59
Accumulated Tax Depreciation		50	145	231	308	377	439	498	557	616	675	734	793
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate		0.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	0.000%
Amortization of State ITC	4.00%	-	4	4	4	4	4	4	4	4	4	4	-
Accumulated Amortization		-	4	8	12	16	20	24	28	32	36	40	40
Deferred ITC		40	36	32	28	24	20	16	12	8	4	-	-
Tax		40											
Deferred Tax Calculation													
Book Accumulated Depreciation		-	18	35	53	70	88	105	123	140	158	175	193
Tax Accumulated Depreciation		50	145	231	308	377	439	498	557	616	675	734	793
Book/Tax Acc Depr Difference		(50)	(127)	(195)	(255)	(307)	(351)	(393)	(434)	(476)	(517)	(559)	(600)
Deferred ITC		40	36	32	28	24	20	16	12	8	4	-	-
Net Deferred Tax Asset (Liability)		(3)	(24)	(42)	(58)	(73)	(85)	(97)	(109)	(120)	(132)	(144)	(155)
Deferred Tax Base		10	81	72	63	56	49	45	45	46	45	46	41
Deferred Taxes - Federal		2	16	14	13	11	10	9	9	9	9	9	8
Deferred Taxes - State excluding credit		1	5	4	4	3	3	3	3	3	3	3	2
Change in Deferred Taxes		3	21	19	16	14	13	12	12	12	12	12	11
Accumulated Deferred Taxes		3	24	42	58	73	85	97	109	120	132	144	155
	check	-	-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC		40	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
		40	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant		1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation		-	18	35	53	70	88	105	123	140	158	175	193
Accumulated Deferred Taxes		3	24	42	58	73	85	97	109	120	132	144	155
Accumulated Deferred ITC		40	36	32	28	24	20	16	12	8	4	-	-
Ending Net Investment	1,000	957	923	891	861	833	807	782	756	731	706	681	652
Average Net Investment		-	940	907	876	847	820	794	769	744	719	693	667
Average Financing:													
Short Term Debt	0.58%	-	5	5	5	5	5	5	4	4	4	4	4
Long Term Debt (Revenue Bonds)	41.42%	-	389	376	363	351	340	329	319	308	298	287	276
Taxable Debt	0.00%	-	-	-	-	-	-	-	-	-	-	-	-
Preferred Stock	0.85%	-	8	8	7	7	7	7	6	6	6	6	6
Common Equity	57.15%	-	537	518	501	484	469	454	440	425	411	396	381
Total Financing		-	940	907	876	847	820	794	769	744	719	693	667

Revenue Requirements Model - Calculations HE Transmission
Transmission - Poles and Fixtures

Manual input		1	2	3	4	5	6	7	8	9	10	11	12
Return on Investment													
Short Term Debt	2.50%	-	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	4.55%	-	18	17	17	16	15	15	14	14	14	13	13
Hybrids	0.00%	-	-	-	-	-	-	-	-	-	-	-	-
Total Interest Expense		-	18	17	17	16	16	15	15	14	14	13	13
Preferred Dividends	5.33%	-	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	9.50%	-	51	49	48	46	45	43	42	40	39	38	36
Income Taxes													
Income Before Pref Dividends		-	51	50	48	46	45	43	42	41	39	38	36
Income Before Taxes (including ITC)		-	69	67	65	62	60	59	57	55	53	51	49
Investment Tax Credit		-	4	4	4	4	4	4	4	4	4	4	-
Income Before Taxes (excluding ITC)		-	65	63	61	58	56	55	53	51	49	47	49
Federal Income Tax		-	14	13	13	12	12	12	11	11	10	10	10
State Income Tax		-	4	4	4	4	4	4	3	3	3	3	3
State Investment Tax Credit		-	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
Total State Tax		-	0	0	(0)	(0)	(0)	(0)	(1)	(1)	(1)	(1)	3
Total Taxes		-	14	13	13	12	12	11	11	10	10	9	13
Revenue Requirement Calculation													
Revenue Requirement Factors		**-**	**0.1105**	**0.1072**	**0.1040**	**0.1011**	**0.0983**	**0.0957**	**0.0931**	**0.0906**	**0.0880**	**0.0854**	**0.0871**
Revenue Requirement		**-**	**111**	**107**	**104**	**101**	**98**	**96**	**93**	**91**	**88**	**85**	**87**
Revenue Taxes		-	10	10	9	9	9	9	8	8	8	8	8
Income Before Depr, Int, Inc Tax		-	101	98	95	92	90	87	85	83	80	78	79
Depreciation Expense		-	18	18	18	18	18	18	18	18	18	18	18
O&M		-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense		-	18	17	17	16	16	15	15	14	14	13	13
Income Before Income Taxes		-	65	63	61	58	56	55	53	51	49	47	49
Income Taxes - Federal		-	14	13	13	12	12	12	11	11	10	10	10
Income Taxes - State		-	4	4	4	4	4	4	3	3	3	3	3
State ITC		-	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
Total Income Taxes		-	14	13	13	12	12	11	11	10	10	9	13
Preferred Dividends		-	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common		-	51	49	48	46	45	43	42	40	39	38	36
check		-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Transmission - Poles and Fixtures

Manual input	13	14	15	16	17	18	19	20	21	22	23	24	25
O&M													
Escalation Rate	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46	1.49	1.52	1.55	1.58	1.61
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%
Depreciation Expense	18	18	18	18	18	18	18	18	18	18	18	18	18
Accumulated Depreciation	211	228	246	263	281	298	316	333	351	368	386	404	421
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	2.500%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	5.910%	5.900%	5.910%	2.950%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	59	59	59	30	-	-	-	-	-	-	-	-	-
Tax Depreciation	59	59	59	30	-	-	-	-	-	-	-	-	-
Accumulated Tax Depreciation	852	911	971	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	211	228	246	263	281	298	316	333	351	368	386	404	421
Tax Accumulated Depreciation	852	911	971	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(642)	(683)	(725)	(737)	(719)	(702)	(684)	(667)	(649)	(632)	(614)	(596)	(579)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(165)	(176)	(187)	(190)	(185)	(181)	(176)	(172)	(167)	(163)	(158)	(154)	(149)
Deferred Tax Base	42	41	42	12	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)
Deferred Taxes - Federal	8	8	8	2	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Deferred Taxes - State excluding credit	2	2	2	1	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Change in Deferred Taxes	11	11	11	3	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Accumulated Deferred Taxes	165	176	187	190	185	181	176	172	167	163	158	154	149
check	-	-	-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	211	228	246	263	281	298	316	333	351	368	386	404	421
Accumulated Deferred Taxes	165	176	187	190	185	181	176	172	167	163	158	154	149
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	624	596	568	547	534	521	508	495	482	469	456	443	430
Average Net Investment	638	610	582	557	541	528	515	502	488	475	462	449	436
Average Financing:													
Short Term Debt	4	4	3	3	3	3	3	3	3	3	3	3	3
Long Term Debt (Revenue Bonds)	264	253	241	231	224	219	213	208	202	197	192	186	181
Taxable Debt	-	-	-	-	-	-	-	-	-	-	-	-	-
Preferred Stock	5	5	5	5	5	4	4	4	4	4	4	4	4
Common Equity	365	349	333	319	309	302	294	287	279	272	264	257	249
Total Financing	638	610	582	557	541	528	515	502	488	475	462	449	436

Revenue Requirements Model - Calculati
Transmission - Poles and Fixtures

Manual input	13	14	15	16	17	18	19	20	21	22	23	24	25
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	12	11	11	11	10	10	10	9	9	9	9	8	8
Hybrids	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Interest Expense	12	12	11	11	10	10	10	10	9	9	9	9	8
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	35	33	32	30	29	29	28	27	27	26	25	24	24
Income Taxes													
Income Before Pref Dividends	35	33	32	31	30	29	28	27	27	26	25	25	24
Income Before Taxes (including ITC)	47	45	43	41	40	39	38	37	36	35	34	33	32
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	47	45	43	41	40	39	38	37	36	35	34	33	32
Federal Income Tax	9	9	8	8	8	8	7	7	7	7	7	7	6
State Income Tax	3	3	3	2	2	2	2	2	2	2	2	2	2
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	3	3	3	2	2	2	2	2	2	2	2	2	2
Total Taxes	12	12	11	11	10	10	10	10	9	9	9	9	8
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0842**	**0.0813**	**0.0785**	**0.0760**	**0.0743**	**0.0729**	**0.0716**	**0.0703**	**0.0690**	**0.0676**	**0.0663**	**0.0650**	**0.0637**
Revenue Requirement	**84**	**81**	**78**	**76**	**74**	**73**	**72**	**70**	**69**	**68**	**66**	**65**	**64**
Revenue Taxes	7	7	7	7	7	6	6	6	6	6	6	6	6
Income Before Depr, Int, Inc Tax	77	74	71	69	68	66	65	64	63	62	60	59	58
Depreciation Expense	18	18	18	18	18	18	18	18	18	18	18	18	18
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	12	12	11	11	10	10	10	10	9	9	9	9	8
Income Before Income Taxes	47	45	43	41	40	39	38	37	36	35	34	33	32
Income Taxes - Federal	9	9	8	8	8	8	7	7	7	7	7	7	6
Income Taxes - State	3	3	3	2	2	2	2	2	2	2	2	2	2
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	12	12	11	11	10	10	10	10	9	9	9	9	8
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	35	33	32	30	29	29	28	27	27	26	25	24	24
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Transmission - Poles and Fixtures

Manual input	26	27	28	29	30	31	32	33	34	35	36	37	38
O&M													
Escalation Rate	1.64	1.67	1.71	1.74	1.78	1.81	1.85	1.88	1.92	1.96	2.00	2.04	2.08
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%
Depreciation Expense	18	18	18	18	18	18	18	18	18	18	18	18	18
Accumulated Depreciation	439	456	474	491	509	526	544	561	579	596	614	632	649
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	439	456	474	491	509	526	544	561	579	596	614	632	649
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(561)	(544)	(526)	(509)	(491)	(474)	(456)	(439)	(421)	(404)	(386)	(368)	(351)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(145)	(140)	(136)	(131)	(127)	(122)	(117)	(113)	(108)	(104)	(99)	(95)	(90)
Deferred Tax Base	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)
Deferred Taxes - Federal	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Change in Deferred Taxes	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Accumulated Deferred Taxes	145	140	136	131	127	122	117	113	108	104	99	95	90
check	-	-	-	-	-	-	-	-	-	-	-	-	0
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	439	456	474	491	509	526	544	561	579	596	614	632	649
Accumulated Deferred Taxes	145	140	136	131	127	122	117	113	108	104	99	95	90
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	417	404	391	378	365	352	339	326	313	300	287	274	261
Average Net Investment	423	410	397	384	371	358	345	332	319	306	293	280	267
Average Financing:													
Short Term Debt	2	2	2	2	2	2	2	2	2	2	2	2	2
Long Term Debt (Revenue Bonds)	175	170	165	159	154	148	143	138	132	127	121	116	111
Taxable Debt	-	-	-	-	-	-	-	-	-	-	-	-	-
Preferred Stock	4	3	3	3	3	3	3	3	3	3	2	2	2
Common Equity	242	235	227	220	212	205	197	190	182	175	168	160	153
Total Financing	423	410	397	384	371	358	345	332	319	306	293	280	267

Revenue Requirements Model - Calculati
Transmission - Poles and Fixtures

Manual input	26	27	28	29	30	31	32	33	34	35	36	37	38
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	8	8	7	7	7	7	7	6	6	6	6	5	5
Hybrids	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Interest Expense	8	8	8	7	7	7	7	6	6	6	6	5	5
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	23	22	22	21	20	19	19	18	17	17	16	15	14
Income Taxes													
Income Before Pref Dividends	23	22	22	21	20	20	19	18	17	17	16	15	15
Income Before Taxes (including ITC)	31	30	29	28	27	26	25	24	24	23	22	21	20
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	31	30	29	28	27	26	25	24	24	23	22	21	20
Federal Income Tax	6	6	6	6	5	5	5	5	5	4	4	4	4
State Income Tax	2	2	2	2	2	2	2	1	1	1	1	1	1
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	2	2	2	2	2	2	2	1	1	1	1	1	1
Total Taxes	8	8	8	7	7	7	7	6	6	6	6	5	5
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0623**	**0.0610**	**0.0597**	**0.0584**	**0.0570**	**0.0557**	**0.0544**	**0.0531**	**0.0517**	**0.0504**	**0.0491**	**0.0478**	**0.0464**
Revenue Requirement	**62**	**61**	**60**	**58**	**57**	**56**	**54**	**53**	**52**	**50**	**49**	**48**	**46**
Revenue Taxes	6	5	5	5	5	5	5	5	5	4	4	4	4
Income Before Depr, Int, Inc Tax	57	56	54	53	52	51	50	48	47	46	45	44	42
Depreciation Expense	18	18	18	18	18	18	18	18	18	18	18	18	18
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	8	8	8	7	7	7	7	6	6	6	6	5	5
Income Before Income Taxes	31	30	29	28	27	26	25	24	24	23	22	21	20
Income Taxes - Federal	6	6	6	6	5	5	5	5	5	4	4	4	4
Income Taxes - State	2	2	2	2	2	2	2	1	1	1	1	1	1
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	8	8	8	7	7	7	7	6	6	6	6	5	5
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	23	22	22	21	20	19	19	18	17	17	16	15	14
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Transmission - Poles and Fixtures

Manual input	39	40	41	42	43	44	45	46	47	48	49	50	51
O&M													
Escalation Rate	2.12	2.16	2.21	2.25	2.30	2.34	2.39	2.44	2.49	2.54	2.59	2.64	2.69
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%
Depreciation Expense	18	18	18	18	18	18	18	18	18	18	18	18	18
Accumulated Depreciation	667	684	702	719	737	754	772	789	807	825	842	860	877
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	667	684	702	719	737	754	772	789	807	825	842	860	877
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(333)	(316)	(298)	(281)	(263)	(246)	(228)	(211)	(193)	(175)	(158)	(140)	(123)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(86)	(81)	(77)	(72)	(68)	(63)	(59)	(54)	(50)	(45)	(41)	(36)	(32)
Deferred Tax Base	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)
Deferred Taxes - Federal	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Change in Deferred Taxes	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Accumulated Deferred Taxes	86	81	77	72	68	63	59	54	50	45	41	36	32
check	0	0	0	0	0	0	0	0	0	0	0	0	0
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	667	684	702	719	737	754	772	789	807	825	842	860	877
Accumulated Deferred Taxes	86	81	77	72	68	63	59	54	50	45	41	36	32
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	247	234	221	208	195	182	169	156	143	130	117	104	91
Average Net Investment	254	241	228	215	202	189	176	163	150	137	124	111	98
Average Financing:													
Short Term Debt	1	1	1	1	1	1	1	1	1	1	1	1	1
Long Term Debt (Revenue Bonds)	105	100	94	89	84	78	73	67	62	57	51	46	40
Taxable Debt	-	-	-	-	-	-	-	-	-	-	-	-	-
Preferred Stock	2	2	2	2	2	2	1	1	1	1	1	1	1
Common Equity	145	138	130	123	115	108	101	93	86	78	71	63	56
Total Financing	254	241	228	215	202	189	176	163	150	137	124	111	98

Revenue Requirements Model - Calculati
Transmission - Poles and Fixtures

Manual input	39	40	41	42	43	44	45	46	47	48	49	50	51
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	5	5	4	4	4	4	3	3	3	3	2	2	2
Hybrids	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Interest Expense	5	5	4	4	4	4	3	3	3	3	2	2	2
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	14	13	12	12	11	10	10	9	8	7	7	6	5
Income Taxes													
Income Before Pref Dividends	14	13	12	12	11	10	10	9	8	7	7	6	5
Income Before Taxes (including ITC)	19	18	17	16	15	14	13	12	11	10	9	8	7
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	19	18	17	16	15	14	13	12	11	10	9	8	7
Federal Income Tax	4	4	3	3	3	3	3	2	2	2	2	2	1
State Income Tax	1	1	1	1	1	1	1	1	1	1	1	0	0
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	1	1	1	1	1	1	1	1	1	1	1	0	0
Total Taxes	5	5	4	4	4	4	3	3	3	3	2	2	2
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0451**	**0.0438**	**0.0425**	**0.0411**	**0.0398**	**0.0385**	**0.0372**	**0.0358**	**0.0345**	**0.0332**	**0.0318**	**0.0305**	**0.0292**
Revenue Requirement	**45**	**44**	**42**	**41**	**40**	**38**	**37**	**36**	**34**	**33**	**32**	**31**	**29**
Revenue Taxes	4	4	4	4	4	3	3	3	3	3	3	3	3
Income Before Depr, Int, Inc Tax	41	40	39	37	36	35	34	33	31	30	29	28	27
Depreciation Expense	18	18	18	18	18	18	18	18	18	18	18	18	18
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	5	5	4	4	4	4	3	3	3	3	2	2	2
Income Before Income Taxes	19	18	17	16	15	14	13	12	11	10	9	8	7
Income Taxes - Federal	4	4	3	3	3	3	3	2	2	2	2	2	1
Income Taxes - State	1	1	1	1	1	1	1	1	1	1	1	0	0
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	5	5	4	4	4	4	3	3	3	3	2	2	2
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	14	13	12	12	11	10	10	9	8	7	7	6	5
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculatio
Transmission - Poles and Fixtures

Manual input	52	53	54	55	56	57	58	59	60	Total
O&M										
Escalation Rate	2.75	2.80	2.86	2.91	2.97	3.03	3.09	3.15	3.22	
O&M	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation										
Book Depreciation										
Book Depreciation Rates	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	0.000%	0.000%	100.00%
Depreciation Expense	18	18	18	18	18	18	18	-	-	1,000
Accumulated Depreciation	895	912	930	947	965	982	1,000	1,000	1,000	
Tax Depreciation										
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	1,000
Tax Depreciation	-	-	-	-	-	-	-	-	-	1,000
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
State Investment Tax Credit (ITC)										
Book										
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	40
Accumulated Amortization	40	40	40	40	40	40	40	40	40	
Deferred ITC	-	-	-	-	-	-	-	-	-	
Tax										
Deferred Tax Calculation										
Book Accumulated Depreciation	895	912	930	947	965	982	1,000	1,000	1,000	
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Book/Tax Acc Depr Difference	(105)	(88)	(70)	(53)	(35)	(18)	-	-	-	
Deferred ITC	-	-	-	-	-	-	-	-	-	
Net Deferred Tax Asset (Liability)	(27)	(23)	(18)	(14)	(9)	(5)	-	-	-	
Deferred Tax Base	(18)	(18)	(18)	(18)	(18)	(18)	(18)	-	-	
Deferred Taxes - Federal	(3)	(3)	(3)	(3)	(3)	(3)	(3)	-	-	
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	(1)	(1)	(1)	-	-	
Change in Deferred Taxes	(5)	(5)	(5)	(5)	(5)	(5)	(5)	-	-	
Accumulated Deferred Taxes	27	23	18	14	9	5	0	0	0	
check	0	0	0	0	0	0	0	0	0	
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	
	-	-	-	-	-	-	-	-	-	
Rate Base and Financing										
Investment: (Rate Base)										
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Accumulated Depreciation	895	912	930	947	965	982	1,000	1,000	1,000	
Accumulated Deferred Taxes	27	23	18	14	9	5	0	0	0	
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	
Ending Net Investment	78	65	52	39	26	13	(0)	(0)	(0)	
Average Net Investment	85	72	59	46	33	20	7	(0)	(0)	
Average Financing:										
Short Term Debt	0	0	0	0	0	0	0	(0)	(0)	
Long Term Debt (Revenue Bonds)	35	30	24	19	13	8	3	(0)	(0)	
Taxable Debt	-	-	-	-	-	-	-	-	-	
Preferred Stock	1	1	0	0	0	0	0	(0)	(0)	
Common Equity	48	41	34	26	19	11	4	(0)	(0)	
Total Financing	85	72	59	46	33	20	7	(0)	(0)	

Revenue Requirements Model - Calculatio
Transmission - Poles and Fixtures

Manual input	52	53	54	55	56	57	58	59	60	Total
Return on Investment										
Short Term Debt	0	0	0	0	0	0	0	(0)	(0)	
Long Term Debt (Taxable Debt)	2	1	1	1	1	0	0	(0)	(0)	
Hybrids	-	-	-	-	-	-	-	-	-	
Total Interest Expense	2	1	1	1	1	0	0	(0)	(0)	
Preferred Dividends	0	0	0	0	0	0	0	(0)	(0)	
Net Income on Common	5	4	3	2	2	1	0	(0)	(0)	
Income Taxes										
Income Before Pref Dividends	5	4	3	2	2	1	0	(0)	(0)	
Income Before Taxes (including ITC)	6	5	4	3	2	1	0	(0)	(0)	
Investment Tax Credit	-	-	-	-	-	-	-	-	-	
Income Before Taxes (excluding ITC)	6	5	4	3	2	1	0	(0)	(0)	
Federal Income Tax	1	1	1	1	0	0	0	(0)	(0)	
State Income Tax	0	0	0	0	0	0	0	(0)	(0)	
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	
Total State Tax	0	0	0	0	0	0	0	(0)	(0)	
Total Taxes	2	1	1	1	1	0	0	(0)	(0)	
Revenue Requirement Calculation										
Revenue Requirement Factors	**0.0279**	**0.0265**	**0.0252**	**0.0239**	**0.0226**	**0.0212**	**0.0199**	**(0.0000)**	**(0.0000)**	
Revenue Requirement	**28**	**27**	**25**	**24**	**23**	**21**	**20**	**(0)**	**(0)**	
Revenue Taxes	2	2	2	2	2	2	2	(0)	(0)	
Income Before Depr, Int, Inc Tax	25	24	23	22	21	19	18	(0)	(0)	
Depreciation Expense	18	18	18	18	18	18	18	-	-	
O&M	-	-	-	-	-	-	-	-	-	
Interest Expense	2	1	1	1	1	0	0	(0)	(0)	
Income Before Income Taxes	6	5	4	3	2	1	0	(0)	(0)	
Income Taxes - Federal	1	1	1	1	0	0	0	(0)	(0)	
Income Taxes - State	0	0	0	0	0	0	0	(0)	(0)	
State ITC	-	-	-	-	-	-	-	-	-	
Total Income Taxes	2	1	1	1	1	0	0	(0)	(0)	
Preferred Dividends	0	0	0	0	0	0	0	(0)	(0)	
Net Income for Common	5	4	3	2	2	1	0	(0)	(0)	
	-	*-*	*-*	*(0)*	*(0)*	*(0)*	*(0)*	*-*	*-*	

Resilience Project/Program
Revenue Requirements Model - Calculations HE Distribution
Distribution - Poles, Towers, and Fixtures

		1	2	3	4	5	6	7	8	9	10	11
Manual input												
O&M												
Escalation Rate		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22
O&M		-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation												
Book Depreciation												
Book Depreciation Rates		0.000%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%
Depreciation Expense		-	23	23	23	23	23	23	23	23	23	23
Accumulated Depreciation		-	23	45	68	91	114	136	159	182	205	227
Tax Depreciation												
Tax Depreciation Rates (Straight Line)	**20**	2.500%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%
Tax Basis (S/L)	0.0%	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	**20**	3.750%	7.219%	6.677%	6.177%	5.713%	5.285%	4.888%	4.522%	4.462%	4.461%	4.462%
NonRB Financed Tax Basis (MACRS)	100.0%	38	72	67	62	57	53	49	45	45	45	45
Tax Depreciation		38	72	67	62	57	53	49	45	45	45	45
Accumulated Tax Depreciation		38	110	176	238	295	348	397	442	487	532	576
State Investment Tax Credit (ITC)												
Book												
State ITC Amortization Rate		0.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%
Amortization of State ITC	4.00%	-	4	4	4	4	4	4	4	4	4	4
Accumulated Amortization		-	4	8	12	16	20	24	28	32	36	40
Deferred ITC		40	36	32	28	24	20	16	12	8	4	-
Tax		40										
Deferred Tax Calculation												
Book Accumulated Depreciation		-	23	45	68	91	114	136	159	182	205	227
Tax Accumulated Depreciation		38	110	176	238	295	348	397	442	487	532	576
Book/Tax Acc Depr Difference		(38)	(87)	(131)	(170)	(204)	(235)	(261)	(283)	(305)	(327)	(349)
Deferred ITC		40	36	32	28	24	20	16	12	8	4	-
Net Deferred Tax Asset (Liability)		1	(13)	(25)	(37)	(46)	(55)	(63)	(70)	(77)	(83)	(90)
Deferred Tax Base		(3)	53	48	43	38	34	30	26	26	26	26
Deferred Taxes - Federal		(0)	11	9	8	8	7	6	5	5	5	5
Deferred Taxes - State excluding credit		(0)	3	3	3	2	2	2	2	2	2	2
Change in Deferred Taxes		(1)	14	12	11	10	9	8	7	7	7	7
Accumulated Deferred Taxes		(1)	13	25	37	46	55	63	70	77	83	90
check		-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC		40	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
		40	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Rate Base and Financing												
Investment: (Rate Base)												
Gross Plant		1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation		-	23	45	68	91	114	136	159	182	205	227
Accumulated Deferred Taxes		(1)	13	25	37	46	55	63	70	77	83	90
Accumulated Deferred ITC		40	36	32	28	24	20	16	12	8	4	-
Ending Net Investment	1,000	961	928	897	867	839	811	785	759	734	708	683
Average Net Investment		-	944	913	882	853	825	798	772	746	721	696
Average Financing:												
Short Term Debt	0.58%	-	6	5	5	5	5	5	4	4	4	4
Long Term Debt (Revenue Bonds)	41.42%	-	391	378	365	353	342	330	320	309	299	288
Taxable Debt	0.00%	-	-	-	-	-	-	-	-	-	-	-
Preferred Stock	0.85%	-	8	8	7	7	7	7	7	6	6	6
Common Equity	57.15%	-	540	522	504	487	471	456	441	427	412	398
Total Financing		-	944	913	882	853	825	798	772	746	721	696

Revenue Requirements Model - Calculations HE Distribution
Distribution - Poles, Towers, and Fixtures

Manual input		1	2	3	4	5	6	7	8	9	10	11
Return on Investment												
Short Term Debt	2.50%	-	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	4.55%	-	18	17	17	16	16	15	15	14	14	13
Hybrids	0.00%	-	-	-	-	-	-	-	-	-	-	-
Total Interest Expense		-	18	17	17	16	16	15	15	14	14	13
Preferred Dividends	5.33%	-	0	0	0	0	0	0	0	0	0	0
Net Income on Common	9.50%	-	51	50	48	46	45	43	42	41	39	38
Income Taxes												
Income Before Pref Dividends		-	52	50	48	47	45	44	42	41	39	38
Income Before Taxes (including ITC)		-	70	67	65	63	61	59	57	55	53	51
Investment Tax Credit		-	4	4	4	4	4	4	4	4	4	4
Income Before Taxes (excluding ITC)		-	66	63	61	59	57	55	53	51	49	47
Federal Income Tax		-	14	13	13	12	12	12	11	11	10	10
State Income Tax		-	4	4	4	4	4	4	3	3	3	3
State Investment Tax Credit		-	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Total State Tax		-	0	0	(0)	(0)	(0)	(0)	(1)	(1)	(1)	(1)
Total Taxes		-	14	13	13	12	12	11	11	10	10	9
Revenue Requirement Calculation												
Revenue Requirement Factors		**-**	**0.1167**	**0.1134**	**0.1103**	**0.1074**	**0.1045**	**0.1017**	**0.0991**	**0.0965**	**0.0939**	**0.0913**
Revenue Requirement		**-**	**117**	**113**	**110**	**107**	**104**	**102**	**99**	**97**	**94**	**91**
Revenue Taxes		-	10	10	10	10	9	9	9	9	8	8
Income Before Depr, Int, Inc Tax		-	106	103	101	98	95	93	90	88	86	83
Depreciation Expense		-	23	23	23	23	23	23	23	23	23	23
O&M		-	-	-	-	-	-	-	-	-	-	-
Interest Expense		-	18	17	17	16	16	15	15	14	14	13
Income Before Income Taxes		-	66	63	61	59	57	55	53	51	49	47
Income Taxes - Federal		-	14	13	13	12	12	12	11	11	10	10
Income Taxes - State		-	4	4	4	4	4	4	3	3	3	3
State ITC		-	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Total Income Taxes		-	14	13	13	12	12	11	11	10	10	9
Preferred Dividends		-	0	0	0	0	0	0	0	0	0	0
Net Income for Common		-	51	50	48	46	45	43	42	41	39	38
check		-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Distribution - Poles, Towers, and Fixtures

Manual input	12	13	14	15	16	17	18	19	20	21	22	23	24
O&M													
Escalation Rate	1.24	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46	1.49	1.52	1.55	1.58
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%
Depreciation Expense	23	23	23	23	23	23	23	23	23	23	23	23	23
Accumulated Depreciation	250	273	295	318	341	364	386	409	432	455	477	500	523
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	2.500%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	4.461%	4.462%	4.461%	4.462%	4.461%	4.462%	4.461%	4.462%	4.461%	2.231%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	45	45	45	45	45	45	45	45	45	22	-	-	-
Tax Depreciation	45	45	45	45	45	45	45	45	45	22	-	-	-
Accumulated Tax Depreciation	621	665	710	755	799	844	888	933	978	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	250	273	295	318	341	364	386	409	432	455	477	500	523
Tax Accumulated Depreciation	621	665	710	755	799	844	888	933	978	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(371)	(393)	(415)	(436)	(458)	(480)	(502)	(524)	(546)	(545)	(523)	(500)	(477)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(95)	(101)	(107)	(112)	(118)	(124)	(129)	(135)	(141)	(140)	(135)	(129)	(123)
Deferred Tax Base	22	22	22	22	22	22	22	22	22	(0)	(23)	(23)	(23)
Deferred Taxes - Federal	4	4	4	4	4	4	4	4	4	(0)	(4)	(4)	(4)
Deferred Taxes - State excluding credit	1	1	1	1	1	1	1	1	1	(0)	(1)	(1)	(1)
Change in Deferred Taxes	6	6	6	6	6	6	6	6	6	(0)	(6)	(6)	(6)
Accumulated Deferred Taxes	95	101	107	112	118	124	129	135	141	140	135	129	123
check	-	-	-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	250	273	295	318	341	364	386	409	432	455	477	500	523
Accumulated Deferred Taxes	95	101	107	112	118	124	129	135	141	140	135	129	123
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	655	626	598	569	541	513	484	456	428	405	388	371	354
Average Net Investment	669	640	612	584	555	527	499	470	442	416	397	380	363
Average Financing:													
Short Term Debt	4	4	4	3	3	3	3	3	3	2	2	2	2
Long Term Debt (Revenue Bonds)	277	265	253	242	230	218	206	195	183	172	164	157	150
Taxable Debt	-	-	-	-	-	-	-	-	-	-	-	-	-
Preferred Stock	6	5	5	5	5	4	4	4	4	4	3	3	3
Common Equity	382	366	350	334	317	301	285	269	252	238	227	217	207
Total Financing	669	640	612	584	555	527	499	470	442	416	397	380	363

Revenue Requirements Model - Calculati
Distribution - Poles, Towers, and Fixtures

Manual input	12	13	14	15	16	17	18	19	20	21	22	23	24
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	13	12	12	11	10	10	9	9	8	8	7	7	7
Hybrids	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Interest Expense	13	12	12	11	11	10	9	9	8	8	8	7	7
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	36	35	33	32	30	29	27	26	24	23	22	21	20
Income Taxes													
Income Before Pref Dividends	37	35	34	32	30	29	27	26	24	23	22	21	20
Income Before Taxes (including ITC)	49	47	45	43	41	39	37	35	33	31	29	28	27
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	49	47	45	43	41	39	37	35	33	31	29	28	27
Federal Income Tax	10	9	9	8	8	8	7	7	6	6	6	6	5
State Income Tax	3	3	3	3	2	2	2	2	2	2	2	2	2
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	3	3	3	3	2	2	2	2	2	2	2	2	2
Total Taxes	13	12	12	11	11	10	9	9	8	8	8	7	7
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0930**	**0.0901**	**0.0872**	**0.0843**	**0.0814**	**0.0786**	**0.0757**	**0.0728**	**0.0699**	**0.0673**	**0.0653**	**0.0636**	**0.0619**
Revenue Requirement	**93**	**90**	**87**	**84**	**81**	**79**	**76**	**73**	**70**	**67**	**65**	**64**	**62**
Revenue Taxes	8	8	8	7	7	7	7	6	6	6	6	6	5
Income Before Depr, Int, Inc Tax	85	82	79	77	74	72	69	66	64	61	59	58	56
Depreciation Expense	23	23	23	23	23	23	23	23	23	23	23	23	23
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	13	12	12	11	11	10	9	9	8	8	8	7	7
Income Before Income Taxes	49	47	45	43	41	39	37	35	33	31	29	28	27
Income Taxes - Federal	10	9	9	8	8	8	7	7	6	6	6	6	5
Income Taxes - State	3	3	3	3	2	2	2	2	2	2	2	2	2
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	13	12	12	11	11	10	9	9	8	8	8	7	7
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	36	35	33	32	30	29	27	26	24	23	22	21	20
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Distribution - Poles, Towers, and Fixtures

Manual input	25	26	27	28	29	30	31	32	33	34	35	36	37
O&M													
Escalation Rate	1.61	1.64	1.67	1.71	1.74	1.78	1.81	1.85	1.88	1.92	1.96	2.00	2.04
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%
Depreciation Expense	23	23	23	23	23	23	23	23	23	23	23	23	23
Accumulated Depreciation	545	568	591	614	636	659	682	705	727	750	773	795	818
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	545	568	591	614	636	659	682	705	727	750	773	795	818
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(455)	(432)	(409)	(386)	(364)	(341)	(318)	(295)	(273)	(250)	(227)	(205)	(182)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(117)	(111)	(105)	(99)	(94)	(88)	(82)	(76)	(70)	(64)	(59)	(53)	(47)
Deferred Tax Base	(23)	(23)	(23)	(23)	(23)	(23)	(23)	(23)	(23)	(23)	(23)	(23)	(23)
Deferred Taxes - Federal	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Change in Deferred Taxes	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)
Accumulated Deferred Taxes	117	111	105	99	94	88	82	76	70	64	59	53	47
check	-	-	0	0	0	0	0	0	0	0	0	0	0
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	545	568	591	614	636	659	682	705	727	750	773	795	818
Accumulated Deferred Taxes	117	111	105	99	94	88	82	76	70	64	59	53	47
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	337	321	304	287	270	253	236	219	202	186	169	152	135
Average Net Investment	346	329	312	295	278	262	245	228	211	194	177	160	143
Average Financing:													
Short Term Debt	2	2	2	2	2	2	1	1	1	1	1	1	1
Long Term Debt (Revenue Bonds)	143	136	129	122	115	108	101	94	87	80	73	66	59
Taxable Debt	-	-	-	-	-	-	-	-	-	-	-	-	-
Preferred Stock	3	3	3	2	2	2	2	2	2	2	1	1	1
Common Equity	198	188	178	169	159	149	140	130	121	111	101	92	82
Total Financing	346	329	312	295	278	262	245	228	211	194	177	160	143

Revenue Requirements Model - Calculati
Distribution - Poles, Towers, and Fixtures

Manual input	25	26	27	28	29	30	31	32	33	34	35	36	37
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	7	6	6	6	5	5	5	4	4	4	3	3	3
Hybrids	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Interest Expense	7	6	6	6	5	5	5	4	4	4	3	3	3
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	19	18	17	16	15	14	13	12	11	11	10	9	8
Income Taxes													
Income Before Pref Dividends	19	18	17	16	15	14	13	12	12	11	10	9	8
Income Before Taxes (including ITC)	26	24	23	22	21	19	18	17	16	14	13	12	11
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	26	24	23	22	21	19	18	17	16	14	13	12	11
Federal Income Tax	5	5	5	4	4	4	4	3	3	3	3	2	2
State Income Tax	2	1	1	1	1	1	1	1	1	1	1	1	1
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	2	1	1	1	1	1	1	1	1	1	1	1	1
Total Taxes	7	6	6	6	5	5	5	4	4	4	3	3	3
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0601**	**0.0584**	**0.0567**	**0.0550**	**0.0533**	**0.0516**	**0.0498**	**0.0481**	**0.0464**	**0.0447**	**0.0430**	**0.0413**	**0.0395**
Revenue Requirement	**60**	**58**	**57**	**55**	**53**	**52**	**50**	**48**	**46**	**45**	**43**	**41**	**40**
Revenue Taxes	5	5	5	5	5	5	4	4	4	4	4	4	4
Income Before Depr, Int, Inc Tax	55	53	52	50	49	47	45	44	42	41	39	38	36
Depreciation Expense	23	23	23	23	23	23	23	23	23	23	23	23	23
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	7	6	6	6	5	5	5	4	4	4	3	3	3
Income Before Income Taxes	26	24	23	22	21	19	18	17	16	14	13	12	11
Income Taxes - Federal	5	5	5	4	4	4	4	3	3	3	3	2	2
Income Taxes - State	2	1	1	1	1	1	1	1	1	1	1	1	1
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	7	6	6	6	5	5	5	4	4	4	3	3	3
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	19	18	17	16	15	14	13	12	11	11	10	9	8
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculatio
Distribution - Poles, Towers, and Fixtures

Manual input	38	39	40	41	42	43	44	45	46	47	48	49	50
O&M													
Escalation Rate	2.08	2.12	2.16	2.21	2.25	2.30	2.34	2.39	2.44	2.49	2.54	2.59	2.64
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	0.000%	0.000%	0.000%	0.000%	0.000%
Depreciation Expense	23	23	23	23	23	23	23	23	-	-	-	-	-
Accumulated Depreciation	841	864	886	909	932	955	977	1,000	1,000	1,000	1,000	1,000	1,000
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	841	864	886	909	932	955	977	1,000	1,000	1,000	1,000	1,000	1,000
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(159)	(136)	(114)	(91)	(68)	(45)	(23)	-	-	-	-	-	-
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(41)	(35)	(29)	(23)	(18)	(12)	(6)	-	-	-	-	-	-
Deferred Tax Base	(23)	(23)	(23)	(23)	(23)	(23)	(23)	(23)	-	-	-	-	-
Deferred Taxes - Federal	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-	-	-	-	-
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	-	-	-	-	-
Change in Deferred Taxes	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	-	-	-	-	-
Accumulated Deferred Taxes	41	35	29	23	18	12	6	0	0	0	0	0	0
check	0	0	0	0	0	0	0	0	0	0	0	0	0
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	841	864	886	909	932	955	977	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Deferred Taxes	41	35	29	23	18	12	6	0	0	0	0	0	0
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	118	101	84	67	51	34	17	(0)	(0)	(0)	(0)	(0)	(0)
Average Net Investment	127	110	93	76	59	42	25	8	(0)	(0)	(0)	(0)	(0)
Average Financing:													
Short Term Debt	1	1	1	0	0	0	0	0	(0)	(0)	(0)	(0)	(0)
Long Term Debt (Revenue Bonds)	52	45	38	31	24	17	10	3	(0)	(0)	(0)	(0)	(0)
Taxable Debt	-	-	-	-	-	-	-	-	-	-	-	-	-
Preferred Stock	1	1	1	1	0	0	0	0	(0)	(0)	(0)	(0)	(0)
Common Equity	72	63	53	43	34	24	14	5	(0)	(0)	(0)	(0)	(0)
Total Financing	127	110	93	76	59	42	25	8	(0)	(0)	(0)	(0)	(0)

Revenue Requirements Model - Calculati
Distribution - Poles, Towers, and Fixtures

Manual input	38	39	40	41	42	43	44	45	46	47	48	49	50
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	(0)	(0)	(0)	(0)	(0)
Long Term Debt (Taxable Debt)	2	2	2	1	1	1	0	0	(0)	(0)	(0)	(0)	(0)
Hybrids	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Interest Expense	2	2	2	1	1	1	0	0	(0)	(0)	(0)	(0)	(0)
Preferred Dividends	0	0	0	0	0	0	0	0	(0)	(0)	(0)	(0)	(0)
Net Income on Common	7	6	5	4	3	2	1	0	(0)	(0)	(0)	(0)	(0)
Income Taxes													
Income Before Pref Dividends	7	6	5	4	3	2	1	0	(0)	(0)	(0)	(0)	(0)
Income Before Taxes (including ITC)	9	8	7	6	4	3	2	1	(0)	(0)	(0)	(0)	(0)
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	9	8	7	6	4	3	2	1	(0)	(0)	(0)	(0)	(0)
Federal Income Tax	2	2	1	1	1	1	0	0	(0)	(0)	(0)	(0)	(0)
State Income Tax	1	0	0	0	0	0	0	0	(0)	(0)	(0)	(0)	(0)
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	1	0	0	0	0	0	0	0	(0)	(0)	(0)	(0)	(0)
Total Taxes	2	2	2	1	1	1	0	0	(0)	(0)	(0)	(0)	(0)
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0378**	**0.0361**	**0.0344**	**0.0327**	**0.0310**	**0.0292**	**0.0275**	**0.0258**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**
Revenue Requirement	**38**	**36**	**34**	**33**	**31**	**29**	**28**	**26**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**
Revenue Taxes	3	3	3	3	3	3	3	2	(0)	(0)	(0)	(0)	(0)
Income Before Depr, Int, Inc Tax	34	33	31	30	28	27	25	24	(0)	(0)	(0)	(0)	(0)
Depreciation Expense	23	23	23	23	23	23	23	23	-	-	-	-	-
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	2	2	2	1	1	1	0	0	(0)	(0)	(0)	(0)	(0)
Income Before Income Taxes	9	8	7	6	4	3	2	1	(0)	(0)	(0)	(0)	(0)
Income Taxes - Federal	2	2	1	1	1	1	0	0	(0)	(0)	(0)	(0)	(0)
Income Taxes - State	1	0	0	0	0	0	0	0	(0)	(0)	(0)	(0)	(0)
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	2	2	2	1	1	1	0	0	(0)	(0)	(0)	(0)	(0)
Preferred Dividends	0	0	0	0	0	0	0	0	(0)	(0)	(0)	(0)	(0)
Net Income for Common	7	6	5	4	3	2	1	0	(0)	(0)	(0)	(0)	(0)
	(0)	*(0)*	-	-	*(0)*	*(0)*	*(0)*	*(0)*	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Distribution - Poles, Towers, and Fixtures

Manual input	51	52	53	54	55	56	57	58	59	60	Total
O&M											
Escalation Rate	2.69	2.75	2.80	2.86	2.91	2.97	3.03	3.09	3.15	3.22	
O&M	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation											
Book Depreciation											
Book Depreciation Rates	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Depreciation Expense	-	-	-	-	-	-	-	-	-	-	1,000
Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Tax Depreciation											
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	1,000
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	1,000
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
State Investment Tax Credit (ITC)											
Book											
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	40
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	
Deferred ITC	-	-	-	-	-	-	-	-	-	-	
Tax											
Deferred Tax Calculation											
Book Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Book/Tax Acc Depr Difference	-	-	-	-	-	-	-	-	-	-	
Deferred ITC	-	-	-	-	-	-	-	-	-	-	
Net Deferred Tax Asset (Liability)	-	-	-	-	-	-	-	-	-	-	
Deferred Tax Base	-	-	-	-	-	-	-	-	-	-	
Deferred Taxes - Federal	-	-	-	-	-	-	-	-	-	-	
Deferred Taxes - State excluding credit	-	-	-	-	-	-	-	-	-	-	
Change in Deferred Taxes	-	-	-	-	-	-	-	-	-	-	
Accumulated Deferred Taxes	0	0	0	0	0	0	0	0	0	0	
check	0	0	0	0	0	0	0	0	0	0	
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	
	-	-	-	-	-	-	-	-	-	-	
Rate Base and Financing											
Investment: (Rate Base)											
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Accumulated Deferred Taxes	0	0	0	0	0	0	0	0	0	0	
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	
Ending Net Investment	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Average Net Investment	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Average Financing:											
Short Term Debt	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Long Term Debt (Revenue Bonds)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Taxable Debt	-	-	-	-	-	-	-	-	-	-	
Preferred Stock	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Common Equity	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Total Financing	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	

Revenue Requirements Model - Calculatic
Distribution - Poles, Towers, and Fixtures

Manual input	51	52	53	54	55	56	57	58	59	60	Total
Return on Investment											
Short Term Debt	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Long Term Debt (Taxable Debt)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Hybrids	-	-	-	-	-	-	-	-	-	-	
Total Interest Expense	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Preferred Dividends	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Net Income on Common	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Taxes											
Income Before Pref Dividends	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Before Taxes (including ITC)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	
Income Before Taxes (excluding ITC)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Federal Income Tax	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
State Income Tax	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	
Total State Tax	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Total Taxes	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Revenue Requirement Calculation											
Revenue Requirement Factors	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	
Revenue Requirement	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	
Revenue Taxes	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Before Depr, Int, Inc Tax	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Depreciation Expense	-	-	-	-	-	-	-	-	-	-	
O&M	-	-	-	-	-	-	-	-	-	-	
Interest Expense	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Before Income Taxes	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Taxes - Federal	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Taxes - State	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
State ITC	-	-	-	-	-	-	-	-	-	-	
Total Income Taxes	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Preferred Dividends	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Net Income for Common	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
	-	-	-	-	-	-	-	-	-	-	

Resilience Project/Program
Revenue Requirements Model - Calculations HE Distribution
Distribution - Overhead Conductors and Devices

		1	2	3	4	5	6	7	8	9	10	11
Manual input												
O&M												
Escalation Rate		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22
O&M		-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation												
Book Depreciation												
Book Depreciation Rates		0.000%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%
Depreciation Expense		-	19	19	19	19	19	19	19	19	19	19
Accumulated Depreciation		-	19	38	58	77	96	115	135	154	173	192
Tax Depreciation												
Tax Depreciation Rates (Straight Line)	**20**	2.500%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%
Tax Basis (S/L)	0.0%	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	**20**	3.750%	7.219%	6.677%	6.177%	5.713%	5.285%	4.888%	4.522%	4.462%	4.461%	4.462%
NonRB Financed Tax Basis (MACRS)	100.0%	38	72	67	62	57	53	49	45	45	45	45
Tax Depreciation		38	72	67	62	57	53	49	45	45	45	45
Accumulated Tax Depreciation		38	110	176	238	295	348	397	442	487	532	576
State Investment Tax Credit (ITC)												
Book												
State ITC Amortization Rate		0.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%
Amortization of State ITC	4.00%	-	4	4	4	4	4	4	4	4	4	4
Accumulated Amortization		-	4	8	12	16	20	24	28	32	36	40
Deferred ITC		40	36	32	28	24	20	16	12	8	4	-
Tax		40										
Deferred Tax Calculation												
Book Accumulated Depreciation		-	19	38	58	77	96	115	135	154	173	192
Tax Accumulated Depreciation		38	110	176	238	295	348	397	442	487	532	576
Book/Tax Acc Depr Difference		(38)	(90)	(138)	(181)	(218)	(252)	(282)	(308)	(333)	(358)	(384)
Deferred ITC		40	36	32	28	24	20	16	12	8	4	-
Net Deferred Tax Asset (Liability)		1	(14)	(27)	(39)	(50)	(60)	(68)	(76)	(84)	(91)	(99)
Deferred Tax Base		(3)	57	52	47	42	38	34	30	29	29	29
Deferred Taxes - Federal		(0)	11	10	9	8	7	7	6	6	6	6
Deferred Taxes - State excluding credit		(0)	3	3	3	3	2	2	2	2	2	2
Change in Deferred Taxes		(1)	15	13	12	11	10	9	8	8	8	8
Accumulated Deferred Taxes		(1)	14	27	39	50	60	68	76	84	91	99
check		-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC		40	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
		40	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Rate Base and Financing												
Investment: (Rate Base)												
Gross Plant		1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation		-	19	38	58	77	96	115	135	154	173	192
Accumulated Deferred Taxes		(1)	14	27	39	50	60	68	76	84	91	99
Accumulated Deferred ITC		40	36	32	28	24	20	16	12	8	4	-
Ending Net Investment	1,000	961	931	902	875	849	824	800	777	754	732	709
Average Net Investment		-	946	916	889	862	837	812	789	766	743	720
Average Financing:												
Short Term Debt	0.58%	-	6	5	5	5	5	5	5	4	4	4
Long Term Debt (Revenue Bonds)	41.42%	-	392	380	368	357	347	336	327	317	308	298
Taxable Debt	0.00%	-	-	-	-	-	-	-	-	-	-	-
Preferred Stock	0.85%	-	8	8	8	7	7	7	7	6	6	6
Common Equity	57.15%	-	540	524	508	493	478	464	451	438	425	412
Total Financing		-	946	916	889	862	837	812	789	766	743	720

Revenue Requirements Model - Calculations HE Distribution
Distribution - Overhead Conductors and Devices

Manual input		1	2	3	4	5	6	7	8	9	10	11
Return on Investment												
Short Term Debt	2.50%	-	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	4.55%	-	18	17	17	16	16	15	15	14	14	14
Hybrids	0.00%	-	-	-	-	-	-	-	-	-	-	-
Total Interest Expense		-	18	17	17	16	16	15	15	15	14	14
Preferred Dividends	5.33%	-	0	0	0	0	0	0	0	0	0	0
Net Income on Common	9.50%	-	51	50	48	47	45	44	43	42	40	39
Income Taxes												
Income Before Pref Dividends		-	52	50	49	47	46	44	43	42	41	39
Income Before Taxes (including ITC)		-	70	68	66	64	62	60	58	56	55	53
Investment Tax Credit		-	4	4	4	4	4	4	4	4	4	4
Income Before Taxes (excluding ITC)		-	66	64	62	60	58	56	54	52	51	49
Federal Income Tax		-	14	13	13	13	12	12	11	11	11	10
State Income Tax		-	4	4	4	4	4	4	3	3	3	3
State Investment Tax Credit		-	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Total State Tax		-	0	0	(0)	(0)	(0)	(0)	(1)	(1)	(1)	(1)
Total Taxes		-	14	13	13	12	12	11	11	11	10	10
Revenue Requirement Calculation												
Revenue Requirement Factors		**-**	**0.1130**	**0.1100**	**0.1071**	**0.1044**	**0.1018**	**0.0994**	**0.0970**	**0.0947**	**0.0923**	**0.0900**
Revenue Requirement		**-**	**113**	**110**	**107**	**104**	**102**	**99**	**97**	**95**	**92**	**90**
Revenue Taxes		-	10	10	10	9	9	9	9	8	8	8
Income Before Depr, Int, Inc Tax		-	103	100	98	95	93	91	88	86	84	82
Depreciation Expense		-	19	19	19	19	19	19	19	19	19	19
O&M		-	-	-	-	-	-	-	-	-	-	-
Interest Expense		-	18	17	17	16	16	15	15	15	14	14
Income Before Income Taxes		-	66	64	62	60	58	56	54	52	51	49
Income Taxes - Federal		-	14	13	13	13	12	12	11	11	11	10
Income Taxes - State		-	4	4	4	4	4	4	3	3	3	3
State ITC		-	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Total Income Taxes		-	14	13	13	12	12	11	11	11	10	10
Preferred Dividends		-	0	0	0	0	0	0	0	0	0	0
Net Income for Common		-	51	50	48	47	45	44	43	42	40	39
check		-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Distribution - Overhead Conductors and I

Manual input	12	13	14	15	16	17	18	19	20	21	22	23	24
O&M													
Escalation Rate	1.24	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46	1.49	1.52	1.55	1.58
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
Accumulated Depreciation	212	231	250	269	288	308	327	346	365	385	404	423	442
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	2.500%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	4.461%	4.462%	4.461%	4.462%	4.461%	4.462%	4.461%	4.462%	4.461%	2.231%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	45	45	45	45	45	45	45	45	45	22	-	-	-
Tax Depreciation	45	45	45	45	45	45	45	45	45	22	-	-	-
Accumulated Tax Depreciation	621	665	710	755	799	844	888	933	978	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	212	231	250	269	288	308	327	346	365	385	404	423	442
Tax Accumulated Depreciation	621	665	710	755	799	844	888	933	978	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(409)	(435)	(460)	(485)	(511)	(536)	(562)	(587)	(612)	(615)	(596)	(577)	(558)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(105)	(112)	(118)	(125)	(132)	(138)	(145)	(151)	(158)	(158)	(154)	(149)	(144)
Deferred Tax Base	25	25	25	25	25	25	25	25	25	3	(19)	(19)	(19)
Deferred Taxes - Federal	5	5	5	5	5	5	5	5	5	1	(4)	(4)	(4)
Deferred Taxes - State excluding credit	2	2	2	2	2	2	2	2	2	0	(1)	(1)	(1)
Change in Deferred Taxes	7	7	7	7	7	7	7	7	7	1	(5)	(5)	(5)
Accumulated Deferred Taxes	105	112	118	125	132	138	145	151	158	158	154	149	144
check	-	-	-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	212	231	250	269	288	308	327	346	365	385	404	423	442
Accumulated Deferred Taxes	105	112	118	125	132	138	145	151	158	158	154	149	144
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	683	657	632	606	580	554	528	503	477	457	443	428	414
Average Net Investment	696	670	644	619	593	567	541	516	490	467	450	435	421
Average Financing:													
Short Term Debt	4	4	4	4	3	3	3	3	3	3	3	3	2
Long Term Debt (Revenue Bonds)	288	278	267	256	246	235	224	214	203	193	186	180	174
Taxable Debt	-	-	-	-	-	-	-	-	-	-	-	-	-
Preferred Stock	6	6	5	5	5	5	5	4	4	4	4	4	4
Common Equity	398	383	368	354	339	324	309	295	280	267	257	249	241
Total Financing	696	670	644	619	593	567	541	516	490	467	450	435	421

Revenue Requirements Model - Calculati
Distribution - Overhead Conductors and I

Manual input	12	13	14	15	16	17	18	19	20	21	22	23	24
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	13	13	12	12	11	11	10	10	9	9	8	8	8
Hybrids	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Interest Expense	13	13	12	12	11	11	10	10	9	9	9	8	8
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	38	36	35	34	32	31	29	28	27	25	24	24	23
Income Taxes													
Income Before Pref Dividends	38	37	35	34	32	31	30	28	27	26	25	24	23
Income Before Taxes (including ITC)	51	49	48	46	44	42	40	38	36	34	33	32	31
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	51	49	48	46	44	42	40	38	36	34	33	32	31
Federal Income Tax	10	10	9	9	9	8	8	8	7	7	7	6	6
State Income Tax	3	3	3	3	3	3	2	2	2	2	2	2	2
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	3	3	3	3	3	3	2	2	2	2	2	2	2
Total Taxes	13	13	12	12	11	11	10	10	9	9	9	8	8
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0919**	**0.0893**	**0.0867**	**0.0841**	**0.0814**	**0.0788**	**0.0762**	**0.0736**	**0.0710**	**0.0686**	**0.0669**	**0.0654**	**0.0640**
Revenue Requirement	**92**	**89**	**87**	**84**	**81**	**79**	**76**	**74**	**71**	**69**	**67**	**65**	**64**
Revenue Taxes	8	8	8	7	7	7	7	7	6	6	6	6	6
Income Before Depr, Int, Inc Tax	84	81	79	77	74	72	69	67	65	63	61	60	58
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	13	13	12	12	11	11	10	10	9	9	9	8	8
Income Before Income Taxes	51	49	48	46	44	42	40	38	36	34	33	32	31
Income Taxes - Federal	10	10	9	9	9	8	8	8	7	7	7	6	6
Income Taxes - State	3	3	3	3	3	3	2	2	2	2	2	2	2
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	13	13	12	12	11	11	10	10	9	9	9	8	8
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	38	36	35	34	32	31	29	28	27	25	24	24	23
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Distribution - Overhead Conductors and I

Manual input	25	26	27	28	29	30	31	32	33	34	35	36	37
O&M													
Escalation Rate	1.61	1.64	1.67	1.71	1.74	1.78	1.81	1.85	1.88	1.92	1.96	2.00	2.04
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
Accumulated Depreciation	462	481	500	519	538	558	577	596	615	635	654	673	692
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	462	481	500	519	538	558	577	596	615	635	654	673	692
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(538)	(519)	(500)	(481)	(462)	(442)	(423)	(404)	(385)	(365)	(346)	(327)	(308)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(139)	(134)	(129)	(124)	(119)	(114)	(109)	(104)	(99)	(94)	(89)	(84)	(79)
Deferred Tax Base	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)
Deferred Taxes - Federal	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Change in Deferred Taxes	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Accumulated Deferred Taxes	139	134	129	124	119	114	109	104	99	94	89	84	79
check	-	-	-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	462	481	500	519	538	558	577	596	615	635	654	673	692
Accumulated Deferred Taxes	139	134	129	124	119	114	109	104	99	94	89	84	79
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	400	386	371	357	343	328	314	300	286	271	257	243	228
Average Net Investment	407	393	378	364	350	336	321	307	293	278	264	250	236
Average Financing:													
Short Term Debt	2	2	2	2	2	2	2	2	2	2	2	1	1
Long Term Debt (Revenue Bonds)	169	163	157	151	145	139	133	127	121	115	109	103	98
Taxable Debt	-	-	-	-	-	-	-	-	-	-	-	-	-
Preferred Stock	3	3	3	3	3	3	3	3	2	2	2	2	2
Common Equity	233	224	216	208	200	192	184	175	167	159	151	143	135
Total Financing	407	393	378	364	350	336	321	307	293	278	264	250	236

Revenue Requirements Model - Calculati
Distribution - Overhead Conductors and I

Manual input	25	26	27	28	29	30	31	32	33	34	35	36	37
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	8	7	7	7	7	6	6	6	6	5	5	5	4
Hybrids	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Interest Expense	8	7	7	7	7	6	6	6	6	5	5	5	4
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	22	21	21	20	19	18	17	17	16	15	14	14	13
Income Taxes													
Income Before Pref Dividends	22	21	21	20	19	18	18	17	16	15	14	14	13
Income Before Taxes (including ITC)	30	29	28	27	26	25	24	23	22	21	19	18	17
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	30	29	28	27	26	25	24	23	22	21	19	18	17
Federal Income Tax	6	6	6	5	5	5	5	4	4	4	4	4	3
State Income Tax	2	2	2	2	2	1	1	1	1	1	1	1	1
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	2	2	2	2	2	1	1	1	1	1	1	1	1
Total Taxes	8	7	7	7	7	6	6	6	6	5	5	5	4
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0625**	**0.0611**	**0.0596**	**0.0582**	**0.0567**	**0.0553**	**0.0538**	**0.0523**	**0.0509**	**0.0494**	**0.0480**	**0.0465**	**0.0451**
Revenue Requirement	**63**	**61**	**60**	**58**	**57**	**55**	**54**	**52**	**51**	**49**	**48**	**47**	**45**
Revenue Taxes	6	5	5	5	5	5	5	5	5	4	4	4	4
Income Before Depr, Int, Inc Tax	57	56	54	53	52	50	49	48	46	45	44	42	41
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	8	7	7	7	7	6	6	6	6	5	5	5	4
Income Before Income Taxes	30	29	28	27	26	25	24	23	22	21	19	18	17
Income Taxes - Federal	6	6	6	5	5	5	5	4	4	4	4	4	3
Income Taxes - State	2	2	2	2	2	1	1	1	1	1	1	1	1
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	8	7	7	7	7	6	6	6	6	5	5	5	4
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	22	21	21	20	19	18	17	17	16	15	14	14	13
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Distribution - Overhead Conductors and I

Manual input	38	39	40	41	42	43	44	45	46	47	48	49	50
O&M													
Escalation Rate	2.08	2.12	2.16	2.21	2.25	2.30	2.34	2.39	2.44	2.49	2.54	2.59	2.64
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
Accumulated Depreciation	712	731	750	769	788	808	827	846	865	885	904	923	942
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	712	731	750	769	788	808	827	846	865	885	904	923	942
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(288)	(269)	(250)	(231)	(212)	(192)	(173)	(154)	(135)	(115)	(96)	(77)	(58)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(74)	(69)	(64)	(59)	(54)	(50)	(45)	(40)	(35)	(30)	(25)	(20)	(15)
Deferred Tax Base	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)
Deferred Taxes - Federal	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Change in Deferred Taxes	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Accumulated Deferred Taxes	74	69	64	59	54	50	45	40	35	30	25	20	15
check	-	-	-	0	0	0	0	0	0	0	0	0	0
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	712	731	750	769	788	808	827	846	865	885	904	923	942
Accumulated Deferred Taxes	74	69	64	59	54	50	45	40	35	30	25	20	15
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	214	200	186	171	157	143	129	114	100	86	71	57	43
Average Net Investment	221	207	193	178	164	150	136	121	107	93	79	64	50
Average Financing:													
Short Term Debt	1	1	1	1	1	1	1	1	1	1	0	0	0
Long Term Debt (Revenue Bonds)	92	86	80	74	68	62	56	50	44	38	33	27	21
Taxable Debt	-	-	-	-	-	-	-	-	-	-	-	-	-
Preferred Stock	2	2	2	2	1	1	1	1	1	1	1	1	0
Common Equity	126	118	110	102	94	86	78	69	61	53	45	37	29
Total Financing	221	207	193	178	164	150	136	121	107	93	79	64	50

Revenue Requirements Model - Calculati
Distribution - Overhead Conductors and I

Manual input	38	39	40	41	42	43	44	45	46	47	48	49	50
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	4	4	4	3	3	3	3	2	2	2	1	1	1
Hybrids	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Interest Expense	4	4	4	3	3	3	3	2	2	2	1	1	1
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	12	11	10	10	9	8	7	7	6	5	4	3	3
Income Taxes													
Income Before Pref Dividends	12	11	11	10	9	8	7	7	6	5	4	4	3
Income Before Taxes (including ITC)	16	15	14	13	12	11	10	9	8	7	6	5	4
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	16	15	14	13	12	11	10	9	8	7	6	5	4
Federal Income Tax	3	3	3	3	2	2	2	2	2	1	1	1	1
State Income Tax	1	1	1	1	1	1	1	1	0	0	0	0	0
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	1	1	1	1	1	1	1	1	0	0	0	0	0
Total Taxes	4	4	4	3	3	3	3	2	2	2	1	1	1
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0436**	**0.0422**	**0.0407**	**0.0393**	**0.0378**	**0.0364**	**0.0349**	**0.0335**	**0.0320**	**0.0306**	**0.0291**	**0.0276**	**0.0262**
Revenue Requirement	**44**	**42**	**41**	**39**	**38**	**36**	**35**	**33**	**32**	**31**	**29**	**28**	**26**
Revenue Taxes	4	4	4	3	3	3	3	3	3	3	3	2	2
Income Before Depr, Int, Inc Tax	40	38	37	36	34	33	32	30	29	28	27	25	24
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	4	4	4	3	3	3	3	2	2	2	1	1	1
Income Before Income Taxes	16	15	14	13	12	11	10	9	8	7	6	5	4
Income Taxes - Federal	3	3	3	3	2	2	2	2	2	1	1	1	1
Income Taxes - State	1	1	1	1	1	1	1	1	0	0	0	0	0
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	4	4	4	3	3	3	3	2	2	2	1	1	1
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	12	11	10	10	9	8	7	7	6	5	4	3	3
	-	-	-	-	-	-	-	*(0)*	*(0)*	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculatio
Distribution - Overhead Conductors and I

Manual input	51	52	53	54	55	56	57	58	59	60	Total
O&M											
Escalation Rate	2.69	2.75	2.80	2.86	2.91	2.97	3.03	3.09	3.15	3.22	
O&M	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation											
Book Depreciation											
Book Depreciation Rates	1.923%	1.923%	1.923%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Depreciation Expense	19	19	19	-	-	-	-	-	-	-	1,000
Accumulated Depreciation	962	981	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Tax Depreciation											
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	1,000
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	1,000
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
State Investment Tax Credit (ITC)											
Book											
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	40
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	
Deferred ITC	-	-	-	-	-	-	-	-	-	-	
Tax											
Deferred Tax Calculation											
Book Accumulated Depreciation	962	981	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Book/Tax Acc Depr Difference	(38)	(19)	0	0	0	0	0	0	0	0	
Deferred ITC	-	-	-	-	-	-	-	-	-	-	
Net Deferred Tax Asset (Liability)	(10)	(5)	0	0	0	0	0	0	0	0	
Deferred Tax Base	(19)	(19)	(19)	-	-	-	-	-	-	-	
Deferred Taxes - Federal	(4)	(4)	(4)	-	-	-	-	-	-	-	
Deferred Taxes - State excluding credit	(1)	(1)	(1)	-	-	-	-	-	-	-	
Change in Deferred Taxes	(5)	(5)	(5)	-	-	-	-	-	-	-	
Accumulated Deferred Taxes	10	5	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
check	0	0	0	0	0	0	0	0	0	0	
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	
	-	-	-	-	-	-	-	-	-	-	
Rate Base and Financing											
Investment: (Rate Base)											
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Accumulated Depreciation	962	981	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Accumulated Deferred Taxes	10	5	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	
Ending Net Investment	29	14	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Average Net Investment	36	21	7	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Average Financing:											
Short Term Debt	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Long Term Debt (Revenue Bonds)	15	9	3	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Taxable Debt	-	-	-	-	-	-	-	-	-	-	
Preferred Stock	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Common Equity	20	12	4	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Total Financing	36	21	7	(0)	(0)	(0)	(0)	(0)	(0)	(0)	

Revenue Requirements Model - Calculati
Distribution - Overhead Conductors and I

Manual input	51	52	53	54	55	56	57	58	59	60	Total
Return on Investment											
Short Term Debt	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Long Term Debt (Taxable Debt)	1	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Hybrids	-	-	-	-	-	-	-	-	-	-	
Total Interest Expense	1	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Preferred Dividends	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Net Income on Common	2	1	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Taxes											
Income Before Pref Dividends	2	1	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Before Taxes (including ITC)	3	2	1	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	
Income Before Taxes (excluding ITC)	3	2	1	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Federal Income Tax	1	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
State Income Tax	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	
Total State Tax	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Total Taxes	1	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Revenue Requirement Calculation											
Revenue Requirement Factors	**0.0247**	**0.0233**	**0.0218**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	
Revenue Requirement	**25**	**23**	**22**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	
Revenue Taxes	2	2	2	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Before Depr, Int, Inc Tax	23	21	20	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Depreciation Expense	19	19	19	-	-	-	-	-	-	-	
O&M	-	-	-	-	-	-	-	-	-	-	
Interest Expense	1	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Before Income Taxes	3	2	1	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Taxes - Federal	1	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Taxes - State	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
State ITC	-	-	-	-	-	-	-	-	-	-	
Total Income Taxes	1	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Preferred Dividends	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Net Income for Common	2	1	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
	(0)	*(0)*	*(0)*	-	-	-	-	-	-	-	

Resilience Project/Program
Revenue Requirements Model - Calculations HE Distribution
Distribution - Station Equipment - Substations / Underground Conductors and Devices

Manual input		1	2	3	4	5	6	7	8	9	10	11
O&M												
Escalation Rate		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22
O&M		-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation												
Book Depreciation												
Book Depreciation Rates		0.000%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%
Depreciation Expense		-	19	19	19	19	19	19	19	19	19	19
Accumulated Depreciation		-	19	37	56	74	93	111	130	148	167	185
Tax Depreciation												
Tax Depreciation Rates (Straight Line)	**20**	2.500%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%
Tax Basis (S/L)	0.0%	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	**20**	3.750%	7.219%	6.677%	6.177%	5.713%	5.285%	4.888%	4.522%	4.462%	4.461%	4.462%
NonRB Financed Tax Basis (MACRS)	100.0%	38	72	67	62	57	53	49	45	45	45	45
Tax Depreciation		38	72	67	62	57	53	49	45	45	45	45
Accumulated Tax Depreciation		38	110	176	238	295	348	397	442	487	532	576
State Investment Tax Credit (ITC)												
Book												
State ITC Amortization Rate		0.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%
Amortization of State ITC	4.00%	-	4	4	4	4	4	4	4	4	4	4
Accumulated Amortization		-	4	8	12	16	20	24	28	32	36	40
Deferred ITC		40	36	32	28	24	20	16	12	8	4	-
Tax		40										
Deferred Tax Calculation												
Book Accumulated Depreciation		-	19	37	56	74	93	111	130	148	167	185
Tax Accumulated Depreciation		38	110	176	238	295	348	397	442	487	532	576
Book/Tax Acc Depr Difference		(38)	(91)	(139)	(183)	(221)	(256)	(286)	(313)	(339)	(365)	(391)
Deferred ITC		40	36	32	28	24	20	16	12	8	4	-
Net Deferred Tax Asset (Liability)		1	(14)	(28)	(40)	(51)	(61)	(70)	(77)	(85)	(93)	(101)
Deferred Tax Base		(3)	58	52	47	43	38	34	31	30	30	30
Deferred Taxes - Federal		(0)	11	10	9	8	8	7	6	6	6	6
Deferred Taxes - State excluding credit		(0)	3	3	3	3	2	2	2	2	2	2
Change in Deferred Taxes		(1)	15	13	12	11	10	9	8	8	8	8
Accumulated Deferred Taxes		(1)	14	28	40	51	61	70	77	85	93	101
check		-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC		40	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
		40	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Rate Base and Financing												
Investment: (Rate Base)												
Gross Plant		1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation		-	19	37	56	74	93	111	130	148	167	185
Accumulated Deferred Taxes		(1)	14	28	40	51	61	70	77	85	93	101
Accumulated Deferred ITC		40	36	32	28	24	20	16	12	8	4	-
Ending Net Investment	1,000	961	931	903	877	851	827	803	781	759	736	714
Average Net Investment		-	946	917	890	864	839	815	792	770	748	725
Average Financing:												
Short Term Debt	0.58%	-	6	5	5	5	5	5	5	4	4	4
Long Term Debt (Revenue Bonds)	41.42%	-	392	380	369	358	347	338	328	319	310	300
Taxable Debt	0.00%	-	-	-	-	-	-	-	-	-	-	-
Preferred Stock	0.85%	-	8	8	8	7	7	7	7	7	6	6
Common Equity	57.15%	-	541	524	509	494	479	466	453	440	427	415
Total Financing		-	946	917	890	864	839	815	792	770	748	725

Revenue Requirements Model - Calculations HE Distribution
Distribution - Station Equipment - Substations / Underground Conductors and Devices

Manual input		1	2	3	4	5	6	7	8	9	10	11
Return on Investment												
Short Term Debt	2.50%	-	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	4.55%	-	18	17	17	16	16	15	15	15	14	14
Hybrids	0.00%	-	-	-	-	-	-	-	-	-	-	-
Total Interest Expense		-	18	17	17	16	16	15	15	15	14	14
Preferred Dividends	5.33%	-	0	0	0	0	0	0	0	0	0	0
Net Income on Common	9.50%	-	51	50	48	47	46	44	43	42	41	39
Income Taxes												
Income Before Pref Dividends		-	52	50	49	47	46	45	43	42	41	40
Income Before Taxes (including ITC)		-	70	68	66	64	62	60	58	57	55	53
Investment Tax Credit		-	4	4	4	4	4	4	4	4	4	4
Income Before Taxes (excluding ITC)		-	66	64	62	60	58	56	54	53	51	49
Federal Income Tax		-	14	13	13	13	12	12	12	11	11	11
State Income Tax		-	4	4	4	4	4	4	4	3	3	3
State Investment Tax Credit		-	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Total State Tax		-	0	0	(0)	(0)	(0)	(0)	(0)	(1)	(1)	(1)
Total Taxes		-	14	13	13	12	12	11	11	11	10	10
Revenue Requirement Calculation												
Revenue Requirement Factors		**-**	**0.1122**	**0.1093**	**0.1065**	**0.1038**	**0.1013**	**0.0989**	**0.0965**	**0.0943**	**0.0920**	**0.0897**
Revenue Requirement		**-**	**112**	**109**	**107**	**104**	**101**	**99**	**97**	**94**	**92**	**90**
Revenue Taxes		-	10	10	9	9	9	9	9	8	8	8
Income Before Depr, Int, Inc Tax		-	102	100	97	95	92	90	88	86	84	82
Depreciation Expense		-	19	19	19	19	19	19	19	19	19	19
O&M		-	-	-	-	-	-	-	-	-	-	-
Interest Expense		-	18	17	17	16	16	15	15	15	14	14
Income Before Income Taxes		-	66	64	62	60	58	56	54	53	51	49
Income Taxes - Federal		-	14	13	13	13	12	12	12	11	11	11
Income Taxes - State		-	4	4	4	4	4	4	4	3	3	3
State ITC		-	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Total Income Taxes		-	14	13	13	12	12	11	11	11	10	10
Preferred Dividends		-	0	0	0	0	0	0	0	0	0	0
Net Income for Common		-	51	50	48	47	46	44	43	42	41	39
check		-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Distribution - Station Equipment - Substa

Manual input	12	13	14	15	16	17	18	19	20	21	22	23	24
O&M													
Escalation Rate	1.24	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46	1.49	1.52	1.55	1.58
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
Accumulated Depreciation	204	222	241	259	278	296	315	333	352	370	389	407	426
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	2.500%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	4.461%	4.462%	4.461%	4.462%	4.461%	4.462%	4.461%	4.462%	4.461%	2.231%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	45	45	45	45	45	45	45	45	45	22	-	-	-
Tax Depreciation	45	45	45	45	45	45	45	45	45	22	-	-	-
Accumulated Tax Depreciation	621	665	710	755	799	844	888	933	978	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	204	222	241	259	278	296	315	333	352	370	389	407	426
Tax Accumulated Depreciation	621	665	710	755	799	844	888	933	978	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(417)	(443)	(469)	(495)	(521)	(548)	(574)	(600)	(626)	(630)	(611)	(593)	(574)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(107)	(114)	(121)	(128)	(134)	(141)	(148)	(154)	(161)	(162)	(157)	(153)	(148)
Deferred Tax Base	26	26	26	26	26	26	26	26	26	4	(19)	(19)	(19)
Deferred Taxes - Federal	5	5	5	5	5	5	5	5	5	1	(4)	(4)	(4)
Deferred Taxes - State excluding credit	2	2	2	2	2	2	2	2	2	0	(1)	(1)	(1)
Change in Deferred Taxes	7	7	7	7	7	7	7	7	7	1	(5)	(5)	(5)
Accumulated Deferred Taxes	107	114	121	128	134	141	148	154	161	162	157	153	148
check	-	-	-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	204	222	241	259	278	296	315	333	352	370	389	407	426
Accumulated Deferred Taxes	107	114	121	128	134	141	148	154	161	162	157	153	148
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	689	664	638	613	588	563	537	512	487	467	454	440	426
Average Net Investment	702	676	651	626	601	575	550	525	500	477	461	447	433
Average Financing:													
Short Term Debt	4	4	4	4	3	3	3	3	3	3	3	3	3
Long Term Debt (Revenue Bonds)	291	280	270	259	249	238	228	217	207	198	191	185	179
Taxable Debt	-	-	-	-	-	-	-	-	-	-	-	-	-
Preferred Stock	6	6	6	5	5	5	5	4	4	4	4	4	4
Common Equity	401	387	372	358	343	329	314	300	286	273	263	255	248
Total Financing	702	676	651	626	601	575	550	525	500	477	461	447	433

Revenue Requirements Model - Calculati
Distribution - Station Equipment - Substa

Manual input	12	13	14	15	16	17	18	19	20	21	22	23	24
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	13	13	12	12	11	11	10	10	9	9	9	8	8
Hybrids	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Interest Expense	13	13	12	12	11	11	10	10	9	9	9	8	8
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	38	37	35	34	33	31	30	28	27	26	25	24	24
Income Taxes													
Income Before Pref Dividends	38	37	36	34	33	31	30	29	27	26	25	24	24
Income Before Taxes (including ITC)	52	50	48	46	44	42	41	39	37	35	34	33	32
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	52	50	48	46	44	42	41	39	37	35	34	33	32
Federal Income Tax	10	10	9	9	9	8	8	8	7	7	7	7	6
State Income Tax	3	3	3	3	3	3	2	2	2	2	2	2	2
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	3	3	3	3	3	3	2	2	2	2	2	2	2
Total Taxes	13	13	12	12	11	11	10	10	9	9	9	8	8
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0917**	**0.0891**	**0.0866**	**0.0840**	**0.0814**	**0.0789**	**0.0763**	**0.0737**	**0.0712**	**0.0689**	**0.0672**	**0.0658**	**0.0644**
Revenue Requirement	**92**	**89**	**87**	**84**	**81**	**79**	**76**	**74**	**71**	**69**	**67**	**66**	**64**
Revenue Taxes	8	8	8	7	7	7	7	7	6	6	6	6	6
Income Before Depr, Int, Inc Tax	84	81	79	77	74	72	70	67	65	63	61	60	59
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	13	13	12	12	11	11	10	10	9	9	9	8	8
Income Before Income Taxes	52	50	48	46	44	42	41	39	37	35	34	33	32
Income Taxes - Federal	10	10	9	9	9	8	8	8	7	7	7	7	6
Income Taxes - State	3	3	3	3	3	3	2	2	2	2	2	2	2
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	13	13	12	12	11	11	10	10	9	9	9	8	8
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	38	37	35	34	33	31	30	28	27	26	25	24	24
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
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Manual input	25	26	27	28	29	30	31	32	33	34	35	36	37
O&M													
Escalation Rate	1.61	1.64	1.67	1.71	1.74	1.78	1.81	1.85	1.88	1.92	1.96	2.00	2.04
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
Accumulated Depreciation	444	463	481	500	519	537	556	574	593	611	630	648	667
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	444	463	481	500	519	537	556	574	593	611	630	648	667
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(556)	(537)	(519)	(500)	(481)	(463)	(444)	(426)	(407)	(389)	(370)	(352)	(333)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(143)	(138)	(134)	(129)	(124)	(119)	(114)	(110)	(105)	(100)	(95)	(91)	(86)
Deferred Tax Base	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)
Deferred Taxes - Federal	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Change in Deferred Taxes	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Accumulated Deferred Taxes	143	138	134	129	124	119	114	110	105	100	95	91	86
check	-	-	-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	444	463	481	500	519	537	556	574	593	611	630	648	667
Accumulated Deferred Taxes	143	138	134	129	124	119	114	110	105	100	95	91	86
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	412	399	385	371	357	344	330	316	302	289	275	261	247
Average Net Investment	419	406	392	378	364	351	337	323	309	296	282	268	254
Average Financing:													
Short Term Debt	2	2	2	2	2	2	2	2	2	2	2	2	1
Long Term Debt (Revenue Bonds)	174	168	162	157	151	145	140	134	128	122	117	111	105
Taxable Debt	-	-	-	-	-	-	-	-	-	-	-	-	-
Preferred Stock	4	3	3	3	3	3	3	3	3	2	2	2	2
Common Equity	240	232	224	216	208	200	193	185	177	169	161	153	145
Total Financing	419	406	392	378	364	351	337	323	309	296	282	268	254

Revenue Requirements Model - Calculati
Distribution - Station Equipment - Substa

Manual input	25	26	27	28	29	30	31	32	33	34	35	36	37
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	8	8	7	7	7	7	6	6	6	6	5	5	5
Hybrids	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Interest Expense	8	8	7	7	7	7	6	6	6	6	5	5	5
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	23	22	21	21	20	19	18	18	17	16	15	15	14
Income Taxes													
Income Before Pref Dividends	23	22	21	21	20	19	18	18	17	16	15	15	14
Income Before Taxes (including ITC)	31	30	29	28	27	26	25	24	23	22	21	20	19
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	31	30	29	28	27	26	25	24	23	22	21	20	19
Federal Income Tax	6	6	6	6	5	5	5	5	5	4	4	4	4
State Income Tax	2	2	2	2	2	2	1	1	1	1	1	1	1
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	2	2	2	2	2	2	1	1	1	1	1	1	1
Total Taxes	8	8	7	7	7	7	6	6	6	6	5	5	5
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0630**	**0.0616**	**0.0602**	**0.0588**	**0.0574**	**0.0560**	**0.0546**	**0.0532**	**0.0518**	**0.0504**	**0.0490**	**0.0476**	**0.0462**
Revenue Requirement	**63**	**62**	**60**	**59**	**57**	**56**	**55**	**53**	**52**	**50**	**49**	**48**	**46**
Revenue Taxes	6	5	5	5	5	5	5	5	5	4	4	4	4
Income Before Depr, Int, Inc Tax	57	56	55	54	52	51	50	48	47	46	45	43	42
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	8	8	7	7	7	7	6	6	6	6	5	5	5
Income Before Income Taxes	31	30	29	28	27	26	25	24	23	22	21	20	19
Income Taxes - Federal	6	6	6	6	5	5	5	5	5	4	4	4	4
Income Taxes - State	2	2	2	2	2	2	1	1	1	1	1	1	1
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	8	8	7	7	7	7	6	6	6	6	5	5	5
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	23	22	21	21	20	19	18	18	17	16	15	15	14
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
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Manual input	38	39	40	41	42	43	44	45	46	47	48	49	50
O&M													
Escalation Rate	2.08	2.12	2.16	2.21	2.25	2.30	2.34	2.39	2.44	2.49	2.54	2.59	2.64
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
Accumulated Depreciation	685	704	722	741	759	778	796	815	833	852	870	889	907
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	685	704	722	741	759	778	796	815	833	852	870	889	907
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(315)	(296)	(278)	(259)	(241)	(222)	(204)	(185)	(167)	(148)	(130)	(111)	(93)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(81)	(76)	(72)	(67)	(62)	(57)	(52)	(48)	(43)	(38)	(33)	(29)	(24)
Deferred Tax Base	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)
Deferred Taxes - Federal	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Change in Deferred Taxes	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Accumulated Deferred Taxes	81	76	72	67	62	57	52	48	43	38	33	29	24
check	-	-	-	-	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	685	704	722	741	759	778	796	815	833	852	870	889	907
Accumulated Deferred Taxes	81	76	72	67	62	57	52	48	43	38	33	29	24
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	234	220	206	192	179	165	151	137	124	110	96	82	69
Average Net Investment	241	227	213	199	186	172	158	144	131	117	103	89	76
Average Financing:													
Short Term Debt	1	1	1	1	1	1	1	1	1	1	1	1	0
Long Term Debt (Revenue Bonds)	100	94	88	83	77	71	65	60	54	48	43	37	31
Taxable Debt	-	-	-	-	-	-	-	-	-	-	-	-	-
Preferred Stock	2	2	2	2	2	1	1	1	1	1	1	1	1
Common Equity	138	130	122	114	106	98	90	83	75	67	59	51	43
Total Financing	241	227	213	199	186	172	158	144	131	117	103	89	76

Revenue Requirements Model - Calculati
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Manual input	38	39	40	41	42	43	44	45	46	47	48	49	50
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	5	4	4	4	3	3	3	3	2	2	2	2	1
Hybrids	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Interest Expense	5	4	4	4	4	3	3	3	2	2	2	2	1
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	13	12	12	11	10	9	9	8	7	6	6	5	4
Income Taxes													
Income Before Pref Dividends	13	12	12	11	10	9	9	8	7	6	6	5	4
Income Before Taxes (including ITC)	18	17	16	15	14	13	12	11	10	9	8	7	6
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	18	17	16	15	14	13	12	11	10	9	8	7	6
Federal Income Tax	4	3	3	3	3	3	2	2	2	2	2	1	1
State Income Tax	1	1	1	1	1	1	1	1	1	1	0	0	0
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	1	1	1	1	1	1	1	1	1	1	0	0	0
Total Taxes	5	4	4	4	4	3	3	3	2	2	2	2	1
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0448**	**0.0434**	**0.0420**	**0.0406**	**0.0392**	**0.0378**	**0.0364**	**0.0350**	**0.0336**	**0.0322**	**0.0308**	**0.0294**	**0.0280**
Revenue Requirement	**45**	**43**	**42**	**41**	**39**	**38**	**36**	**35**	**34**	**32**	**31**	**29**	**28**
Revenue Taxes	4	4	4	4	3	3	3	3	3	3	3	3	2
Income Before Depr, Int, Inc Tax	41	40	38	37	36	34	33	32	31	29	28	27	26
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	5	4	4	4	4	3	3	3	2	2	2	2	1
Income Before Income Taxes	18	17	16	15	14	13	12	11	10	9	8	7	6
Income Taxes - Federal	4	3	3	3	3	3	2	2	2	2	2	1	1
Income Taxes - State	1	1	1	1	1	1	1	1	1	1	0	0	0
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	5	4	4	4	4	3	3	3	2	2	2	2	1
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	13	12	12	11	10	9	9	8	7	6	6	5	4
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculatio
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Manual input	51	52	53	54	55	56	57	58	59	60	Total
O&M											
Escalation Rate	2.69	2.75	2.80	2.86	2.91	2.97	3.03	3.09	3.15	3.22	
O&M	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation											
Book Depreciation											
Book Depreciation Rates	1.852%	1.852%	1.852%	1.852%	1.852%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Depreciation Expense	19	19	19	19	19	-	-	-	-	-	1,000
Accumulated Depreciation	926	944	963	981	1,000	1,000	1,000	1,000	1,000	1,000	
Tax Depreciation											
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	1,000
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	1,000
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
State Investment Tax Credit (ITC)											
Book											
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	40
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	
Deferred ITC	-	-	-	-	-	-	-	-	-	-	
Tax											
Deferred Tax Calculation											
Book Accumulated Depreciation	926	944	963	981	1,000	1,000	1,000	1,000	1,000	1,000	
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Book/Tax Acc Depr Difference	(74)	(56)	(37)	(19)	-	-	-	-	-	-	
Deferred ITC	-	-	-	-	-	-	-	-	-	-	
Net Deferred Tax Asset (Liability)	(19)	(14)	(10)	(5)	-	-	-	-	-	-	
Deferred Tax Base	(19)	(19)	(19)	(19)	(19)	-	-	-	-	-	
Deferred Taxes - Federal	(4)	(4)	(4)	(4)	(4)	-	-	-	-	-	
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	(1)	-	-	-	-	-	
Change in Deferred Taxes	(5)	(5)	(5)	(5)	(5)	-	-	-	-	-	
Accumulated Deferred Taxes	19	14	10	5	(0)	(0)	(0)	(0)	(0)	(0)	
check	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	
	-	-	-	-	-	-	-	-	-	-	
Rate Base and Financing											
Investment: (Rate Base)											
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Accumulated Depreciation	926	944	963	981	1,000	1,000	1,000	1,000	1,000	1,000	
Accumulated Deferred Taxes	19	14	10	5	(0)	(0)	(0)	(0)	(0)	(0)	
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	
Ending Net Investment	55	41	27	14	0	0	0	0	0	0	
Average Net Investment	62	48	34	21	7	0	0	0	0	0	
Average Financing:											
Short Term Debt	0	0	0	0	0	0	0	0	0	0	
Long Term Debt (Revenue Bonds)	26	20	14	9	3	0	0	0	0	0	
Taxable Debt	-	-	-	-	-	-	-	-	-	-	
Preferred Stock	1	0	0	0	0	0	0	0	0	0	
Common Equity	35	28	20	12	4	0	0	0	0	0	
Total Financing	62	48	34	21	7	0	0	0	0	0	

Revenue Requirements Model - Calculatio
Distribution - Station Equipment - Substa

Manual input	51	52	53	54	55	56	57	58	59	60	Total
Return on Investment											
Short Term Debt	0	0	0	0	0	0	0	0	0	0	
Long Term Debt (Taxable Debt)	1	1	1	0	0	0	0	0	0	0	
Hybrids	-	-	-	-	-	-	-	-	-	-	
Total Interest Expense	1	1	1	0	0	0	0	0	0	0	
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	
Net Income on Common	3	3	2	1	0	0	0	0	0	0	
Income Taxes											
Income Before Pref Dividends	3	3	2	1	0	0	0	0	0	0	
Income Before Taxes (including ITC)	5	4	3	2	1	0	0	0	0	0	
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	
Income Before Taxes (excluding ITC)	5	4	3	2	1	0	0	0	0	0	
Federal Income Tax	1	1	1	0	0	0	0	0	0	0	
State Income Tax	0	0	0	0	0	0	0	0	0	0	
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	
Total State Tax	0	0	0	0	0	0	0	0	0	0	
Total Taxes	1	1	1	0	0	0	0	0	0	0	
Revenue Requirement Calculation											
Revenue Requirement Factors	**0.0266**	**0.0252**	**0.0238**	**0.0224**	**0.0210**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	
Revenue Requirement	**27**	**25**	**24**	**22**	**21**	**0**	**0**	**0**	**0**	**0**	
Revenue Taxes	2	2	2	2	2	0	0	0	0	0	
Income Before Depr, Int, Inc Tax	24	23	22	20	19	0	0	0	0	0	
Depreciation Expense	19	19	19	19	19	-	-	-	-	-	
O&M	-	-	-	-	-	-	-	-	-	-	
Interest Expense	1	1	1	0	0	0	0	0	0	0	
Income Before Income Taxes	5	4	3	2	1	0	0	0	0	0	
Income Taxes - Federal	1	1	1	0	0	0	0	0	0	0	
Income Taxes - State	0	0	0	0	0	0	0	0	0	0	
State ITC	-	-	-	-	-	-	-	-	-	-	
Total Income Taxes	1	1	1	0	0	0	0	0	0	0	
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	
Net Income for Common	3	3	2	1	0	0	0	0	0	0	
	-	*-*	*(0)*	*(0)*	*(0)*	*-*	*-*	*-*	*-*	*-*	

Resilience Project/Program
Revenue Requirements Model - Calculations HE Distribution
Distribution - Underground Conduit

Manual input		1	2	3	4	5	6	7	8	9	10	11
O&M												
Escalation Rate		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22
O&M		-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation												
Book Depreciation												
Book Depreciation Rates		0.000%	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%
Depreciation Expense		-	17	17	17	17	17	17	17	17	17	17
Accumulated Depreciation		-	17	34	51	68	85	102	119	136	153	169
Tax Depreciation												
Tax Depreciation Rates (Straight Line)	**20**	2.500%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%
Tax Basis (S/L)	0.0%	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	**20**	3.750%	7.219%	6.677%	6.177%	5.713%	5.285%	4.888%	4.522%	4.462%	4.461%	4.462%
NonRB Financed Tax Basis (MACRS)	100.0%	38	72	67	62	57	53	49	45	45	45	45
Tax Depreciation		38	72	67	62	57	53	49	45	45	45	45
Accumulated Tax Depreciation		38	110	176	238	295	348	397	442	487	532	576
State Investment Tax Credit (ITC)												
Book												
State ITC Amortization Rate		0.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%
Amortization of State ITC	4.00%	-	4	4	4	4	4	4	4	4	4	4
Accumulated Amortization		-	4	8	12	16	20	24	28	32	36	40
Deferred ITC		40	36	32	28	24	20	16	12	8	4	-
Tax		40										
Deferred Tax Calculation												
Book Accumulated Depreciation		-	17	34	51	68	85	102	119	136	153	169
Tax Accumulated Depreciation		38	110	176	238	295	348	397	442	487	532	576
Book/Tax Acc Depr Difference		(38)	(93)	(143)	(187)	(228)	(263)	(295)	(324)	(351)	(379)	(407)
Deferred ITC		40	36	32	28	24	20	16	12	8	4	-
Net Deferred Tax Asset (Liability)		1	(15)	(28)	(41)	(52)	(63)	(72)	(80)	(88)	(97)	(105)
Deferred Tax Base		(3)	59	54	49	44	40	36	32	32	32	32
Deferred Taxes - Federal		(0)	12	11	10	9	8	7	6	6	6	6
Deferred Taxes - State excluding credit		(0)	4	3	3	3	2	2	2	2	2	2
Change in Deferred Taxes		(1)	15	14	13	11	10	9	8	8	8	8
Accumulated Deferred Taxes		(1)	15	28	41	52	63	72	80	88	97	105
check		-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC		40	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
		40	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Rate Base and Financing												
Investment: (Rate Base)												
Gross Plant		1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation		-	17	34	51	68	85	102	119	136	153	169
Accumulated Deferred Taxes		(1)	15	28	41	52	63	72	80	88	97	105
Accumulated Deferred ITC		40	36	32	28	24	20	16	12	8	4	-
Ending Net Investment	1,000	961	932	906	880	856	833	810	789	768	747	726
Average Net Investment		-	947	919	893	868	844	821	800	779	757	736
Average Financing:												
Short Term Debt	0.58%	-	6	5	5	5	5	5	5	5	4	4
Long Term Debt (Revenue Bonds)	41.42%	-	392	381	370	360	350	340	331	322	314	305
Taxable Debt	0.00%	-	-	-	-	-	-	-	-	-	-	-
Preferred Stock	0.85%	-	8	8	8	7	7	7	7	7	6	6
Common Equity	57.15%	-	541	525	510	496	482	469	457	445	433	421
Total Financing		-	947	919	893	868	844	821	800	779	757	736

Revenue Requirements Model - Calculations HE Distribution
Distribution - Underground Conduit

Manual input		1	2	3	4	5	6	7	8	9	10	11
Return on Investment												
Short Term Debt	2.50%	-	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	4.55%	-	18	17	17	16	16	15	15	15	14	14
Hybrids	0.00%	-	-	-	-	-	-	-	-	-	-	-
Total Interest Expense		-	18	17	17	16	16	16	15	15	14	14
Preferred Dividends	5.33%	-	0	0	0	0	0	0	0	0	0	0
Net Income on Common	9.50%	-	51	50	48	47	46	45	43	42	41	40
Income Taxes												
Income Before Pref Dividends		-	52	50	49	48	46	45	44	43	41	40
Income Before Taxes (including ITC)		-	70	68	66	64	62	61	59	57	56	54
Investment Tax Credit		-	4	4	4	4	4	4	4	4	4	4
Income Before Taxes (excluding ITC)		-	66	64	62	60	58	57	55	53	52	50
Federal Income Tax		-	14	13	13	13	12	12	12	11	11	11
State Income Tax		-	4	4	4	4	4	4	4	3	3	3
State Investment Tax Credit		-	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Total State Tax		-	0	0	(0)	(0)	(0)	(0)	(0)	(1)	(1)	(1)
Total Taxes		-	14	13	13	12	12	12	11	11	10	10
Revenue Requirement Calculation												
Revenue Requirement Factors		**-**	**0.1105**	**0.1077**	**0.1051**	**0.1025**	**0.1001**	**0.0978**	**0.0956**	**0.0934**	**0.0913**	**0.0891**
Revenue Requirement		**-**	**111**	**108**	**105**	**103**	**100**	**98**	**96**	**93**	**91**	**89**
Revenue Taxes		-	10	10	9	9	9	9	8	8	8	8
Income Before Depr, Int, Inc Tax		-	101	98	96	93	91	89	87	85	83	81
Depreciation Expense		-	17	17	17	17	17	17	17	17	17	17
O&M		-	-	-	-	-	-	-	-	-	-	-
Interest Expense		-	18	17	17	16	16	16	15	15	14	14
Income Before Income Taxes		-	66	64	62	60	58	57	55	53	52	50
Income Taxes - Federal		-	14	13	13	13	12	12	12	11	11	11
Income Taxes - State		-	4	4	4	4	4	4	4	3	3	3
State ITC		-	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Total Income Taxes		-	14	13	13	12	12	12	11	11	10	10
Preferred Dividends		-	0	0	0	0	0	0	0	0	0	0
Net Income for Common		-	51	50	48	47	46	45	43	42	41	40
check		-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Distribution - Underground Conduit

Manual input	12	13	14	15	16	17	18	19	20	21	22	23	24
O&M													
Escalation Rate	1.24	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46	1.49	1.52	1.55	1.58
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%
Depreciation Expense	17	17	17	17	17	17	17	17	17	17	17	17	17
Accumulated Depreciation	186	203	220	237	254	271	288	305	322	339	356	373	390
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	2.500%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	4.461%	4.462%	4.461%	4.462%	4.461%	4.462%	4.461%	4.462%	4.461%	2.231%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	45	45	45	45	45	45	45	45	45	22	-	-	-
Tax Depreciation	45	45	45	45	45	45	45	45	45	22	-	-	-
Accumulated Tax Depreciation	621	665	710	755	799	844	888	933	978	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	186	203	220	237	254	271	288	305	322	339	356	373	390
Tax Accumulated Depreciation	621	665	710	755	799	844	888	933	978	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(434)	(462)	(490)	(517)	(545)	(573)	(600)	(628)	(656)	(661)	(644)	(627)	(610)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(112)	(119)	(126)	(133)	(140)	(147)	(155)	(162)	(169)	(170)	(166)	(161)	(157)
Deferred Tax Base	28	28	28	28	28	28	28	28	28	5	(17)	(17)	(17)
Deferred Taxes - Federal	5	5	5	5	5	5	5	5	5	1	(3)	(3)	(3)
Deferred Taxes - State excluding credit	2	2	2	2	2	2	2	2	2	0	(1)	(1)	(1)
Change in Deferred Taxes	7	7	7	7	7	7	7	7	7	1	(4)	(4)	(4)
Accumulated Deferred Taxes	112	119	126	133	140	147	155	162	169	170	166	161	157
check	-	-	-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	186	203	220	237	254	271	288	305	322	339	356	373	390
Accumulated Deferred Taxes	112	119	126	133	140	147	155	162	169	170	166	161	157
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	702	678	654	629	605	581	557	533	509	491	478	466	453
Average Net Investment	714	690	666	642	617	593	569	545	521	500	485	472	459
Average Financing:													
Short Term Debt	4	4	4	4	4	3	3	3	3	3	3	3	3
Long Term Debt (Revenue Bonds)	296	286	276	266	256	246	236	226	216	207	201	195	190
Taxable Debt	-	-	-	-	-	-	-	-	-	-	-	-	-
Preferred Stock	6	6	6	5	5	5	5	5	4	4	4	4	4
Common Equity	408	394	380	367	353	339	325	312	298	286	277	270	263
Total Financing	714	690	666	642	617	593	569	545	521	500	485	472	459

Revenue Requirements Model - Calculati
Distribution - Underground Conduit

Manual input	12	13	14	15	16	17	18	19	20	21	22	23	24
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	13	13	13	12	12	11	11	10	10	9	9	9	9
Hybrids	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Interest Expense	14	13	13	12	12	11	11	10	10	9	9	9	9
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	39	37	36	35	34	32	31	30	28	27	26	26	25
Income Taxes													
Income Before Pref Dividends	39	38	36	35	34	32	31	30	29	27	27	26	25
Income Before Taxes (including ITC)	53	51	49	47	46	44	42	40	38	37	36	35	34
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	53	51	49	47	46	44	42	40	38	37	36	35	34
Federal Income Tax	10	10	10	9	9	9	8	8	8	7	7	7	7
State Income Tax	3	3	3	3	3	3	3	2	2	2	2	2	2
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	3	3	3	3	3	3	3	2	2	2	2	2	2
Total Taxes	14	13	13	12	12	11	11	10	10	9	9	9	9
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0912**	**0.0888**	**0.0863**	**0.0839**	**0.0814**	**0.0790**	**0.0765**	**0.0741**	**0.0716**	**0.0695**	**0.0679**	**0.0666**	**0.0653**
Revenue Requirement	**91**	**89**	**86**	**84**	**81**	**79**	**77**	**74**	**72**	**69**	**68**	**67**	**65**
Revenue Taxes	8	8	8	7	7	7	7	7	6	6	6	6	6
Income Before Depr, Int, Inc Tax	83	81	79	76	74	72	70	68	65	63	62	61	60
Depreciation Expense	17	17	17	17	17	17	17	17	17	17	17	17	17
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	14	13	13	12	12	11	11	10	10	9	9	9	9
Income Before Income Taxes	53	51	49	47	46	44	42	40	38	37	36	35	34
Income Taxes - Federal	10	10	10	9	9	9	8	8	8	7	7	7	7
Income Taxes - State	3	3	3	3	3	3	3	2	2	2	2	2	2
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	14	13	13	12	12	11	11	10	10	9	9	9	9
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	39	37	36	35	34	32	31	30	28	27	26	26	25
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Distribution - Underground Conduit

Manual input	25	26	27	28	29	30	31	32	33	34	35	36	37
O&M													
Escalation Rate	1.61	1.64	1.67	1.71	1.74	1.78	1.81	1.85	1.88	1.92	1.96	2.00	2.04
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%
Depreciation Expense	17	17	17	17	17	17	17	17	17	17	17	17	17
Accumulated Depreciation	407	424	441	458	475	492	508	525	542	559	576	593	610
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	407	424	441	458	475	492	508	525	542	559	576	593	610
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(593)	(576)	(559)	(542)	(525)	(508)	(492)	(475)	(458)	(441)	(424)	(407)	(390)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(153)	(148)	(144)	(140)	(135)	(131)	(127)	(122)	(118)	(113)	(109)	(105)	(100)
Deferred Tax Base	(17)	(17)	(17)	(17)	(17)	(17)	(17)	(17)	(17)	(17)	(17)	(17)	(17)
Deferred Taxes - Federal	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Change in Deferred Taxes	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Accumulated Deferred Taxes	153	148	144	140	135	131	127	122	118	113	109	105	100
check	-	-	-	-	-	-	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	407	424	441	458	475	492	508	525	542	559	576	593	610
Accumulated Deferred Taxes	153	148	144	140	135	131	127	122	118	113	109	105	100
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	440	428	415	403	390	378	365	352	340	327	315	302	289
Average Net Investment	447	434	422	409	396	384	371	359	346	333	321	308	296
Average Financing:													
Short Term Debt	3	3	2	2	2	2	2	2	2	2	2	2	2
Long Term Debt (Revenue Bonds)	185	180	175	169	164	159	154	149	143	138	133	128	122
Taxable Debt	-	-	-	-	-	-	-	-	-	-	-	-	-
Preferred Stock	4	4	4	3	3	3	3	3	3	3	3	3	2
Common Equity	255	248	241	234	227	219	212	205	198	191	183	176	169
Total Financing	447	434	422	409	396	384	371	359	346	333	321	308	296

Revenue Requirements Model - Calculati
Distribution - Underground Conduit

Manual input	25	26	27	28	29	30	31	32	33	34	35	36	37
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	8	8	8	8	7	7	7	7	7	6	6	6	6
Hybrids	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Interest Expense	8	8	8	8	8	7	7	7	7	6	6	6	6
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	24	24	23	22	22	21	20	19	19	18	17	17	16
Income Taxes													
Income Before Pref Dividends	24	24	23	22	22	21	20	20	19	18	18	17	16
Income Before Taxes (including ITC)	33	32	31	30	29	28	27	26	26	25	24	23	22
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	33	32	31	30	29	28	27	26	26	25	24	23	22
Federal Income Tax	7	6	6	6	6	6	5	5	5	5	5	4	4
State Income Tax	2	2	2	2	2	2	2	2	2	1	1	1	1
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	2	2	2	2	2	2	2	2	2	1	1	1	1
Total Taxes	8	8	8	8	8	7	7	7	7	6	6	6	6
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0641**	**0.0628**	**0.0615**	**0.0602**	**0.0589**	**0.0577**	**0.0564**	**0.0551**	**0.0538**	**0.0525**	**0.0513**	**0.0500**	**0.0487**
Revenue Requirement	**64**	**63**	**62**	**60**	**59**	**58**	**56**	**55**	**54**	**53**	**51**	**50**	**49**
Revenue Taxes	6	6	5	5	5	5	5	5	5	5	5	4	4
Income Before Depr, Int, Inc Tax	58	57	56	55	54	53	51	50	49	48	47	46	44
Depreciation Expense	17	17	17	17	17	17	17	17	17	17	17	17	17
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	8	8	8	8	8	7	7	7	7	6	6	6	6
Income Before Income Taxes	33	32	31	30	29	28	27	26	26	25	24	23	22
Income Taxes - Federal	7	6	6	6	6	6	5	5	5	5	5	4	4
Income Taxes - State	2	2	2	2	2	2	2	2	2	1	1	1	1
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	8	8	8	8	8	7	7	7	7	6	6	6	6
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	24	24	23	22	22	21	20	19	19	18	17	17	16
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Distribution - Underground Conduit

Manual input	38	39	40	41	42	43	44	45	46	47	48	49	50
O&M													
Escalation Rate	2.08	2.12	2.16	2.21	2.25	2.30	2.34	2.39	2.44	2.49	2.54	2.59	2.64
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%
Depreciation Expense	17	17	17	17	17	17	17	17	17	17	17	17	17
Accumulated Depreciation	627	644	661	678	695	712	729	746	763	780	797	814	831
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	627	644	661	678	695	712	729	746	763	780	797	814	831
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(373)	(356)	(339)	(322)	(305)	(288)	(271)	(254)	(237)	(220)	(203)	(186)	(169)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(96)	(92)	(87)	(83)	(79)	(74)	(70)	(65)	(61)	(57)	(52)	(48)	(44)
Deferred Tax Base	(17)	(17)	(17)	(17)	(17)	(17)	(17)	(17)	(17)	(17)	(17)	(17)	(17)
Deferred Taxes - Federal	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Change in Deferred Taxes	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Accumulated Deferred Taxes	96	92	87	83	79	74	70	65	61	57	52	48	44
check	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	627	644	661	678	695	712	729	746	763	780	797	814	831
Accumulated Deferred Taxes	96	92	87	83	79	74	70	65	61	57	52	48	44
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	277	264	252	239	227	214	201	189	176	164	151	138	126
Average Net Investment	283	271	258	245	233	220	208	195	182	170	157	145	132
Average Financing:													
Short Term Debt	2	2	2	1	1	1	1	1	1	1	1	1	1
Long Term Debt (Revenue Bonds)	117	112	107	102	96	91	86	81	76	70	65	60	55
Taxable Debt	-	-	-	-	-	-	-	-	-	-	-	-	-
Preferred Stock	2	2	2	2	2	2	2	2	2	1	1	1	1
Common Equity	162	155	147	140	133	126	119	111	104	97	90	83	76
Total Financing	283	271	258	245	233	220	208	195	182	170	157	145	132

Revenue Requirements Model - Calculati
Distribution - Underground Conduit

Manual input	38	39	40	41	42	43	44	45	46	47	48	49	50
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	5	5	5	5	4	4	4	4	3	3	3	3	2
Hybrids	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Interest Expense	5	5	5	5	4	4	4	4	3	3	3	3	3
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	15	15	14	13	13	12	11	11	10	9	9	8	7
Income Taxes													
Income Before Pref Dividends	16	15	14	13	13	12	11	11	10	9	9	8	7
Income Before Taxes (including ITC)	21	20	19	18	17	16	15	14	13	13	12	11	10
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	21	20	19	18	17	16	15	14	13	13	12	11	10
Federal Income Tax	4	4	4	4	3	3	3	3	3	2	2	2	2
State Income Tax	1	1	1	1	1	1	1	1	1	1	1	1	1
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	1	1	1	1	1	1	1	1	1	1	1	1	1
Total Taxes	5	5	5	5	4	4	4	4	3	3	3	3	3
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0474**	**0.0461**	**0.0449**	**0.0436**	**0.0423**	**0.0410**	**0.0397**	**0.0385**	**0.0372**	**0.0359**	**0.0346**	**0.0333**	**0.0320**
Revenue Requirement	**47**	**46**	**45**	**44**	**42**	**41**	**40**	**38**	**37**	**36**	**35**	**33**	**32**
Revenue Taxes	4	4	4	4	4	4	4	3	3	3	3	3	3
Income Before Depr, Int, Inc Tax	43	42	41	40	39	37	36	35	34	33	32	30	29
Depreciation Expense	17	17	17	17	17	17	17	17	17	17	17	17	17
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	5	5	5	5	4	4	4	4	3	3	3	3	3
Income Before Income Taxes	21	20	19	18	17	16	15	14	13	13	12	11	10
Income Taxes - Federal	4	4	4	4	3	3	3	3	3	2	2	2	2
Income Taxes - State	1	1	1	1	1	1	1	1	1	1	1	1	1
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	5	5	5	5	4	4	4	4	3	3	3	3	3
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	15	15	14	13	13	12	11	11	10	9	9	8	7
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Distribution - Underground Conduit

Manual input	51	52	53	54	55	56	57	58	59	60	Total
O&M											
Escalation Rate	2.69	2.75	2.80	2.86	2.91	2.97	3.03	3.09	3.15	3.22	
O&M	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation											
Book Depreciation											
Book Depreciation Rates	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%	1.695%	100.00%
Depreciation Expense	17	17	17	17	17	17	17	17	17	17	1,000
Accumulated Depreciation	847	864	881	898	915	932	949	966	983	1,000	
Tax Depreciation											
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	1,000
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	1,000
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
State Investment Tax Credit (ITC)											
Book											
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	40
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	
Deferred ITC	-	-	-	-	-	-	-	-	-	-	
Tax											
Deferred Tax Calculation											
Book Accumulated Depreciation	847	864	881	898	915	932	949	966	983	1,000	
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Book/Tax Acc Depr Difference	(153)	(136)	(119)	(102)	(85)	(68)	(51)	(34)	(17)	-	
Deferred ITC	-	-	-	-	-	-	-	-	-	-	
Net Deferred Tax Asset (Liability)	(39)	(35)	(31)	(26)	(22)	(17)	(13)	(9)	(4)	-	
Deferred Tax Base	(17)	(17)	(17)	(17)	(17)	(17)	(17)	(17)	(17)	(17)	
Deferred Taxes - Federal	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	
Change in Deferred Taxes	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	
Accumulated Deferred Taxes	39	35	31	26	22	17	13	9	4	(0)	
check	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	
	-	-	-	-	-	-	-	-	-	-	
Rate Base and Financing											
Investment: (Rate Base)											
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Accumulated Depreciation	847	864	881	898	915	932	949	966	983	1,000	
Accumulated Deferred Taxes	39	35	31	26	22	17	13	9	4	(0)	
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	
Ending Net Investment	113	101	88	76	63	50	38	25	13	0	
Average Net Investment	120	107	94	82	69	57	44	31	19	6	
Average Financing:											
Short Term Debt	1	1	1	0	0	0	0	0	0	0	
Long Term Debt (Revenue Bonds)	50	44	39	34	29	23	18	13	8	3	
Taxable Debt	-	-	-	-	-	-	-	-	-	-	
Preferred Stock	1	1	1	1	1	0	0	0	0	0	
Common Equity	68	61	54	47	40	32	25	18	11	4	
Total Financing	120	107	94	82	69	57	44	31	19	6	

Revenue Requirements Model - Calculatio
Distribution - Underground Conduit

Manual input	51	52	53	54	55	56	57	58	59	60	Total
Return on Investment											
Short Term Debt	0	0	0	0	0	0	0	0	0	0	
Long Term Debt (Taxable Debt)	2	2	2	2	1	1	1	1	0	0	
Hybrids	-	-	-	-	-	-	-	-	-	-	
Total Interest Expense	2	2	2	2	1	1	1	1	0	0	
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	
Net Income on Common	6	6	5	4	4	3	2	2	1	0	
Income Taxes											
Income Before Pref Dividends	7	6	5	4	4	3	2	2	1	0	
Income Before Taxes (including ITC)	9	8	7	6	5	4	3	2	1	0	
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	
Income Before Taxes (excluding ITC)	9	8	7	6	5	4	3	2	1	0	
Federal Income Tax	2	2	1	1	1	1	1	0	0	0	
State Income Tax	1	0	0	0	0	0	0	0	0	0	
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	
Total State Tax	1	0	0	0	0	0	0	0	0	0	
Total Taxes	2	2	2	2	1	1	1	1	0	0	
Revenue Requirement Calculation											
Revenue Requirement Factors	**0.0308**	**0.0295**	**0.0282**	**0.0269**	**0.0256**	**0.0244**	**0.0231**	**0.0218**	**0.0205**	**0.0192**	
Revenue Requirement	**31**	**29**	**28**	**27**	**26**	**24**	**23**	**22**	**21**	**19**	
Revenue Taxes	3	3	3	2	2	2	2	2	2	2	
Income Before Depr, Int, Inc Tax	28	27	26	25	23	22	21	20	19	18	
Depreciation Expense	17	17	17	17	17	17	17	17	17	17	
O&M	-	-	-	-	-	-	-	-	-	-	
Interest Expense	2	2	2	2	1	1	1	1	0	0	
Income Before Income Taxes	9	8	7	6	5	4	3	2	1	0	
Income Taxes - Federal	2	2	1	1	1	1	1	0	0	0	
Income Taxes - State	1	0	0	0	0	0	0	0	0	0	
State ITC	-	-	-	-	-	-	-	-	-	-	
Total Income Taxes	2	2	2	2	1	1	1	1	0	0	
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	
Net Income for Common	6	6	5	4	4	3	2	2	1	0	
	-	-	-	-	-	-	-	-	-	*(0)*	

Resilience Project/Program
Revenue Requirements Model - Calculations HE Distribution
Distribution - Line Transformers

		1	2	3	4	5	6	7	8	9	10	11
Manual input												
O&M												
Escalation Rate		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22
O&M		-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation												
Book Depreciation												
Book Depreciation Rates		0.000%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%
Depreciation Expense		-	34	34	34	34	34	34	34	34	34	34
Accumulated Depreciation		-	34	69	103	138	172	207	241	276	310	345
Tax Depreciation												
Tax Depreciation Rates (Straight Line)	**20**	2.500%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%
Tax Basis (S/L)	0.0%	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	**20**	3.750%	7.219%	6.677%	6.177%	5.713%	5.285%	4.888%	4.522%	4.462%	4.461%	4.462%
NonRB Financed Tax Basis (MACRS)	100.0%	38	72	67	62	57	53	49	45	45	45	45
Tax Depreciation		38	72	67	62	57	53	49	45	45	45	45
Accumulated Tax Depreciation		38	110	176	238	295	348	397	442	487	532	576
State Investment Tax Credit (ITC)												
Book												
State ITC Amortization Rate		0.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%
Amortization of State ITC	4.00%	-	4	4	4	4	4	4	4	4	4	4
Accumulated Amortization		-	4	8	12	16	20	24	28	32	36	40
Deferred ITC		40	36	32	28	24	20	16	12	8	4	-
Tax		40										
Deferred Tax Calculation												
Book Accumulated Depreciation		-	34	69	103	138	172	207	241	276	310	345
Tax Accumulated Depreciation		38	110	176	238	295	348	397	442	487	532	576
Book/Tax Acc Depr Difference		(38)	(75)	(107)	(135)	(157)	(176)	(190)	(201)	(211)	(221)	(231)
Deferred ITC		40	36	32	28	24	20	16	12	8	4	-
Net Deferred Tax Asset (Liability)		1	(10)	(19)	(27)	(34)	(40)	(45)	(49)	(52)	(56)	(60)
Deferred Tax Base		(3)	42	36	31	27	22	18	15	14	14	14
Deferred Taxes - Federal		(0)	8	7	6	5	4	4	3	3	3	3
Deferred Taxes - State excluding credit		(0)	3	2	2	2	1	1	1	1	1	1
Change in Deferred Taxes		(1)	11	9	8	7	6	5	4	4	4	4
Accumulated Deferred Taxes		(1)	10	19	27	34	40	45	49	52	56	60
check		-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC		40	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
		40	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Rate Base and Financing												
Investment: (Rate Base)												
Gross Plant		1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation		-	34	69	103	138	172	207	241	276	310	345
Accumulated Deferred Taxes		(1)	10	19	27	34	40	45	49	52	56	60
Accumulated Deferred ITC		40	36	32	28	24	20	16	12	8	4	-
Ending Net Investment	1,000	961	919	880	841	804	767	732	698	664	630	596
Average Net Investment		-	940	900	860	822	786	750	715	681	647	613
Average Financing:												
Short Term Debt	0.58%	-	5	5	5	5	5	4	4	4	4	4
Long Term Debt (Revenue Bonds)	41.42%	-	389	373	356	341	325	311	296	282	268	254
Taxable Debt	0.00%	-	-	-	-	-	-	-	-	-	-	-
Preferred Stock	0.85%	-	8	8	7	7	7	6	6	6	5	5
Common Equity	57.15%	-	537	514	492	470	449	429	409	389	370	350
Total Financing		-	940	900	860	822	786	750	715	681	647	613

Revenue Requirements Model - Calculations HE Distribution
Distribution - Line Transformers

Manual input		1	2	3	4	5	6	7	8	9	10	11
Return on Investment												
Short Term Debt	2.50%	-	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	4.55%	-	18	17	16	15	15	14	13	13	12	12
Hybrids	0.00%	-	-	-	-	-	-	-	-	-	-	-
Total Interest Expense		-	18	17	16	16	15	14	14	13	12	12
Preferred Dividends	5.33%	-	0	0	0	0	0	0	0	0	0	0
Net Income on Common	9.50%	-	51	49	47	45	43	41	39	37	35	33
Income Taxes												
Income Before Pref Dividends		-	51	49	47	45	43	41	39	37	35	34
Income Before Taxes (including ITC)		-	69	66	63	61	58	55	53	50	48	45
Investment Tax Credit		-	4	4	4	4	4	4	4	4	4	4
Income Before Taxes (excluding ITC)		-	65	62	59	57	54	51	49	46	44	41
Federal Income Tax		-	14	13	13	12	11	11	10	10	9	9
State Income Tax		-	4	4	4	4	3	3	3	3	3	3
State Investment Tax Credit		-	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Total State Tax		-	0	(0)	(0)	(0)	(1)	(1)	(1)	(1)	(1)	(1)
Total Taxes		-	14	13	12	12	11	10	10	9	8	8
Revenue Requirement Calculation												
Revenue Requirement Factors		**-**	**0.1291**	**0.1250**	**0.1210**	**0.1171**	**0.1134**	**0.1098**	**0.1062**	**0.1027**	**0.0993**	**0.0958**
Revenue Requirement		**-**	**129**	**125**	**121**	**117**	**113**	**110**	**106**	**103**	**99**	**96**
Revenue Taxes		-	11	11	11	10	10	10	9	9	9	9
Income Before Depr, Int, Inc Tax		-	118	114	110	107	103	100	97	94	90	87
Depreciation Expense		-	34	34	34	34	34	34	34	34	34	34
O&M		-	-	-	-	-	-	-	-	-	-	-
Interest Expense		-	18	17	16	16	15	14	14	13	12	12
Income Before Income Taxes		-	65	62	59	57	54	51	49	46	44	41
Income Taxes - Federal		-	14	13	13	12	11	11	10	10	9	9
Income Taxes - State		-	4	4	4	4	3	3	3	3	3	3
State ITC		-	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Total Income Taxes		-	14	13	12	12	11	10	10	9	8	8
Preferred Dividends		-	0	0	0	0	0	0	0	0	0	0
Net Income for Common		-	51	49	47	45	43	41	39	37	35	33
check		-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Distribution - Line Transformers

Manual input	12	13	14	15	16	17	18	19	20	21	22	23	24
O&M													
Escalation Rate	1.24	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46	1.49	1.52	1.55	1.58
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%
Depreciation Expense	34	34	34	34	34	34	34	34	34	34	34	34	34
Accumulated Depreciation	379	414	448	483	517	552	586	621	655	690	724	759	793
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	2.500%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	4.461%	4.462%	4.461%	4.462%	4.461%	4.462%	4.461%	4.462%	4.461%	2.231%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	45	45	45	45	45	45	45	45	45	22	-	-	-
Tax Depreciation	45	45	45	45	45	45	45	45	45	22	-	-	-
Accumulated Tax Depreciation	621	665	710	755	799	844	888	933	978	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	379	414	448	483	517	552	586	621	655	690	724	759	793
Tax Accumulated Depreciation	621	665	710	755	799	844	888	933	978	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(241)	(252)	(262)	(272)	(282)	(292)	(302)	(312)	(323)	(310)	(276)	(241)	(207)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(62)	(65)	(67)	(70)	(73)	(75)	(78)	(80)	(83)	(80)	(71)	(62)	(53)
Deferred Tax Base	10	10	10	10	10	10	10	10	10	(12)	(34)	(34)	(34)
Deferred Taxes - Federal	2	2	2	2	2	2	2	2	2	(2)	(7)	(7)	(7)
Deferred Taxes - State excluding credit	1	1	1	1	1	1	1	1	1	(1)	(2)	(2)	(2)
Change in Deferred Taxes	3	3	3	3	3	3	3	3	3	(3)	(9)	(9)	(9)
Accumulated Deferred Taxes	62	65	67	70	73	75	78	80	83	80	71	62	53
check	-	-	-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	379	414	448	483	517	552	586	621	655	690	724	759	793
Accumulated Deferred Taxes	62	65	67	70	73	75	78	80	83	80	71	62	53
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	559	521	484	447	410	373	336	299	262	230	205	179	154
Average Net Investment	577	540	503	466	429	392	355	317	280	246	218	192	166
Average Financing:													
Short Term Debt	3	3	3	3	2	2	2	2	2	1	1	1	1
Long Term Debt (Revenue Bonds)	239	224	208	193	178	162	147	131	116	102	90	80	69
Taxable Debt	-	-	-	-	-	-	-	-	-	-	-	-	-
Preferred Stock	5	5	4	4	4	3	3	3	2	2	2	2	1
Common Equity	330	309	287	266	245	224	203	181	160	141	124	110	95
Total Financing	577	540	503	466	429	392	355	317	280	246	218	192	166

Revenue Requirements Model - Calculati
Distribution - Line Transformers

Manual input	12	13	14	15	16	17	18	19	20	21	22	23	24
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	11	10	9	9	8	7	7	6	5	5	4	4	3
Hybrids	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Interest Expense	11	10	10	9	8	7	7	6	5	5	4	4	3
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	31	29	27	25	23	21	19	17	15	13	12	10	9
Income Taxes													
Income Before Pref Dividends	32	30	28	25	23	21	19	17	15	13	12	11	9
Income Before Taxes (including ITC)	43	40	37	34	32	29	26	23	21	18	16	14	12
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	43	40	37	34	32	29	26	23	21	18	16	14	12
Federal Income Tax	8	8	7	7	6	6	5	5	4	4	3	3	2
State Income Tax	3	2	2	2	2	2	2	1	1	1	1	1	1
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	3	2	2	2	2	2	2	1	1	1	1	1	1
Total Taxes	11	10	10	9	8	7	7	6	5	5	4	4	3
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0966**	**0.0928**	**0.0890**	**0.0852**	**0.0815**	**0.0777**	**0.0739**	**0.0701**	**0.0664**	**0.0629**	**0.0600**	**0.0574**	**0.0548**
Revenue Requirement	**97**	**93**	**89**	**85**	**81**	**78**	**74**	**70**	**66**	**63**	**60**	**57**	**55**
Revenue Taxes	9	8	8	8	7	7	7	6	6	6	5	5	5
Income Before Depr, Int, Inc Tax	88	85	81	78	74	71	67	64	60	57	55	52	50
Depreciation Expense	34	34	34	34	34	34	34	34	34	34	34	34	34
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	11	10	10	9	8	7	7	6	5	5	4	4	3
Income Before Income Taxes	43	40	37	34	32	29	26	23	21	18	16	14	12
Income Taxes - Federal	8	8	7	7	6	6	5	5	4	4	3	3	2
Income Taxes - State	3	2	2	2	2	2	2	1	1	1	1	1	1
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	11	10	10	9	8	7	7	6	5	5	4	4	3
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	31	29	27	25	23	21	19	17	15	13	12	10	9
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Distribution - Line Transformers

Manual input	25	26	27	28	29	30	31	32	33	34	35	36	37
O&M													
Escalation Rate	1.61	1.64	1.67	1.71	1.74	1.78	1.81	1.85	1.88	1.92	1.96	2.00	2.04
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Depreciation Expense	34	34	34	34	34	34	-	-	-	-	-	-	-
Accumulated Depreciation	828	862	897	931	966	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	828	862	897	931	966	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(172)	(138)	(103)	(69)	(34)	-	-	-	-	-	-	-	-
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(44)	(36)	(27)	(18)	(9)	-	-	-	-	-	-	-	-
Deferred Tax Base	(34)	(34)	(34)	(34)	(34)	(34)	-	-	-	-	-	-	-
Deferred Taxes - Federal	(7)	(7)	(7)	(7)	(7)	(7)	-	-	-	-	-	-	-
Deferred Taxes - State excluding credit	(2)	(2)	(2)	(2)	(2)	(2)	-	-	-	-	-	-	-
Change in Deferred Taxes	(9)	(9)	(9)	(9)	(9)	(9)	-	-	-	-	-	-	-
Accumulated Deferred Taxes	44	36	27	18	9	-	-	-	-	-	-	-	-
check	-	-	(0)	(0)	(0)	-	-	-	-	-	-	-	-
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	828	862	897	931	966	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Deferred Taxes	44	36	27	18	9	-	-	-	-	-	-	-	-
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	128	102	77	51	26	0	0	0	0	0	0	0	0
Average Net Investment	141	115	90	64	38	13	0	0	0	0	0	0	0
Average Financing:													
Short Term Debt	1	1	1	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Revenue Bonds)	58	48	37	27	16	5	0	0	0	0	0	0	0
Taxable Debt	-	-	-	-	-	-	-	-	-	-	-	-	-
Preferred Stock	1	1	1	1	0	0	0	0	0	0	0	0	0
Common Equity	80	66	51	37	22	7	0	0	0	0	0	0	0
Total Financing	141	115	90	64	38	13	0	0	0	0	0	0	0

Revenue Requirements Model - Calculati
Distribution - Line Transformers

Manual input	25	26	27	28	29	30	31	32	33	34	35	36	37
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	3	2	2	1	1	0	0	0	0	0	0	0	0
Hybrids	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Interest Expense	3	2	2	1	1	0	0	0	0	0	0	0	0
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	8	6	5	3	2	1	0	0	0	0	0	0	0
Income Taxes													
Income Before Pref Dividends	8	6	5	4	2	1	0	0	0	0	0	0	0
Income Before Taxes (including ITC)	10	8	7	5	3	1	0	0	0	0	0	0	0
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	10	8	7	5	3	1	0	0	0	0	0	0	0
Federal Income Tax	2	2	1	1	1	0	0	0	0	0	0	0	0
State Income Tax	1	1	0	0	0	0	0	0	0	0	0	0	0
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	1	1	0	0	0	0	0	0	0	0	0	0	0
Total Taxes	3	2	2	1	1	0	0	0	0	0	0	0	0
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0522**	**0.0496**	**0.0470**	**0.0444**	**0.0418**	**0.0391**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**
Revenue Requirement	**52**	**50**	**47**	**44**	**42**	**39**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Revenue Taxes	5	4	4	4	4	3	0	0	0	0	0	0	0
Income Before Depr, Int, Inc Tax	48	45	43	40	38	36	0	0	0	0	0	0	0
Depreciation Expense	34	34	34	34	34	34	-	-	-	-	-	-	-
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	3	2	2	1	1	0	0	0	0	0	0	0	0
Income Before Income Taxes	10	8	7	5	3	1	0	0	0	0	0	0	0
Income Taxes - Federal	2	2	1	1	1	0	0	0	0	0	0	0	0
Income Taxes - State	1	1	0	0	0	0	0	0	0	0	0	0	0
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	3	2	2	1	1	0	0	0	0	0	0	0	0
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	8	6	5	3	2	1	0	0	0	0	0	0	0
	(0)	*(0)*	-	-	*(0)*	*(0)*	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Distribution - Line Transformers

Manual input	38	39	40	41	42	43	44	45	46	47	48	49	50
O&M													
Escalation Rate	2.08	2.12	2.16	2.21	2.25	2.30	2.34	2.39	2.44	2.49	2.54	2.59	2.64
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Depreciation Expense	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	-	-	-	-	-	-	-	-	-	-	-	-	-
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	-	-	-	-	-	-	-	-	-	-	-	-	-
Deferred Tax Base	-	-	-	-	-	-	-	-	-	-	-	-	-
Deferred Taxes - Federal	-	-	-	-	-	-	-	-	-	-	-	-	-
Deferred Taxes - State excluding credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Change in Deferred Taxes	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Deferred Taxes	-	-	-	-	-	-	-	-	-	-	-	-	-
check	-	-	-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Deferred Taxes	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	0	0	0	0	0	0	0	0	0	0	0	0	0
Average Net Investment	0	0	0	0	0	0	0	0	0	0	0	0	0
Average Financing:													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Revenue Bonds)	0	0	0	0	0	0	0	0	0	0	0	0	0
Taxable Debt	-	-	-	-	-	-	-	-	-	-	-	-	-
Preferred Stock	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Equity	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Financing	0	0	0	0	0	0	0	0	0	0	0	0	0

Revenue Requirements Model - Calculati
Distribution - Line Transformers

Manual input	38	39	40	41	42	43	44	45	46	47	48	49	50
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	0	0	0	0	0	0	0	0	0	0	0	0	0
Hybrids	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Interest Expense	0	0	0	0	0	0	0	0	0	0	0	0	0
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	0	0	0	0	0	0	0	0	0	0	0	0	0
Income Taxes													
Income Before Pref Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Income Before Taxes (including ITC)	0	0	0	0	0	0	0	0	0	0	0	0	0
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	0	0	0	0	0	0	0	0	0	0	0	0	0
Federal Income Tax	0	0	0	0	0	0	0	0	0	0	0	0	0
State Income Tax	0	0	0	0	0	0	0	0	0	0	0	0	0
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Taxes	0	0	0	0	0	0	0	0	0	0	0	0	0
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**
Revenue Requirement	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Revenue Taxes	0	0	0	0	0	0	0	0	0	0	0	0	0
Income Before Depr, Int, Inc Tax	0	0	0	0	0	0	0	0	0	0	0	0	0
Depreciation Expense	-	-	-	-	-	-	-	-	-	-	-	-	-
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	0	0	0	0	0	0	0	0	0	0	0	0	0
Income Before Income Taxes	0	0	0	0	0	0	0	0	0	0	0	0	0
Income Taxes - Federal	0	0	0	0	0	0	0	0	0	0	0	0	0
Income Taxes - State	0	0	0	0	0	0	0	0	0	0	0	0	0
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	0	0	0	0	0	0	0	0	0	0	0	0	0
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	0	0	0	0	0	0	0	0	0	0	0	0	0
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculatio
Distribution - Line Transformers

Manual input	51	52	53	54	55	56	57	58	59	60	Total
O&M											
Escalation Rate	2.69	2.75	2.80	2.86	2.91	2.97	3.03	3.09	3.15	3.22	
O&M	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation											
Book Depreciation											
Book Depreciation Rates	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Depreciation Expense	-	-	-	-	-	-	-	-	-	-	1,000
Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Tax Depreciation											
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	1,000
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	1,000
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
State Investment Tax Credit (ITC)											
Book											
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	40
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	
Deferred ITC	-	-	-	-	-	-	-	-	-	-	
Tax											
Deferred Tax Calculation											
Book Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Book/Tax Acc Depr Difference	-	-	-	-	-	-	-	-	-	-	
Deferred ITC	-	-	-	-	-	-	-	-	-	-	
Net Deferred Tax Asset (Liability)	-	-	-	-	-	-	-	-	-	-	
Deferred Tax Base	-	-	-	-	-	-	-	-	-	-	
Deferred Taxes - Federal	-	-	-	-	-	-	-	-	-	-	
Deferred Taxes - State excluding credit	-	-	-	-	-	-	-	-	-	-	
Change in Deferred Taxes	-	-	-	-	-	-	-	-	-	-	
Accumulated Deferred Taxes	-	-	-	-	-	-	-	-	-	-	
check	-	-	-	-	-	-	-	-	-	-	
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	
	-	-	-	-	-	-	-	-	-	-	
Rate Base and Financing											
Investment: (Rate Base)											
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Accumulated Deferred Taxes	-	-	-	-	-	-	-	-	-	-	
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	
Ending Net Investment	0	0	0	0	0	0	0	0	0	0	
Average Net Investment	0	0	0	0	0	0	0	0	0	0	
Average Financing:											
Short Term Debt	0	0	0	0	0	0	0	0	0	0	
Long Term Debt (Revenue Bonds)	0	0	0	0	0	0	0	0	0	0	
Taxable Debt	-	-	-	-	-	-	-	-	-	-	
Preferred Stock	0	0	0	0	0	0	0	0	0	0	
Common Equity	0	0	0	0	0	0	0	0	0	0	
Total Financing	0	0	0	0	0	0	0	0	0	0	

Revenue Requirements Model - Calculatio
Distribution - Line Transformers

Manual input	51	52	53	54	55	56	57	58	59	60	Total
Return on Investment											
Short Term Debt	0	0	0	0	0	0	0	0	0	0	
Long Term Debt (Taxable Debt)	0	0	0	0	0	0	0	0	0	0	
Hybrids	-	-	-	-	-	-	-	-	-	-	
Total Interest Expense	0	0	0	0	0	0	0	0	0	0	
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	
Net Income on Common	0	0	0	0	0	0	0	0	0	0	
Income Taxes											
Income Before Pref Dividends	0	0	0	0	0	0	0	0	0	0	
Income Before Taxes (including ITC)	0	0	0	0	0	0	0	0	0	0	
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	
Income Before Taxes (excluding ITC)	0	0	0	0	0	0	0	0	0	0	
Federal Income Tax	0	0	0	0	0	0	0	0	0	0	
State Income Tax	0	0	0	0	0	0	0	0	0	0	
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	
Total State Tax	0	0	0	0	0	0	0	0	0	0	
Total Taxes	0	0	0	0	0	0	0	0	0	0	
Revenue Requirement Calculation											
Revenue Requirement Factors	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	
Revenue Requirement	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	
Revenue Taxes	0	0	0	0	0	0	0	0	0	0	
Income Before Depr, Int, Inc Tax	0	0	0	0	0	0	0	0	0	0	
Depreciation Expense	-	-	-	-	-	-	-	-	-	-	
O&M	-	-	-	-	-	-	-	-	-	-	
Interest Expense	0	0	0	0	0	0	0	0	0	0	
Income Before Income Taxes	0	0	0	0	0	0	0	0	0	0	
Income Taxes - Federal	0	0	0	0	0	0	0	0	0	0	
Income Taxes - State	0	0	0	0	0	0	0	0	0	0	
State ITC	-	-	-	-	-	-	-	-	-	-	
Total Income Taxes	0	0	0	0	0	0	0	0	0	0	
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	
Net Income for Common	0	0	0	0	0	0	0	0	0	0	
	-	-	-	-	-	-	-	-	-	-	

Resilience Project/Program
Revenue Requirements Model - Calculations HL Transmission
Transmission - Poles and Fixtures

Manual input		1	2	3	4	5	6	7	8	9	10	11
O&M												
Escalation Rate		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22
O&M		-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation												
Book Depreciation												
Book Depreciation Rates		0.000%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%
Depreciation Expense		-	18	18	18	18	18	18	18	18	18	18
Accumulated Depreciation		-	18	35	53	70	88	105	123	140	158	175
Tax Depreciation												
Tax Depreciation Rates (Straight Line)	**20**	2.500%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%
Tax Basis (S/L)	0.0%	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	**15**	5.000%	9.500%	8.550%	7.700%	6.930%	6.230%	5.900%	5.900%	5.910%	5.900%	5.910%
NonRB Financed Tax Basis (MACRS)	100.0%	50	95	86	77	69	62	59	59	59	59	59
Tax Depreciation		50	95	86	77	69	62	59	59	59	59	59
Accumulated Tax Depreciation		50	145	231	308	377	439	498	557	616	675	734
State Investment Tax Credit (ITC)												
Book												
State ITC Amortization Rate		0.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%
Amortization of State ITC	4.00%	-	4	4	4	4	4	4	4	4	4	4
Accumulated Amortization		-	4	8	12	16	20	24	28	32	36	40
Deferred ITC		40	36	32	28	24	20	16	12	8	4	-
Tax		40										
Deferred Tax Calculation												
Book Accumulated Depreciation		-	18	35	53	70	88	105	123	140	158	175
Tax Accumulated Depreciation		50	145	231	308	377	439	498	557	616	675	734
Book/Tax Acc Depr Difference		(50)	(127)	(195)	(255)	(307)	(351)	(393)	(434)	(476)	(517)	(559)
Deferred ITC		40	36	32	28	24	20	16	12	8	4	-
Net Deferred Tax Asset (Liability)		(3)	(24)	(42)	(58)	(73)	(85)	(97)	(109)	(120)	(132)	(144)
Deferred Tax Base		10	81	72	63	56	49	45	45	46	45	46
Deferred Taxes - Federal		2	16	14	13	11	10	9	9	9	9	9
Deferred Taxes - State excluding credit		1	5	4	4	3	3	3	3	3	3	3
Change in Deferred Taxes		3	21	19	16	14	13	12	12	12	12	12
Accumulated Deferred Taxes		3	24	42	58	73	85	97	109	120	132	144
check		-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC		40	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
		40	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Rate Base and Financing												
Investment: (Rate Base)												
Gross Plant		1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation		-	18	35	53	70	88	105	123	140	158	175
Accumulated Deferred Taxes		3	24	42	58	73	85	97	109	120	132	144
Accumulated Deferred ITC		40	36	32	28	24	20	16	12	8	4	-
Ending Net Investment	1,000	957	923	891	861	833	807	782	756	731	706	681
Average Net Investment		-	940	907	876	847	820	794	769	744	719	693
Average Financing:												
Short Term Debt	0.61%	-	6	6	5	5	5	5	5	5	4	4
Long Term Debt (Revenue Bonds)	40.59%	-	382	368	356	344	333	322	312	302	292	281
Taxable Debt	0.80%	-	8	7	7	7	7	6	6	6	6	6
Preferred Stock	1.17%	-	11	11	10	10	10	9	9	9	8	8
Common Equity	56.83%	-	534	515	498	481	466	451	437	423	408	394
Total Financing		-	940	907	876	847	820	794	769	744	719	693

Revenue Requirements Model - Calculations HL Transmission
Transmission - Poles and Fixtures

Manual input		1	2	3	4	5	6	7	8	9	10	11
Return on Investment												
Short Term Debt	3.75%	-	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	4.79%	-	18	18	17	16	16	15	15	14	14	13
Hybrids	7.83%	-	1	1	1	1	1	0	0	0	0	0
Total Interest Expense		-	19	18	18	17	17	16	16	15	15	14
Preferred Dividends	8.12%	-	1	1	1	1	1	1	1	1	1	1
Net Income on Common	9.50%	-	51	49	47	46	44	43	42	40	39	37
Income Taxes												
Income Before Pref Dividends		-	52	50	48	47	45	44	42	41	39	38
Income Before Taxes (including ITC)		-	70	67	65	63	61	59	57	55	53	51
Investment Tax Credit		-	4	4	4	4	4	4	4	4	4	4
Income Before Taxes (excluding ITC)		-	66	63	61	59	57	55	53	51	49	47
Federal Income Tax		-	14	13	13	12	12	12	11	11	10	10
State Income Tax		-	4	4	4	4	4	4	3	3	3	3
State Investment Tax Credit		-	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Total State Tax		-	0	0	(0)	(0)	(0)	(0)	(1)	(1)	(1)	(1)
Total Taxes		-	14	13	13	12	12	11	11	10	10	9
Revenue Requirement Calculation												
Revenue Requirement Factors		**-**	**0.1122**	**0.1087**	**0.1055**	**0.1025**	**0.0997**	**0.0971**	**0.0945**	**0.0918**	**0.0892**	**0.0866**
Revenue Requirement		**-**	**112**	**109**	**106**	**103**	**100**	**97**	**94**	**92**	**89**	**87**
Revenue Taxes		-	10	10	9	9	9	9	8	8	8	8
Income Before Depr, Int, Inc Tax		-	102	99	96	93	91	88	86	84	81	79
Depreciation Expense		-	18	18	18	18	18	18	18	18	18	18
O&M		-	-	-	-	-	-	-	-	-	-	-
Interest Expense		-	19	18	18	17	17	16	16	15	15	14
Income Before Income Taxes		-	66	63	61	59	57	55	53	51	49	47
Income Taxes - Federal		-	14	13	13	12	12	12	11	11	10	10
Income Taxes - State		-	4	4	4	4	4	4	3	3	3	3
State ITC		-	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Total Income Taxes		-	14	13	13	12	12	11	11	10	10	9
Preferred Dividends		-	1	1	1	1	1	1	1	1	1	1
Net Income for Common		-	51	49	47	46	44	43	42	40	39	37
	check	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Transmission - Poles and Fixtures

Manual input	12	13	14	15	16	17	18	19	20	21	22	23	24
O&M													
Escalation Rate	1.24	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46	1.49	1.52	1.55	1.58
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%
Depreciation Expense	18	18	18	18	18	18	18	18	18	18	18	18	18
Accumulated Depreciation	193	211	228	246	263	281	298	316	333	351	368	386	404
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	2.500%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	5.900%	5.910%	5.900%	5.910%	2.950%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	59	59	59	59	30	-	-	-	-	-	-	-	-
Tax Depreciation	59	59	59	59	30	-	-	-	-	-	-	-	-
Accumulated Tax Depreciation	793	852	911	971	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	193	211	228	246	263	281	298	316	333	351	368	386	404
Tax Accumulated Depreciation	793	852	911	971	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(600)	(642)	(683)	(725)	(737)	(719)	(702)	(684)	(667)	(649)	(632)	(614)	(596)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(155)	(165)	(176)	(187)	(190)	(185)	(181)	(176)	(172)	(167)	(163)	(158)	(154)
Deferred Tax Base	41	42	41	42	12	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)
Deferred Taxes - Federal	8	8	8	8	2	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Deferred Taxes - State excluding credit	2	2	2	2	1	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Change in Deferred Taxes	11	11	11	11	3	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Accumulated Deferred Taxes	155	165	176	187	190	185	181	176	172	167	163	158	154
check	-	-	-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	193	211	228	246	263	281	298	316	333	351	368	386	404
Accumulated Deferred Taxes	155	165	176	187	190	185	181	176	172	167	163	158	154
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	652	624	596	568	547	534	521	508	495	482	469	456	443
Average Net Investment	667	638	610	582	557	541	528	515	502	488	475	462	449
Average Financing:													
Short Term Debt	4	4	4	4	3	3	3	3	3	3	3	3	3
Long Term Debt (Revenue Bonds)	271	259	248	236	226	219	214	209	204	198	193	188	182
Taxable Debt	5	5	5	5	4	4	4	4	4	4	4	4	4
Preferred Stock	8	7	7	7	7	6	6	6	6	6	6	5	5
Common Equity	379	363	347	331	317	307	300	292	285	278	270	263	255
Total Financing	667	638	610	582	557	541	528	515	502	488	475	462	449

Revenue Requirements Model - Calculati
Transmission - Poles and Fixtures

Manual input	12	13	14	15	16	17	18	19	20	21	22	23	24
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	13	12	12	11	11	11	10	10	10	9	9	9	9
Hybrids	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Interest Expense	14	13	12	12	11	11	11	10	10	10	10	9	9
Preferred Dividends	1	1	1	1	1	1	1	0	0	0	0	0	0
Net Income on Common	36	34	33	31	30	29	28	28	27	26	26	25	24
Income Taxes													
Income Before Pref Dividends	37	35	34	32	31	30	29	28	28	27	26	25	25
Income Before Taxes (including ITC)	49	47	45	43	41	40	39	38	37	36	35	34	33
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	49	47	45	43	41	40	39	38	37	36	35	34	33
Federal Income Tax	10	9	9	8	8	8	8	8	7	7	7	7	7
State Income Tax	3	3	3	3	2	2	2	2	2	2	2	2	2
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	3	3	3	3	2	2	2	2	2	2	2	2	2
Total Taxes	13	12	12	11	11	10	10	10	10	9	9	9	9
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0882**	**0.0853**	**0.0824**	**0.0795**	**0.0769**	**0.0752**	**0.0738**	**0.0725**	**0.0712**	**0.0698**	**0.0685**	**0.0671**	**0.0658**
Revenue Requirement	**88**	**85**	**82**	**79**	**77**	**75**	**74**	**73**	**71**	**70**	**68**	**67**	**66**
Revenue Taxes	8	8	7	7	7	7	7	6	6	6	6	6	6
Income Before Depr, Int, Inc Tax	80	78	75	72	70	69	67	66	65	64	62	61	60
Depreciation Expense	18	18	18	18	18	18	18	18	18	18	18	18	18
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	14	13	12	12	11	11	11	10	10	10	10	9	9
Income Before Income Taxes	49	47	45	43	41	40	39	38	37	36	35	34	33
Income Taxes - Federal	10	9	9	8	8	8	8	8	7	7	7	7	7
Income Taxes - State	3	3	3	3	2	2	2	2	2	2	2	2	2
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	13	12	12	11	11	10	10	10	10	9	9	9	9
Preferred Dividends	1	1	1	1	1	1	1	0	0	0	0	0	0
Net Income for Common	36	34	33	31	30	29	28	28	27	26	26	25	24
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Transmission - Poles and Fixtures

Manual input	25	26	27	28	29	30	31	32	33	34	35	36	37
O&M													
Escalation Rate	1.61	1.64	1.67	1.71	1.74	1.78	1.81	1.85	1.88	1.92	1.96	2.00	2.04
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%
Depreciation Expense	18	18	18	18	18	18	18	18	18	18	18	18	18
Accumulated Depreciation	421	439	456	474	491	509	526	544	561	579	596	614	632
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	421	439	456	474	491	509	526	544	561	579	596	614	632
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(579)	(561)	(544)	(526)	(509)	(491)	(474)	(456)	(439)	(421)	(404)	(386)	(368)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(149)	(145)	(140)	(136)	(131)	(127)	(122)	(117)	(113)	(108)	(104)	(99)	(95)
Deferred Tax Base	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)
Deferred Taxes - Federal	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Change in Deferred Taxes	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Accumulated Deferred Taxes	149	145	140	136	131	127	122	117	113	108	104	99	95
check	-	-	-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	421	439	456	474	491	509	526	544	561	579	596	614	632
Accumulated Deferred Taxes	149	145	140	136	131	127	122	117	113	108	104	99	95
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	430	417	404	391	378	365	352	339	326	313	300	287	274
Average Net Investment	436	423	410	397	384	371	358	345	332	319	306	293	280
Average Financing:													
Short Term Debt	3	3	2	2	2	2	2	2	2	2	2	2	2
Long Term Debt (Revenue Bonds)	177	172	167	161	156	151	145	140	135	130	124	119	114
Taxable Debt	3	3	3	3	3	3	3	3	3	3	2	2	2
Preferred Stock	5	5	5	5	4	4	4	4	4	4	4	3	3
Common Equity	248	241	233	226	218	211	204	196	189	181	174	167	159
Total Financing	436	423	410	397	384	371	358	345	332	319	306	293	280

Revenue Requirements Model - Calculati
Transmission - Poles and Fixtures

Manual input	25	26	27	28	29	30	31	32	33	34	35	36	37
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	8	8	8	8	7	7	7	7	6	6	6	6	5
Hybrids	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Interest Expense	9	9	8	8	8	8	7	7	7	6	6	6	6
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	24	23	22	21	21	20	19	19	18	17	17	16	15
Income Taxes													
Income Before Pref Dividends	24	23	23	22	21	20	20	19	18	18	17	16	15
Income Before Taxes (including ITC)	32	31	30	29	28	27	27	26	25	24	23	22	21
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	32	31	30	29	28	27	27	26	25	24	23	22	21
Federal Income Tax	6	6	6	6	6	5	5	5	5	5	4	4	4
State Income Tax	2	2	2	2	2	2	2	2	1	1	1	1	1
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	2	2	2	2	2	2	2	2	1	1	1	1	1
Total Taxes	8	8	8	8	7	7	7	7	6	6	6	6	5
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0644**	**0.0631**	**0.0617**	**0.0604**	**0.0590**	**0.0577**	**0.0563**	**0.0550**	**0.0536**	**0.0523**	**0.0509**	**0.0496**	**0.0482**
Revenue Requirement	**64**	**63**	**62**	**60**	**59**	**58**	**56**	**55**	**54**	**52**	**51**	**50**	**48**
Revenue Taxes	6	6	5	5	5	5	5	5	5	5	5	4	4
Income Before Depr, Int, Inc Tax	59	57	56	55	54	53	51	50	49	48	46	45	44
Depreciation Expense	18	18	18	18	18	18	18	18	18	18	18	18	18
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	9	9	8	8	8	8	7	7	7	6	6	6	6
Income Before Income Taxes	32	31	30	29	28	27	27	26	25	24	23	22	21
Income Taxes - Federal	6	6	6	6	6	5	5	5	5	5	4	4	4
Income Taxes - State	2	2	2	2	2	2	2	2	1	1	1	1	1
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	8	8	8	8	7	7	7	7	6	6	6	6	5
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	24	23	22	21	21	20	19	19	18	17	17	16	15
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Transmission - Poles and Fixtures

Manual input	38	39	40	41	42	43	44	45	46	47	48	49	50
O&M													
Escalation Rate	2.08	2.12	2.16	2.21	2.25	2.30	2.34	2.39	2.44	2.49	2.54	2.59	2.64
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%
Depreciation Expense	18	18	18	18	18	18	18	18	18	18	18	18	18
Accumulated Depreciation	649	667	684	702	719	737	754	772	789	807	825	842	860
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	649	667	684	702	719	737	754	772	789	807	825	842	860
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(351)	(333)	(316)	(298)	(281)	(263)	(246)	(228)	(211)	(193)	(175)	(158)	(140)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(90)	(86)	(81)	(77)	(72)	(68)	(63)	(59)	(54)	(50)	(45)	(41)	(36)
Deferred Tax Base	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)
Deferred Taxes - Federal	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Change in Deferred Taxes	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Accumulated Deferred Taxes	90	86	81	77	72	68	63	59	54	50	45	41	36
check	0	0	0	0	0	0	0	0	0	0	0	0	0
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	649	667	684	702	719	737	754	772	789	807	825	842	860
Accumulated Deferred Taxes	90	86	81	77	72	68	63	59	54	50	45	41	36
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	261	247	234	221	208	195	182	169	156	143	130	117	104
Average Net Investment	267	254	241	228	215	202	189	176	163	150	137	124	111
Average Financing:													
Short Term Debt	2	2	1	1	1	1	1	1	1	1	1	1	1
Long Term Debt (Revenue Bonds)	108	103	98	93	87	82	77	71	66	61	56	50	45
Taxable Debt	2	2	2	2	2	2	2	1	1	1	1	1	1
Preferred Stock	3	3	3	3	3	2	2	2	2	2	2	1	1
Common Equity	152	144	137	130	122	115	107	100	93	85	78	70	63
Total Financing	267	254	241	228	215	202	189	176	163	150	137	124	111

Revenue Requirements Model - Calculati
Transmission - Poles and Fixtures

Manual input	38	39	40	41	42	43	44	45	46	47	48	49	50
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	5	5	5	4	4	4	4	3	3	3	3	2	2
Hybrids	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Interest Expense	5	5	5	5	4	4	4	4	3	3	3	3	2
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	14	14	13	12	12	11	10	9	9	8	7	7	6
Income Taxes													
Income Before Pref Dividends	15	14	13	13	12	11	10	10	9	8	8	7	6
Income Before Taxes (including ITC)	20	19	18	17	16	15	14	13	12	11	10	9	8
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	20	19	18	17	16	15	14	13	12	11	10	9	8
Federal Income Tax	4	4	4	3	3	3	3	3	2	2	2	2	2
State Income Tax	1	1	1	1	1	1	1	1	1	1	1	1	0
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	1	1	1	1	1	1	1	1	1	1	1	1	0
Total Taxes	5	5	5	4	4	4	4	3	3	3	3	2	2
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0469**	**0.0455**	**0.0442**	**0.0428**	**0.0415**	**0.0401**	**0.0388**	**0.0375**	**0.0361**	**0.0348**	**0.0334**	**0.0321**	**0.0307**
Revenue Requirement	**47**	**46**	**44**	**43**	**41**	**40**	**39**	**37**	**36**	**35**	**33**	**32**	**31**
Revenue Taxes	4	4	4	4	4	4	3	3	3	3	3	3	3
Income Before Depr, Int, Inc Tax	43	41	40	39	38	37	35	34	33	32	30	29	28
Depreciation Expense	18	18	18	18	18	18	18	18	18	18	18	18	18
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	5	5	5	5	4	4	4	4	3	3	3	3	2
Income Before Income Taxes	20	19	18	17	16	15	14	13	12	11	10	9	8
Income Taxes - Federal	4	4	4	3	3	3	3	3	2	2	2	2	2
Income Taxes - State	1	1	1	1	1	1	1	1	1	1	1	1	0
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	5	5	5	4	4	4	4	3	3	3	3	2	2
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	14	14	13	12	12	11	10	9	9	8	7	7	6
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculatio
Transmission - Poles and Fixtures

Manual input	51	52	53	54	55	56	57	58	59	60	Total
O&M											
Escalation Rate	2.69	2.75	2.80	2.86	2.91	2.97	3.03	3.09	3.15	3.22	
O&M	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation											
Book Depreciation											
Book Depreciation Rates	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	0.000%	0.000%	100.00%
Depreciation Expense	18	18	18	18	18	18	18	18	-	-	1,000
Accumulated Depreciation	877	895	912	930	947	965	982	1,000	1,000	1,000	
Tax Depreciation											
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	1,000
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	1,000
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
State Investment Tax Credit (ITC)											
Book											
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	40
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	
Deferred ITC	-	-	-	-	-	-	-	-	-	-	
Tax											
Deferred Tax Calculation											
Book Accumulated Depreciation	877	895	912	930	947	965	982	1,000	1,000	1,000	
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Book/Tax Acc Depr Difference	(123)	(105)	(88)	(70)	(53)	(35)	(18)	-	-	-	
Deferred ITC	-	-	-	-	-	-	-	-	-	-	
Net Deferred Tax Asset (Liability)	(32)	(27)	(23)	(18)	(14)	(9)	(5)	-	-	-	
Deferred Tax Base	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	-	-	
Deferred Taxes - Federal	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	-	-	
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	-	-	
Change in Deferred Taxes	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	-	-	
Accumulated Deferred Taxes	32	27	23	18	14	9	5	0	0	0	
check	0	0	0	0	0	0	0	0	0	0	
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	
	-	-	-	-	-	-	-	-	-	-	
Rate Base and Financing											
Investment: (Rate Base)											
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Accumulated Depreciation	877	895	912	930	947	965	982	1,000	1,000	1,000	
Accumulated Deferred Taxes	32	27	23	18	14	9	5	0	0	0	
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	
Ending Net Investment	91	78	65	52	39	26	13	(0)	(0)	(0)	
Average Net Investment	98	85	72	59	46	33	20	7	(0)	(0)	
Average Financing:											
Short Term Debt	1	1	0	0	0	0	0	0	(0)	(0)	
Long Term Debt (Revenue Bonds)	40	34	29	24	19	13	8	3	(0)	(0)	
Taxable Debt	1	1	1	0	0	0	0	0	(0)	(0)	
Preferred Stock	1	1	1	1	1	0	0	0	(0)	(0)	
Common Equity	56	48	41	33	26	19	11	4	(0)	(0)	
Total Financing	98	85	72	59	46	33	20	7	(0)	(0)	

Revenue Requirements Model - Calculatio
Transmission - Poles and Fixtures

Manual input	51	52	53	54	55	56	57	58	59	60	Total
Return on Investment											
Short Term Debt	0	0	0	0	0	0	0	0	(0)	(0)	
Long Term Debt (Taxable Debt)	2	2	1	1	1	1	0	0	(0)	(0)	
Hybrids	0	0	0	0	0	0	0	0	(0)	(0)	
Total Interest Expense	2	2	1	1	1	1	0	0	(0)	(0)	
Preferred Dividends	0	0	0	0	0	0	0	0	(0)	(0)	
Net Income on Common	5	5	4	3	2	2	1	0	(0)	(0)	
Income Taxes											
Income Before Pref Dividends	5	5	4	3	3	2	1	0	(0)	(0)	
Income Before Taxes (including ITC)	7	6	5	4	3	2	1	0	(0)	(0)	
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	
Income Before Taxes (excluding ITC)	7	6	5	4	3	2	1	0	(0)	(0)	
Federal Income Tax	1	1	1	1	1	0	0	0	(0)	(0)	
State Income Tax	0	0	0	0	0	0	0	0	(0)	(0)	
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	
Total State Tax	0	0	0	0	0	0	0	0	(0)	(0)	
Total Taxes	2	2	1	1	1	1	0	0	(0)	(0)	
Revenue Requirement Calculation											
Revenue Requirement Factors	**0.0294**	**0.0280**	**0.0267**	**0.0253**	**0.0240**	**0.0226**	**0.0213**	**0.0199**	**(0.0000)**	**(0.0000)**	
Revenue Requirement	**29**	**28**	**27**	**25**	**24**	**23**	**21**	**20**	**(0)**	**(0)**	
Revenue Taxes	3	2	2	2	2	2	2	2	(0)	(0)	
Income Before Depr, Int, Inc Tax	27	26	24	23	22	21	19	18	(0)	(0)	
Depreciation Expense	18	18	18	18	18	18	18	18	-	-	
O&M	-	-	-	-	-	-	-	-	-	-	
Interest Expense	2	2	1	1	1	1	0	0	(0)	(0)	
Income Before Income Taxes	7	6	5	4	3	2	1	0	(0)	(0)	
Income Taxes - Federal	1	1	1	1	1	0	0	0	(0)	(0)	
Income Taxes - State	0	0	0	0	0	0	0	0	(0)	(0)	
State ITC	-	-	-	-	-	-	-	-	-	-	
Total Income Taxes	2	2	1	1	1	1	0	0	(0)	(0)	
Preferred Dividends	0	0	0	0	0	0	0	0	(0)	(0)	
Net Income for Common	5	5	4	3	2	2	1	0	(0)	(0)	
	-	*-*	*-*	*(0)*	*-*	*(0)*	*(0)*	*0*	*-*	*-*	

Resilience Project/Program
Revenue Requirements Model - Calculations HL Distribution
Distribution - Poles, Towers, and Fixtures

Manual input		1	2	3	4	5	6	7	8	9	10	11	12
O&M													
Escalation Rate		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24
O&M		-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates		0.000%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%
Depreciation Expense		-	23	23	23	23	23	23	23	23	23	23	23
Accumulated Depreciation		-	23	45	68	91	114	136	159	182	205	227	250
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	20	2.500%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%
Tax Basis (S/L)	0.0%	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	20	3.750%	7.219%	6.677%	6.177%	5.713%	5.285%	4.888%	4.522%	4.462%	4.461%	4.462%	4.461%
NonRB Financed Tax Basis (MACRS)	100.0%	38	72	67	62	57	53	49	45	45	45	45	45
Tax Depreciation		38	72	67	62	57	53	49	45	45	45	45	45
Accumulated Tax Depreciation		38	110	176	238	295	348	397	442	487	532	576	621
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate		0.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	0.000%
Amortization of State ITC	4.00%	-	4	4	4	4	4	4	4	4	4	4	-
Accumulated Amortization		-	4	8	12	16	20	24	28	32	36	40	40
Deferred ITC		40	36	32	28	24	20	16	12	8	4	-	-
Tax		40											
Deferred Tax Calculation													
Book Accumulated Depreciation		-	23	45	68	91	114	136	159	182	205	227	250
Tax Accumulated Depreciation		38	110	176	238	295	348	397	442	487	532	576	621
Book/Tax Acc Depr Difference		(38)	(87)	(131)	(170)	(204)	(235)	(261)	(283)	(305)	(327)	(349)	(371)
Deferred ITC		40	36	32	28	24	20	16	12	8	4	-	-
Net Deferred Tax Asset (Liability)		1	(13)	(25)	(37)	(46)	(55)	(63)	(70)	(77)	(83)	(90)	(95)
Deferred Tax Base		(3)	53	48	43	38	34	30	26	26	26	26	22
Deferred Taxes - Federal		(0)	11	9	8	8	7	6	5	5	5	5	4
Deferred Taxes - State excluding credit		(0)	3	3	3	2	2	2	2	2	2	2	1
Change in Deferred Taxes		(1)	14	12	11	10	9	8	7	7	7	7	6
Accumulated Deferred Taxes		(1)	13	25	37	46	55	63	70	77	83	90	95
	check	-	-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC		40	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
		40	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant		1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation		-	23	45	68	91	114	136	159	182	205	227	250
Accumulated Deferred Taxes		(1)	13	25	37	46	55	63	70	77	83	90	95
Accumulated Deferred ITC		40	36	32	28	24	20	16	12	8	4	-	-
Ending Net Investment	1,000	961	928	897	867	839	811	785	759	734	708	683	655
Average Net Investment		-	944	913	882	853	825	798	772	746	721	696	669
Average Financing:													
Short Term Debt	0.61%	-	6	6	5	5	5	5	5	5	4	4	4
Long Term Debt (Revenue Bonds)	40.59%	-	383	370	358	346	335	324	313	303	293	282	271
Taxable Debt	0.80%	-	8	7	7	7	7	6	6	6	6	6	5
Preferred Stock	1.17%	-	11	11	10	10	10	9	9	9	8	8	8
Common Equity	56.83%	-	537	519	501	485	469	453	439	424	410	395	380
Total Financing		-	944	913	882	853	825	798	772	746	721	696	669

Revenue Requirements Model - Calculations HL Distribution
Distribution - Poles, Towers, and Fixtures

Manual input		1	2	3	4	5	6	7	8	9	10	11	12
Return on Investment													
Short Term Debt	3.75%	-	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	4.79%	-	18	18	17	17	16	16	15	15	14	14	13
Hybrids	7.83%	-	1	1	1	1	1	0	0	0	0	0	0
Total Interest Expense		-	19	19	18	17	17	16	16	15	15	14	14
Preferred Dividends	8.12%	-	1	1	1	1	1	1	1	1	1	1	1
Net Income on Common	9.50%	-	51	49	48	46	45	43	42	40	39	38	36
Income Taxes													
Income Before Pref Dividends		-	52	50	48	47	45	44	42	41	40	38	37
Income Before Taxes (including ITC)		-	70	68	65	63	61	59	57	55	53	51	49
Investment Tax Credit		-	4	4	4	4	4	4	4	4	4	4	-
Income Before Taxes (excluding ITC)		-	66	64	61	59	57	55	53	51	49	47	49
Federal Income Tax		-	14	13	13	12	12	12	11	11	11	10	10
State Income Tax		-	4	4	4	4	4	4	3	3	3	3	3
State Investment Tax Credit		-	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
Total State Tax		-	0	0	(0)	(0)	(0)	(0)	(1)	(1)	(1)	(1)	3
Total Taxes		-	14	13	13	12	12	11	11	10	10	9	13
Revenue Requirement Calculation													
Revenue Requirement Factors		**-**	**0.1183**	**0.1150**	**0.1118**	**0.1088**	**0.1059**	**0.1031**	**0.1004**	**0.0978**	**0.0952**	**0.0925**	**0.0941**
Revenue Requirement		**-**	**118**	**115**	**112**	**109**	**106**	**103**	**100**	**98**	**95**	**93**	**94**
Revenue Taxes		-	11	10	10	10	9	9	9	9	8	8	8
Income Before Depr, Int, Inc Tax		-	108	105	102	99	97	94	92	89	87	84	86
Depreciation Expense		-	23	23	23	23	23	23	23	23	23	23	23
O&M		-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense		-	19	19	18	17	17	16	16	15	15	14	14
Income Before Income Taxes		-	66	64	61	59	57	55	53	51	49	47	49
Income Taxes - Federal		-	14	13	13	12	12	12	11	11	11	10	10
Income Taxes - State		-	4	4	4	4	4	4	3	3	3	3	3
State ITC		-	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
Total Income Taxes		-	14	13	13	12	12	11	11	10	10	9	13
Preferred Dividends		-	1	1	1	1	1	1	1	1	1	1	1
Net Income for Common		-	51	49	48	46	45	43	42	40	39	38	36
check		-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Distribution - Poles, Towers, and Fixtures

Manual input	13	14	15	16	17	18	19	20	21	22	23	24	25
O&M													
Escalation Rate	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46	1.49	1.52	1.55	1.58	1.61
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%
Depreciation Expense	23	23	23	23	23	23	23	23	23	23	23	23	23
Accumulated Depreciation	273	295	318	341	364	386	409	432	455	477	500	523	545
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	2.500%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	4.462%	4.461%	4.462%	4.461%	4.462%	4.461%	4.462%	4.461%	2.231%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	45	45	45	45	45	45	45	45	22	-	-	-	-
Tax Depreciation	45	45	45	45	45	45	45	45	22	-	-	-	-
Accumulated Tax Depreciation	665	710	755	799	844	888	933	978	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	273	295	318	341	364	386	409	432	455	477	500	523	545
Tax Accumulated Depreciation	665	710	755	799	844	888	933	978	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(393)	(415)	(436)	(458)	(480)	(502)	(524)	(546)	(545)	(523)	(500)	(477)	(455)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(101)	(107)	(112)	(118)	(124)	(129)	(135)	(141)	(140)	(135)	(129)	(123)	(117)
Deferred Tax Base	22	22	22	22	22	22	22	22	(0)	(23)	(23)	(23)	(23)
Deferred Taxes - Federal	4	4	4	4	4	4	4	4	(0)	(4)	(4)	(4)	(4)
Deferred Taxes - State excluding credit	1	1	1	1	1	1	1	1	(0)	(1)	(1)	(1)	(1)
Change in Deferred Taxes	6	6	6	6	6	6	6	6	(0)	(6)	(6)	(6)	(6)
Accumulated Deferred Taxes	101	107	112	118	124	129	135	141	140	135	129	123	117
check	-	-	-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	273	295	318	341	364	386	409	432	455	477	500	523	545
Accumulated Deferred Taxes	101	107	112	118	124	129	135	141	140	135	129	123	117
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	626	598	569	541	513	484	456	428	405	388	371	354	337
Average Net Investment	640	612	584	555	527	499	470	442	416	397	380	363	346
Average Financing:													
Short Term Debt	4	4	4	3	3	3	3	3	3	2	2	2	2
Long Term Debt (Revenue Bonds)	260	248	237	225	214	202	191	179	169	161	154	147	140
Taxable Debt	5	5	5	4	4	4	4	4	3	3	3	3	3
Preferred Stock	7	7	7	6	6	6	5	5	5	5	4	4	4
Common Equity	364	348	332	316	299	283	267	251	237	225	216	206	197
Total Financing	640	612	584	555	527	499	470	442	416	397	380	363	346

Revenue Requirements Model - Calculati
Distribution - Poles, Towers, and Fixtures

Manual input	13	14	15	16	17	18	19	20	21	22	23	24	25
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	12	12	11	11	10	10	9	9	8	8	7	7	7
Hybrids	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Interest Expense	13	12	12	11	11	10	10	9	8	8	8	7	7
Preferred Dividends	1	1	1	1	1	0	0	0	0	0	0	0	0
Net Income on Common	35	33	32	30	28	27	25	24	22	21	20	20	19
Income Taxes													
Income Before Pref Dividends	35	34	32	31	29	27	26	24	23	22	21	20	19
Income Before Taxes (including ITC)	47	45	43	41	39	37	35	33	31	29	28	27	26
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	47	45	43	41	39	37	35	33	31	29	28	27	26
Federal Income Tax	9	9	9	8	8	7	7	6	6	6	6	5	5
State Income Tax	3	3	3	2	2	2	2	2	2	2	2	2	2
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	3	3	3	2	2	2	2	2	2	2	2	2	2
Total Taxes	12	12	11	11	10	9	9	8	8	8	7	7	7
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0912**	**0.0883**	**0.0853**	**0.0824**	**0.0795**	**0.0765**	**0.0736**	**0.0707**	**0.0680**	**0.0660**	**0.0642**	**0.0625**	**0.0607**
Revenue Requirement	**91**	**88**	**85**	**82**	**79**	**77**	**74**	**71**	**68**	**66**	**64**	**62**	**61**
Revenue Taxes	8	8	8	7	7	7	7	6	6	6	6	6	5
Income Before Depr, Int, Inc Tax	83	80	78	75	72	70	67	64	62	60	59	57	55
Depreciation Expense	23	23	23	23	23	23	23	23	23	23	23	23	23
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	13	12	12	11	11	10	10	9	8	8	8	7	7
Income Before Income Taxes	47	45	43	41	39	37	35	33	31	29	28	27	26
Income Taxes - Federal	9	9	9	8	8	7	7	6	6	6	6	5	5
Income Taxes - State	3	3	3	2	2	2	2	2	2	2	2	2	2
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	12	12	11	11	10	9	9	8	8	8	7	7	7
Preferred Dividends	1	1	1	1	1	0	0	0	0	0	0	0	0
Net Income for Common	35	33	32	30	28	27	25	24	22	21	20	20	19
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Distribution - Poles, Towers, and Fixtures

Manual input	26	27	28	29	30	31	32	33	34	35	36	37	38
O&M													
Escalation Rate	1.64	1.67	1.71	1.74	1.78	1.81	1.85	1.88	1.92	1.96	2.00	2.04	2.08
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%
Depreciation Expense	23	23	23	23	23	23	23	23	23	23	23	23	23
Accumulated Depreciation	568	591	614	636	659	682	705	727	750	773	795	818	841
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	568	591	614	636	659	682	705	727	750	773	795	818	841
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(432)	(409)	(386)	(364)	(341)	(318)	(295)	(273)	(250)	(227)	(205)	(182)	(159)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(111)	(105)	(99)	(94)	(88)	(82)	(76)	(70)	(64)	(59)	(53)	(47)	(41)
Deferred Tax Base	(23)	(23)	(23)	(23)	(23)	(23)	(23)	(23)	(23)	(23)	(23)	(23)	(23)
Deferred Taxes - Federal	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Change in Deferred Taxes	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)
Accumulated Deferred Taxes	111	105	99	94	88	82	76	70	64	59	53	47	41
check	-	0	0	0	0	0	0	0	0	0	0	0	0
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	568	591	614	636	659	682	705	727	750	773	795	818	841
Accumulated Deferred Taxes	111	105	99	94	88	82	76	70	64	59	53	47	41
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	321	304	287	270	253	236	219	202	186	169	152	135	118
Average Net Investment	329	312	295	278	262	245	228	211	194	177	160	143	127
Average Financing:													
Short Term Debt	2	2	2	2	2	1	1	1	1	1	1	1	1
Long Term Debt (Revenue Bonds)	134	127	120	113	106	99	92	86	79	72	65	58	51
Taxable Debt	3	2	2	2	2	2	2	2	2	1	1	1	1
Preferred Stock	4	4	3	3	3	3	3	2	2	2	2	2	1
Common Equity	187	177	168	158	149	139	129	120	110	101	91	82	72
Total Financing	329	312	295	278	262	245	228	211	194	177	160	143	127

Revenue Requirements Model - Calculati
Distribution - Poles, Towers, and Fixtures

Manual input	26	27	28	29	30	31	32	33	34	35	36	37	38
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	6	6	6	5	5	5	4	4	4	3	3	3	2
Hybrids	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Interest Expense	7	6	6	6	5	5	5	4	4	4	3	3	3
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	18	17	16	15	14	13	12	11	10	10	9	8	7
Income Taxes													
Income Before Pref Dividends	18	17	16	15	14	13	13	12	11	10	9	8	7
Income Before Taxes (including ITC)	24	23	22	21	19	18	17	16	14	13	12	11	9
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	24	23	22	21	19	18	17	16	14	13	12	11	9
Federal Income Tax	5	5	4	4	4	4	3	3	3	3	2	2	2
State Income Tax	1	1	1	1	1	1	1	1	1	1	1	1	1
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	1	1	1	1	1	1	1	1	1	1	1	1	1
Total Taxes	6	6	6	5	5	5	4	4	4	3	3	3	2
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0590**	**0.0572**	**0.0555**	**0.0538**	**0.0520**	**0.0503**	**0.0485**	**0.0468**	**0.0450**	**0.0433**	**0.0415**	**0.0398**	**0.0380**
Revenue Requirement	**59**	**57**	**56**	**54**	**52**	**50**	**49**	**47**	**45**	**43**	**42**	**40**	**38**
Revenue Taxes	5	5	5	5	5	4	4	4	4	4	4	4	3
Income Before Depr, Int, Inc Tax	54	52	51	49	47	46	44	43	41	39	38	36	35
Depreciation Expense	23	23	23	23	23	23	23	23	23	23	23	23	23
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	7	6	6	6	5	5	5	4	4	4	3	3	3
Income Before Income Taxes	24	23	22	21	19	18	17	16	14	13	12	11	9
Income Taxes - Federal	5	5	4	4	4	4	3	3	3	3	2	2	2
Income Taxes - State	1	1	1	1	1	1	1	1	1	1	1	1	1
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	6	6	6	5	5	5	4	4	4	3	3	3	2
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	18	17	16	15	14	13	12	11	10	10	9	8	7
	-	-	-	-	-	-	-	-	-	-	-	*(0)*	*(0)*

Resilience Project/Program
Revenue Requirements Model - Calculati
Distribution - Poles, Towers, and Fixtures

Manual input	39	40	41	42	43	44	45	46	47	48	49	50	51
O&M													
Escalation Rate	2.12	2.16	2.21	2.25	2.30	2.34	2.39	2.44	2.49	2.54	2.59	2.64	2.69
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Depreciation Expense	23	23	23	23	23	23	23	-	-	-	-	-	-
Accumulated Depreciation	864	886	909	932	955	977	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	864	886	909	932	955	977	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(136)	(114)	(91)	(68)	(45)	(23)	-	-	-	-	-	-	-
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(35)	(29)	(23)	(18)	(12)	(6)	-	-	-	-	-	-	-
Deferred Tax Base	(23)	(23)	(23)	(23)	(23)	(23)	(23)	-	-	-	-	-	-
Deferred Taxes - Federal	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-	-	-	-	-	-
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	(1)	(1)	(1)	-	-	-	-	-	-
Change in Deferred Taxes	(6)	(6)	(6)	(6)	(6)	(6)	(6)	-	-	-	-	-	-
Accumulated Deferred Taxes	35	29	23	18	12	6	0	0	0	0	0	0	0
check	0	0	0	0	0	0	0	0	0	0	0	0	0
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	864	886	909	932	955	977	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Deferred Taxes	35	29	23	18	12	6	0	0	0	0	0	0	0
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	101	84	67	51	34	17	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Average Net Investment	110	93	76	59	42	25	8	(0)	(0)	(0)	(0)	(0)	(0)
Average Financing:													
Short Term Debt	1	1	0	0	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)
Long Term Debt (Revenue Bonds)	45	38	31	24	17	10	3	(0)	(0)	(0)	(0)	(0)	(0)
Taxable Debt	1	1	1	0	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)
Preferred Stock	1	1	1	1	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)
Common Equity	62	53	43	34	24	14	5	(0)	(0)	(0)	(0)	(0)	(0)
Total Financing	110	93	76	59	42	25	8	(0)	(0)	(0)	(0)	(0)	(0)

Revenue Requirements Model - Calculati
Distribution - Poles, Towers, and Fixtures

Manual input	39	40	41	42	43	44	45	46	47	48	49	50	51
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)
Long Term Debt (Taxable Debt)	2	2	1	1	1	0	0	(0)	(0)	(0)	(0)	(0)	(0)
Hybrids	0	0	0	0	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)
Total Interest Expense	2	2	2	1	1	1	0	(0)	(0)	(0)	(0)	(0)	(0)
Preferred Dividends	0	0	0	0	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)
Net Income on Common	6	5	4	3	2	1	0	(0)	(0)	(0)	(0)	(0)	(0)
Income Taxes													
Income Before Pref Dividends	6	5	4	3	2	1	0	(0)	(0)	(0)	(0)	(0)	(0)
Income Before Taxes (including ITC)	8	7	6	4	3	2	1	(0)	(0)	(0)	(0)	(0)	(0)
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	8	7	6	4	3	2	1	(0)	(0)	(0)	(0)	(0)	(0)
Federal Income Tax	2	1	1	1	1	0	0	(0)	(0)	(0)	(0)	(0)	(0)
State Income Tax	0	0	0	0	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	0	0	0	0	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)
Total Taxes	2	2	1	1	1	0	0	(0)	(0)	(0)	(0)	(0)	(0)
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0363**	**0.0345**	**0.0328**	**0.0311**	**0.0293**	**0.0276**	**0.0258**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**
Revenue Requirement	**36**	**35**	**33**	**31**	**29**	**28**	**26**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**
Revenue Taxes	3	3	3	3	3	3	2	(0)	(0)	(0)	(0)	(0)	(0)
Income Before Depr, Int, Inc Tax	33	31	30	28	27	25	24	(0)	(0)	(0)	(0)	(0)	(0)
Depreciation Expense	23	23	23	23	23	23	23	-	-	-	-	-	-
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	2	2	2	1	1	1	0	(0)	(0)	(0)	(0)	(0)	(0)
Income Before Income Taxes	8	7	6	4	3	2	1	(0)	(0)	(0)	(0)	(0)	(0)
Income Taxes - Federal	2	1	1	1	1	0	0	(0)	(0)	(0)	(0)	(0)	(0)
Income Taxes - State	0	0	0	0	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	2	2	1	1	1	0	0	(0)	(0)	(0)	(0)	(0)	(0)
Preferred Dividends	0	0	0	0	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)
Net Income for Common	6	5	4	3	2	1	0	(0)	(0)	(0)	(0)	(0)	(0)
	(0)	-	-	-	*(0)*	*(0)*	*(0)*	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculatio
Distribution - Poles, Towers, and Fixtures

Manual input	52	53	54	55	56	57	58	59	60	Total
O&M										
Escalation Rate	2.75	2.80	2.86	2.91	2.97	3.03	3.09	3.15	3.22	
O&M	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation										
Book Depreciation										
Book Depreciation Rates	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Depreciation Expense	-	-	-	-	-	-	-	-	-	1,000
Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Tax Depreciation										
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	1,000
Tax Depreciation	-	-	-	-	-	-	-	-	-	1,000
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
State Investment Tax Credit (ITC)										
Book										
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	40
Accumulated Amortization	40	40	40	40	40	40	40	40	40	
Deferred ITC	-	-	-	-	-	-	-	-	-	
Tax										
Deferred Tax Calculation										
Book Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Book/Tax Acc Depr Difference	-	-	-	-	-	-	-	-	-	
Deferred ITC	-	-	-	-	-	-	-	-	-	
Net Deferred Tax Asset (Liability)	-	-	-	-	-	-	-	-	-	
Deferred Tax Base	-	-	-	-	-	-	-	-	-	
Deferred Taxes - Federal	-	-	-	-	-	-	-	-	-	
Deferred Taxes - State excluding credit	-	-	-	-	-	-	-	-	-	
Change in Deferred Taxes	-	-	-	-	-	-	-	-	-	
Accumulated Deferred Taxes	0	0	0	0	0	0	0	0	0	
check	0	0	0	0	0	0	0	0	0	
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	
	-	-	-	-	-	-	-	-	-	
Rate Base and Financing										
Investment: (Rate Base)										
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Accumulated Deferred Taxes	0	0	0	0	0	0	0	0	0	
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	
Ending Net Investment	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Average Net Investment	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Average Financing:										
Short Term Debt	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Long Term Debt (Revenue Bonds)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Taxable Debt	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Preferred Stock	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Common Equity	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Total Financing	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	

Revenue Requirements Model - Calculati
Distribution - Poles, Towers, and Fixtures

Manual input	52	53	54	55	56	57	58	59	60	Total
Return on Investment										
Short Term Debt	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Long Term Debt (Taxable Debt)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Hybrids	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Total Interest Expense	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Preferred Dividends	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Net Income on Common	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Taxes										
Income Before Pref Dividends	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Before Taxes (including ITC)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Investment Tax Credit	-	-	-	-	-	-	-	-	-	
Income Before Taxes (excluding ITC)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Federal Income Tax	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
State Income Tax	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	
Total State Tax	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Total Taxes	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Revenue Requirement Calculation										
Revenue Requirement Factors	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	
Revenue Requirement	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	
Revenue Taxes	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Before Depr, Int, Inc Tax	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Depreciation Expense	-	-	-	-	-	-	-	-	-	
O&M	-	-	-	-	-	-	-	-	-	
Interest Expense	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Before Income Taxes	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Taxes - Federal	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Taxes - State	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
State ITC	-	-	-	-	-	-	-	-	-	
Total Income Taxes	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Preferred Dividends	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Net Income for Common	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
	-	-	-	-	-	-	-	-	-	

Resilience Project/Program
Revenue Requirements Model - Calculations HL Distribution
Distribution - Overhead Conductors and Devices

		1	2	3	4	5	6	7	8	9	10	11	12
Manual input													
O&M													
Escalation Rate		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24
O&M		-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates		0.000%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%
Depreciation Expense		-	19	19	19	19	19	19	19	19	19	19	19
Accumulated Depreciation		-	19	38	58	77	96	115	135	154	173	192	212
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	**20**	2.500%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%
Tax Basis (S/L)	0.0%	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	**20**	3.750%	7.219%	6.677%	6.177%	5.713%	5.285%	4.888%	4.522%	4.462%	4.461%	4.462%	4.461%
NonRB Financed Tax Basis (MACRS)	100.0%	38	72	67	62	57	53	49	45	45	45	45	45
Tax Depreciation		38	72	67	62	57	53	49	45	45	45	45	45
Accumulated Tax Depreciation		38	110	176	238	295	348	397	442	487	532	576	621
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate		0.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	0.000%
Amortization of State ITC	4.00%	-	4	4	4	4	4	4	4	4	4	4	-
Accumulated Amortization		-	4	8	12	16	20	24	28	32	36	40	40
Deferred ITC		40	36	32	28	24	20	16	12	8	4	-	-
Tax		40											
Deferred Tax Calculation													
Book Accumulated Depreciation		-	19	38	58	77	96	115	135	154	173	192	212
Tax Accumulated Depreciation		38	110	176	238	295	348	397	442	487	532	576	621
Book/Tax Acc Depr Difference		(38)	(90)	(138)	(181)	(218)	(252)	(282)	(308)	(333)	(358)	(384)	(409)
Deferred ITC		40	36	32	28	24	20	16	12	8	4	-	-
Net Deferred Tax Asset (Liability)		1	(14)	(27)	(39)	(50)	(60)	(68)	(76)	(84)	(91)	(99)	(105)
Deferred Tax Base		(3)	57	52	47	42	38	34	30	29	29	29	25
Deferred Taxes - Federal		(0)	11	10	9	8	7	7	6	6	6	6	5
Deferred Taxes - State excluding credit		(0)	3	3	3	3	2	2	2	2	2	2	2
Change in Deferred Taxes		(1)	15	13	12	11	10	9	8	8	8	8	7
Accumulated Deferred Taxes		(1)	14	27	39	50	60	68	76	84	91	99	105
check		-	-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC		40	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
		40	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant		1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation		-	19	38	58	77	96	115	135	154	173	192	212
Accumulated Deferred Taxes		(1)	14	27	39	50	60	68	76	84	91	99	105
Accumulated Deferred ITC		40	36	32	28	24	20	16	12	8	4	-	-
Ending Net Investment	1,000	961	931	902	875	849	824	800	777	754	732	709	683
Average Net Investment		-	946	916	889	862	837	812	789	766	743	720	696
Average Financing:													
Short Term Debt	0.61%	-	6	6	5	5	5	5	5	5	5	4	4
Long Term Debt (Revenue Bonds)	40.59%	-	384	372	361	350	340	330	320	311	302	292	283
Taxable Debt	0.80%	-	8	7	7	7	7	6	6	6	6	6	6
Preferred Stock	1.17%	-	11	11	10	10	10	9	9	9	9	8	8
Common Equity	56.83%	-	537	521	505	490	475	462	448	435	422	409	396
Total Financing		-	946	916	889	862	837	812	789	766	743	720	696

Revenue Requirements Model - Calculations HL Distribution
Distribution - Overhead Conductors and Devices

Manual input		1	2	3	4	5	6	7	8	9	10	11	12
Return on Investment													
Short Term Debt	3.75%	-	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	4.79%	-	18	18	17	17	16	16	15	15	14	14	14
Hybrids	7.83%	-	1	1	1	1	1	1	0	0	0	0	0
Total Interest Expense		-	19	19	18	17	17	16	16	16	15	15	14
Preferred Dividends	8.12%	-	1	1	1	1	1	1	1	1	1	1	1
Net Income on Common	9.50%	-	51	49	48	47	45	44	43	41	40	39	38
Income Taxes													
Income Before Pref Dividends		-	52	50	49	47	46	45	43	42	41	40	38
Income Before Taxes (including ITC)		-	70	68	66	64	62	60	58	57	55	53	51
Investment Tax Credit		-	4	4	4	4	4	4	4	4	4	4	-
Income Before Taxes (excluding ITC)		-	66	64	62	60	58	56	54	53	51	49	51
Federal Income Tax		-	14	13	13	13	12	12	12	11	11	11	10
State Income Tax		-	4	4	4	4	4	4	4	3	3	3	3
State Investment Tax Credit		-	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
Total State Tax		-	0	0	(0)	(0)	(0)	(0)	(0)	(1)	(1)	(1)	3
Total Taxes		-	14	13	13	12	12	11	11	11	10	10	13
Revenue Requirement Calculation													
Revenue Requirement Factors		**-**	**0.1146**	**0.1116**	**0.1087**	**0.1059**	**0.1033**	**0.1008**	**0.0983**	**0.0960**	**0.0936**	**0.0913**	**0.0931**
Revenue Requirement		**-**	**115**	**112**	**109**	**106**	**103**	**101**	**98**	**96**	**94**	**91**	**93**
Revenue Taxes		-	10	10	10	9	9	9	9	9	8	8	8
Income Before Depr, Int, Inc Tax		-	104	102	99	97	94	92	90	87	85	83	85
Depreciation Expense		-	19	19	19	19	19	19	19	19	19	19	19
O&M		-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense		-	19	19	18	17	17	16	16	16	15	15	14
Income Before Income Taxes		-	66	64	62	60	58	56	54	53	51	49	51
Income Taxes - Federal		-	14	13	13	13	12	12	12	11	11	11	10
Income Taxes - State		-	4	4	4	4	4	4	4	3	3	3	3
State ITC		-	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
Total Income Taxes		-	14	13	13	12	12	11	11	11	10	10	13
Preferred Dividends		-	1	1	1	1	1	1	1	1	1	1	1
Net Income for Common		-	51	49	48	47	45	44	43	41	40	39	38
	check	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Distribution - Overhead Conductors and I

Manual input	13	14	15	16	17	18	19	20	21	22	23	24	25
O&M													
Escalation Rate	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46	1.49	1.52	1.55	1.58	1.61
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
Accumulated Depreciation	231	250	269	288	308	327	346	365	385	404	423	442	462
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	2.500%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	4.462%	4.461%	4.462%	4.461%	4.462%	4.461%	4.462%	4.461%	2.231%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	45	45	45	45	45	45	45	45	22	-	-	-	-
Tax Depreciation	45	45	45	45	45	45	45	45	22	-	-	-	-
Accumulated Tax Depreciation	665	710	755	799	844	888	933	978	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	231	250	269	288	308	327	346	365	385	404	423	442	462
Tax Accumulated Depreciation	665	710	755	799	844	888	933	978	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(435)	(460)	(485)	(511)	(536)	(562)	(587)	(612)	(615)	(596)	(577)	(558)	(538)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(112)	(118)	(125)	(132)	(138)	(145)	(151)	(158)	(158)	(154)	(149)	(144)	(139)
Deferred Tax Base	25	25	25	25	25	25	25	25	3	(19)	(19)	(19)	(19)
Deferred Taxes - Federal	5	5	5	5	5	5	5	5	1	(4)	(4)	(4)	(4)
Deferred Taxes - State excluding credit	2	2	2	2	2	2	2	2	0	(1)	(1)	(1)	(1)
Change in Deferred Taxes	7	7	7	7	7	7	7	7	1	(5)	(5)	(5)	(5)
Accumulated Deferred Taxes	112	118	125	132	138	145	151	158	158	154	149	144	139
check	-	-	-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	231	250	269	288	308	327	346	365	385	404	423	442	462
Accumulated Deferred Taxes	112	118	125	132	138	145	151	158	158	154	149	144	139
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	657	632	606	580	554	528	503	477	457	443	428	414	400
Average Net Investment	670	644	619	593	567	541	516	490	467	450	435	421	407
Average Financing:													
Short Term Debt	4	4	4	4	3	3	3	3	3	3	3	3	2
Long Term Debt (Revenue Bonds)	272	262	251	241	230	220	209	199	190	183	177	171	165
Taxable Debt	5	5	5	5	5	4	4	4	4	4	3	3	3
Preferred Stock	8	8	7	7	7	6	6	6	5	5	5	5	5
Common Equity	381	366	352	337	322	308	293	278	265	256	247	239	231
Total Financing	670	644	619	593	567	541	516	490	467	450	435	421	407

Revenue Requirements Model - Calculati
Distribution - Overhead Conductors and I

Manual input	13	14	15	16	17	18	19	20	21	22	23	24	25
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	13	13	12	12	11	11	10	10	9	9	8	8	8
Hybrids	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Interest Expense	14	13	13	12	12	11	10	10	9	9	9	9	8
Preferred Dividends	1	1	1	1	1	1	0	0	0	0	0	0	0
Net Income on Common	36	35	33	32	31	29	28	26	25	24	24	23	22
Income Taxes													
Income Before Pref Dividends	37	35	34	33	31	30	28	27	26	25	24	23	22
Income Before Taxes (including ITC)	50	48	46	44	42	40	38	36	35	33	32	31	30
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	50	48	46	44	42	40	38	36	35	33	32	31	30
Federal Income Tax	10	9	9	9	8	8	8	7	7	7	6	6	6
State Income Tax	3	3	3	3	3	2	2	2	2	2	2	2	2
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	3	3	3	3	3	2	2	2	2	2	2	2	2
Total Taxes	13	12	12	11	11	10	10	9	9	9	8	8	8
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0905**	**0.0878**	**0.0851**	**0.0825**	**0.0798**	**0.0771**	**0.0745**	**0.0718**	**0.0694**	**0.0677**	**0.0662**	**0.0647**	**0.0632**
Revenue Requirement	**90**	**88**	**85**	**82**	**80**	**77**	**74**	**72**	**69**	**68**	**66**	**65**	**63**
Revenue Taxes	8	8	8	7	7	7	7	6	6	6	6	6	6
Income Before Depr, Int, Inc Tax	82	80	78	75	73	70	68	65	63	62	60	59	58
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	14	13	13	12	12	11	10	10	9	9	9	9	8
Income Before Income Taxes	50	48	46	44	42	40	38	36	35	33	32	31	30
Income Taxes - Federal	10	9	9	9	8	8	8	7	7	7	6	6	6
Income Taxes - State	3	3	3	3	3	2	2	2	2	2	2	2	2
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	13	12	12	11	11	10	10	9	9	9	8	8	8
Preferred Dividends	1	1	1	1	1	1	0	0	0	0	0	0	0
Net Income for Common	36	35	33	32	31	29	28	26	25	24	24	23	22
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Distribution - Overhead Conductors and I

Manual input	26	27	28	29	30	31	32	33	34	35	36	37	38
O&M													
Escalation Rate	1.64	1.67	1.71	1.74	1.78	1.81	1.85	1.88	1.92	1.96	2.00	2.04	2.08
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
Accumulated Depreciation	481	500	519	538	558	577	596	615	635	654	673	692	712
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	481	500	519	538	558	577	596	615	635	654	673	692	712
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(519)	(500)	(481)	(462)	(442)	(423)	(404)	(385)	(365)	(346)	(327)	(308)	(288)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(134)	(129)	(124)	(119)	(114)	(109)	(104)	(99)	(94)	(89)	(84)	(79)	(74)
Deferred Tax Base	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)
Deferred Taxes - Federal	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Change in Deferred Taxes	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Accumulated Deferred Taxes	134	129	124	119	114	109	104	99	94	89	84	79	74
check	-	-	-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	481	500	519	538	558	577	596	615	635	654	673	692	712
Accumulated Deferred Taxes	134	129	124	119	114	109	104	99	94	89	84	79	74
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	386	371	357	343	328	314	300	286	271	257	243	228	214
Average Net Investment	393	378	364	350	336	321	307	293	278	264	250	236	221
Average Financing:													
Short Term Debt	2	2	2	2	2	2	2	2	2	2	2	1	1
Long Term Debt (Revenue Bonds)	159	154	148	142	136	130	125	119	113	107	101	96	90
Taxable Debt	3	3	3	3	3	3	2	2	2	2	2	2	2
Preferred Stock	5	4	4	4	4	4	4	3	3	3	3	3	3
Common Equity	223	215	207	199	191	183	174	166	158	150	142	134	126
Total Financing	393	378	364	350	336	321	307	293	278	264	250	236	221

Revenue Requirements Model - Calculati
Distribution - Overhead Conductors and I

Manual input	26	27	28	29	30	31	32	33	34	35	36	37	38
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	8	7	7	7	7	6	6	6	5	5	5	5	4
Hybrids	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Interest Expense	8	8	7	7	7	7	6	6	6	5	5	5	4
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	21	20	20	19	18	17	17	16	15	14	13	13	12
Income Taxes													
Income Before Pref Dividends	22	21	20	19	18	18	17	16	15	15	14	13	12
Income Before Taxes (including ITC)	29	28	27	26	25	24	23	22	21	20	18	17	16
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	29	28	27	26	25	24	23	22	21	20	18	17	16
Federal Income Tax	6	6	5	5	5	5	4	4	4	4	4	3	3
State Income Tax	2	2	2	2	1	1	1	1	1	1	1	1	1
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	2	2	2	2	1	1	1	1	1	1	1	1	1
Total Taxes	7	7	7	7	6	6	6	6	5	5	5	4	4
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0617**	**0.0603**	**0.0588**	**0.0573**	**0.0558**	**0.0544**	**0.0529**	**0.0514**	**0.0499**	**0.0484**	**0.0470**	**0.0455**	**0.0440**
Revenue Requirement	**62**	**60**	**59**	**57**	**56**	**54**	**53**	**51**	**50**	**48**	**47**	**45**	**44**
Revenue Taxes	5	5	5	5	5	5	5	5	4	4	4	4	4
Income Before Depr, Int, Inc Tax	56	55	54	52	51	50	48	47	45	44	43	41	40
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	8	8	7	7	7	7	6	6	6	5	5	5	4
Income Before Income Taxes	29	28	27	26	25	24	23	22	21	20	18	17	16
Income Taxes - Federal	6	6	5	5	5	5	4	4	4	4	4	3	3
Income Taxes - State	2	2	2	2	1	1	1	1	1	1	1	1	1
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	7	7	7	7	6	6	6	6	5	5	5	4	4
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	21	20	20	19	18	17	17	16	15	14	13	13	12
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Distribution - Overhead Conductors and I

Manual input	39	40	41	42	43	44	45	46	47	48	49	50	51
O&M													
Escalation Rate	2.12	2.16	2.21	2.25	2.30	2.34	2.39	2.44	2.49	2.54	2.59	2.64	2.69
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
Accumulated Depreciation	731	750	769	788	808	827	846	865	885	904	923	942	962
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	731	750	769	788	808	827	846	865	885	904	923	942	962
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(269)	(250)	(231)	(212)	(192)	(173)	(154)	(135)	(115)	(96)	(77)	(58)	(38)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(69)	(64)	(59)	(54)	(50)	(45)	(40)	(35)	(30)	(25)	(20)	(15)	(10)
Deferred Tax Base	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)
Deferred Taxes - Federal	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Change in Deferred Taxes	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Accumulated Deferred Taxes	69	64	59	54	50	45	40	35	30	25	20	15	10
check	-	-	0	0	0	0	0	0	0	0	0	0	0
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	731	750	769	788	808	827	846	865	885	904	923	942	962
Accumulated Deferred Taxes	69	64	59	54	50	45	40	35	30	25	20	15	10
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	200	186	171	157	143	129	114	100	86	71	57	43	29
Average Net Investment	207	193	178	164	150	136	121	107	93	79	64	50	36
Average Financing:													
Short Term Debt	1	1	1	1	1	1	1	1	1	0	0	0	0
Long Term Debt (Revenue Bonds)	84	78	72	67	61	55	49	43	38	32	26	20	14
Taxable Debt	2	2	1	1	1	1	1	1	1	1	1	0	0
Preferred Stock	2	2	2	2	2	2	1	1	1	1	1	1	0
Common Equity	118	110	101	93	85	77	69	61	53	45	37	28	20
Total Financing	207	193	178	164	150	136	121	107	93	79	64	50	36

Revenue Requirements Model - Calculati
Distribution - Overhead Conductors and I

Manual input	39	40	41	42	43	44	45	46	47	48	49	50	51
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	4	4	3	3	3	3	2	2	2	2	1	1	1
Hybrids	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Interest Expense	4	4	4	3	3	3	2	2	2	2	1	1	1
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	11	10	10	9	8	7	7	6	5	4	3	3	2
Income Taxes													
Income Before Pref Dividends	11	11	10	9	8	7	7	6	5	4	4	3	2
Income Before Taxes (including ITC)	15	14	13	12	11	10	9	8	7	6	5	4	3
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	15	14	13	12	11	10	9	8	7	6	5	4	3
Federal Income Tax	3	3	3	2	2	2	2	2	1	1	1	1	1
State Income Tax	1	1	1	1	1	1	1	0	0	0	0	0	0
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	1	1	1	1	1	1	1	0	0	0	0	0	0
Total Taxes	4	4	3	3	3	3	2	2	2	1	1	1	1
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0425**	**0.0411**	**0.0396**	**0.0381**	**0.0366**	**0.0351**	**0.0337**	**0.0322**	**0.0307**	**0.0292**	**0.0278**	**0.0263**	**0.0248**
Revenue Requirement	**43**	**41**	**40**	**38**	**37**	**35**	**34**	**32**	**31**	**29**	**28**	**26**	**25**
Revenue Taxes	4	4	4	3	3	3	3	3	3	3	2	2	2
Income Before Depr, Int, Inc Tax	39	37	36	35	33	32	31	29	28	27	25	24	23
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	4	4	4	3	3	3	2	2	2	2	1	1	1
Income Before Income Taxes	15	14	13	12	11	10	9	8	7	6	5	4	3
Income Taxes - Federal	3	3	3	2	2	2	2	2	1	1	1	1	1
Income Taxes - State	1	1	1	1	1	1	1	0	0	0	0	0	0
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	4	4	3	3	3	3	2	2	2	1	1	1	1
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	11	10	10	9	8	7	7	6	5	4	3	3	2
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculatio
Distribution - Overhead Conductors and I

Manual input	52	53	54	55	56	57	58	59	60	Total
O&M										
Escalation Rate	2.75	2.80	2.86	2.91	2.97	3.03	3.09	3.15	3.22	
O&M	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation										
Book Depreciation										
Book Depreciation Rates	1.923%	1.923%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Depreciation Expense	19	19	-	-	-	-	-	-	-	1,000
Accumulated Depreciation	981	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Tax Depreciation										
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	1,000
Tax Depreciation	-	-	-	-	-	-	-	-	-	1,000
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
State Investment Tax Credit (ITC)										
Book										
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	40
Accumulated Amortization	40	40	40	40	40	40	40	40	40	
Deferred ITC	-	-	-	-	-	-	-	-	-	
Tax										
Deferred Tax Calculation										
Book Accumulated Depreciation	981	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Book/Tax Acc Depr Difference	(19)	0	0	0	0	0	0	0	0	
Deferred ITC	-	-	-	-	-	-	-	-	-	
Net Deferred Tax Asset (Liability)	(5)	0	0	0	0	0	0	0	0	
Deferred Tax Base	(19)	(19)	-	-	-	-	-	-	-	
Deferred Taxes - Federal	(4)	(4)	-	-	-	-	-	-	-	
Deferred Taxes - State excluding credit	(1)	(1)	-	-	-	-	-	-	-	
Change in Deferred Taxes	(5)	(5)	-	-	-	-	-	-	-	
Accumulated Deferred Taxes	5	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
check	0	0	0	0	0	0	0	0	0	
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	
	-	-	-	-	-	-	-	-	-	
Rate Base and Financing										
Investment: (Rate Base)										
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Accumulated Depreciation	981	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Accumulated Deferred Taxes	5	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	
Ending Net Investment	14	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Average Net Investment	21	7	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Average Financing:										
Short Term Debt	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Long Term Debt (Revenue Bonds)	9	3	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Taxable Debt	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Preferred Stock	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Common Equity	12	4	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Total Financing	21	7	(0)	(0)	(0)	(0)	(0)	(0)	(0)	

Revenue Requirements Model - Calculati
Distribution - Overhead Conductors and I

Manual input	52	53	54	55	56	57	58	59	60	Total
Return on Investment										
Short Term Debt	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Long Term Debt (Taxable Debt)	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Hybrids	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Total Interest Expense	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Preferred Dividends	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Net Income on Common	1	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Taxes										
Income Before Pref Dividends	1	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Before Taxes (including ITC)	2	1	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Investment Tax Credit	-	-	-	-	-	-	-	-	-	
Income Before Taxes (excluding ITC)	2	1	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Federal Income Tax	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
State Income Tax	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	
Total State Tax	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Total Taxes	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Revenue Requirement Calculation										
Revenue Requirement Factors	**0.0233**	**0.0218**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	
Revenue Requirement	**23**	**22**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	
Revenue Taxes	2	2	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Before Depr, Int, Inc Tax	21	20	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Depreciation Expense	19	19	-	-	-	-	-	-	-	
O&M	-	-	-	-	-	-	-	-	-	
Interest Expense	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Before Income Taxes	2	1	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Taxes - Federal	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Taxes - State	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
State ITC	-	-	-	-	-	-	-	-	-	
Total Income Taxes	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Preferred Dividends	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Net Income for Common	1	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
	-	*(0)*	-	-	-	-	-	-	-	

Resilience Project/Program
Revenue Requirements Model - Calculations HL Distribution
Distribution - Station Equipment - Substations

		1	2	3	4	5	6	7	8	9	10	11	12
Manual input													
O&M													
Escalation Rate		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24
O&M		-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates		0.000%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%
Depreciation Expense		-	19	19	19	19	19	19	19	19	19	19	19
Accumulated Depreciation		-	19	37	56	74	93	111	130	148	167	185	204
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	**20**	2.500%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%
Tax Basis (S/L)	0.0%	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	**20**	3.750%	7.219%	6.677%	6.177%	5.713%	5.285%	4.888%	4.522%	4.462%	4.461%	4.462%	4.461%
NonRB Financed Tax Basis (MACRS)	100.0%	38	72	67	62	57	53	49	45	45	45	45	45
Tax Depreciation		38	72	67	62	57	53	49	45	45	45	45	45
Accumulated Tax Depreciation		38	110	176	238	295	348	397	442	487	532	576	621
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate		0.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	0.000%
Amortization of State ITC	4.00%	-	4	4	4	4	4	4	4	4	4	4	-
Accumulated Amortization		-	4	8	12	16	20	24	28	32	36	40	40
Deferred ITC		40	36	32	28	24	20	16	12	8	4	-	-
Tax		40											
Deferred Tax Calculation													
Book Accumulated Depreciation		-	19	37	56	74	93	111	130	148	167	185	204
Tax Accumulated Depreciation		38	110	176	238	295	348	397	442	487	532	576	621
Book/Tax Acc Depr Difference		(38)	(91)	(139)	(183)	(221)	(256)	(286)	(313)	(339)	(365)	(391)	(417)
Deferred ITC		40	36	32	28	24	20	16	12	8	4	-	-
Net Deferred Tax Asset (Liability)		1	(14)	(28)	(40)	(51)	(61)	(70)	(77)	(85)	(93)	(101)	(107)
Deferred Tax Base		(3)	58	52	47	43	38	34	31	30	30	30	26
Deferred Taxes - Federal		(0)	11	10	9	8	8	7	6	6	6	6	5
Deferred Taxes - State excluding credit		(0)	3	3	3	3	2	2	2	2	2	2	2
Change in Deferred Taxes		(1)	15	13	12	11	10	9	8	8	8	8	7
Accumulated Deferred Taxes		(1)	14	28	40	51	61	70	77	85	93	101	107
	check	-	-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC		40	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
		40	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant		1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation		-	19	37	56	74	93	111	130	148	167	185	204
Accumulated Deferred Taxes		(1)	14	28	40	51	61	70	77	85	93	101	107
Accumulated Deferred ITC		40	36	32	28	24	20	16	12	8	4	-	-
Ending Net Investment	1,000	961	931	903	877	851	827	803	781	759	736	714	689
Average Net Investment		-	946	917	890	864	839	815	792	770	748	725	702
Average Financing:													
Short Term Debt	0.61%	-	6	6	5	5	5	5	5	5	5	4	4
Long Term Debt (Revenue Bonds)	40.59%	-	384	372	361	351	341	331	322	312	303	294	285
Taxable Debt	0.80%	-	8	7	7	7	7	7	6	6	6	6	6
Preferred Stock	1.17%	-	11	11	10	10	10	10	9	9	9	8	8
Common Equity	56.83%	-	538	521	506	491	477	463	450	437	425	412	399
Total Financing		-	946	917	890	864	839	815	792	770	748	725	702

Revenue Requirements Model - Calculations HL Distribution
Distribution - Station Equipment - Substations

Manual input		1	2	3	4	5	6	7	8	9	10	11	12
Return on Investment													
Short Term Debt	3.75%	-	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	4.79%	-	18	18	17	17	16	16	15	15	15	14	14
Hybrids	7.83%	-	1	1	1	1	1	1	0	0	0	0	0
Total Interest Expense		-	19	19	18	18	17	17	16	16	15	15	14
Preferred Dividends	8.12%	-	1	1	1	1	1	1	1	1	1	1	1
Net Income on Common	9.50%	-	51	50	48	47	45	44	43	42	40	39	38
Income Taxes													
Income Before Pref Dividends		-	52	50	49	47	46	45	44	42	41	40	39
Income Before Taxes (including ITC)		-	70	68	66	64	62	60	59	57	55	54	52
Investment Tax Credit		-	4	4	4	4	4	4	4	4	4	4	-
Income Before Taxes (excluding ITC)		-	66	64	62	60	58	56	55	53	51	50	52
Federal Income Tax		-	14	13	13	13	12	12	12	11	11	11	10
State Income Tax		-	4	4	4	4	4	4	4	3	3	3	3
State Investment Tax Credit		-	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
Total State Tax		-	0	0	(0)	(0)	(0)	(0)	(0)	(1)	(1)	(1)	3
Total Taxes		-	14	13	13	12	12	12	11	11	10	10	13
Revenue Requirement Calculation													
Revenue Requirement Factors		**-**	**0.1138**	**0.1109**	**0.1080**	**0.1053**	**0.1028**	**0.1003**	**0.0979**	**0.0956**	**0.0933**	**0.0910**	**0.0929**
Revenue Requirement		**-**	**114**	**111**	**108**	**105**	**103**	**100**	**98**	**96**	**93**	**91**	**93**
Revenue Taxes		-	10	10	10	9	9	9	9	8	8	8	8
Income Before Depr, Int, Inc Tax		-	104	101	98	96	94	91	89	87	85	83	85
Depreciation Expense		-	19	19	19	19	19	19	19	19	19	19	19
O&M		-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense		-	19	19	18	18	17	17	16	16	15	15	14
Income Before Income Taxes		-	66	64	62	60	58	56	55	53	51	50	52
Income Taxes - Federal		-	14	13	13	13	12	12	12	11	11	11	10
Income Taxes - State		-	4	4	4	4	4	4	4	3	3	3	3
State ITC		-	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
Total Income Taxes		-	14	13	13	12	12	12	11	11	10	10	13
Preferred Dividends		-	1	1	1	1	1	1	1	1	1	1	1
Net Income for Common		-	51	50	48	47	45	44	43	42	40	39	38
check		-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Distribution - Station Equipment - Substa

Manual input	13	14	15	16	17	18	19	20	21	22	23	24	25
O&M													
Escalation Rate	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46	1.49	1.52	1.55	1.58	1.61
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
Accumulated Depreciation	222	241	259	278	296	315	333	352	370	389	407	426	444
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	2.500%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	4.462%	4.461%	4.462%	4.461%	4.462%	4.461%	4.462%	4.461%	2.231%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	45	45	45	45	45	45	45	45	22	-	-	-	-
Tax Depreciation	45	45	45	45	45	45	45	45	22	-	-	-	-
Accumulated Tax Depreciation	665	710	755	799	844	888	933	978	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	222	241	259	278	296	315	333	352	370	389	407	426	444
Tax Accumulated Depreciation	665	710	755	799	844	888	933	978	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(443)	(469)	(495)	(521)	(548)	(574)	(600)	(626)	(630)	(611)	(593)	(574)	(556)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(114)	(121)	(128)	(134)	(141)	(148)	(154)	(161)	(162)	(157)	(153)	(148)	(143)
Deferred Tax Base	26	26	26	26	26	26	26	26	4	(19)	(19)	(19)	(19)
Deferred Taxes - Federal	5	5	5	5	5	5	5	5	1	(4)	(4)	(4)	(4)
Deferred Taxes - State excluding credit	2	2	2	2	2	2	2	2	0	(1)	(1)	(1)	(1)
Change in Deferred Taxes	7	7	7	7	7	7	7	7	1	(5)	(5)	(5)	(5)
Accumulated Deferred Taxes	114	121	128	134	141	148	154	161	162	157	153	148	143
check	-	-	-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	222	241	259	278	296	315	333	352	370	389	407	426	444
Accumulated Deferred Taxes	114	121	128	134	141	148	154	161	162	157	153	148	143
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	664	638	613	588	563	537	512	487	467	454	440	426	412
Average Net Investment	676	651	626	601	575	550	525	500	477	461	447	433	419
Average Financing:													
Short Term Debt	4	4	4	4	4	3	3	3	3	3	3	3	3
Long Term Debt (Revenue Bonds)	275	264	254	244	234	223	213	203	194	187	181	176	170
Taxable Debt	5	5	5	5	5	4	4	4	4	4	4	3	3
Preferred Stock	8	8	7	7	7	6	6	6	6	5	5	5	5
Common Equity	384	370	356	341	327	313	298	284	271	262	254	246	238
Total Financing	676	651	626	601	575	550	525	500	477	461	447	433	419

Revenue Requirements Model - Calculati
Distribution - Station Equipment - Substa

Manual input	13	14	15	16	17	18	19	20	21	22	23	24	25
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	13	13	12	12	11	11	10	10	9	9	9	8	8
Hybrids	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Interest Expense	14	13	13	12	12	11	11	10	10	9	9	9	9
Preferred Dividends	1	1	1	1	1	1	0	0	0	0	0	0	0
Net Income on Common	37	35	34	32	31	30	28	27	26	25	24	23	23
Income Taxes													
Income Before Pref Dividends	37	36	34	33	32	30	29	27	26	25	25	24	23
Income Before Taxes (including ITC)	50	48	46	44	43	41	39	37	35	34	33	32	31
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	50	48	46	44	43	41	39	37	35	34	33	32	31
Federal Income Tax	10	10	9	9	8	8	8	7	7	7	7	6	6
State Income Tax	3	3	3	3	3	2	2	2	2	2	2	2	2
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	3	3	3	3	3	2	2	2	2	2	2	2	2
Total Taxes	13	12	12	11	11	10	10	10	9	9	9	8	8
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0903**	**0.0877**	**0.0851**	**0.0825**	**0.0799**	**0.0772**	**0.0746**	**0.0720**	**0.0697**	**0.0680**	**0.0666**	**0.0651**	**0.0637**
Revenue Requirement	**90**	**88**	**85**	**82**	**80**	**77**	**75**	**72**	**70**	**68**	**67**	**65**	**64**
Revenue Taxes	8	8	8	7	7	7	7	6	6	6	6	6	6
Income Before Depr, Int, Inc Tax	82	80	78	75	73	70	68	66	64	62	61	59	58
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	14	13	13	12	12	11	11	10	10	9	9	9	9
Income Before Income Taxes	50	48	46	44	43	41	39	37	35	34	33	32	31
Income Taxes - Federal	10	10	9	9	8	8	8	7	7	7	7	6	6
Income Taxes - State	3	3	3	3	3	2	2	2	2	2	2	2	2
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	13	12	12	11	11	10	10	10	9	9	9	8	8
Preferred Dividends	1	1	1	1	1	1	0	0	0	0	0	0	0
Net Income for Common	37	35	34	32	31	30	28	27	26	25	24	23	23
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
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Manual input	26	27	28	29	30	31	32	33	34	35	36	37	38
O&M													
Escalation Rate	1.64	1.67	1.71	1.74	1.78	1.81	1.85	1.88	1.92	1.96	2.00	2.04	2.08
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
Accumulated Depreciation	463	481	500	519	537	556	574	593	611	630	648	667	685
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	463	481	500	519	537	556	574	593	611	630	648	667	685
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(537)	(519)	(500)	(481)	(463)	(444)	(426)	(407)	(389)	(370)	(352)	(333)	(315)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(138)	(134)	(129)	(124)	(119)	(114)	(110)	(105)	(100)	(95)	(91)	(86)	(81)
Deferred Tax Base	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)
Deferred Taxes - Federal	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Change in Deferred Taxes	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Accumulated Deferred Taxes	138	134	129	124	119	114	110	105	100	95	91	86	81
check	-	-	-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	463	481	500	519	537	556	574	593	611	630	648	667	685
Accumulated Deferred Taxes	138	134	129	124	119	114	110	105	100	95	91	86	81
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	399	385	371	357	344	330	316	302	289	275	261	247	234
Average Net Investment	406	392	378	364	351	337	323	309	296	282	268	254	241
Average Financing:													
Short Term Debt	2	2	2	2	2	2	2	2	2	2	2	2	1
Long Term Debt (Revenue Bonds)	165	159	153	148	142	137	131	126	120	114	109	103	98
Taxable Debt	3	3	3	3	3	3	3	2	2	2	2	2	2
Preferred Stock	5	5	4	4	4	4	4	4	3	3	3	3	3
Common Equity	231	223	215	207	199	191	184	176	168	160	152	145	137
Total Financing	406	392	378	364	351	337	323	309	296	282	268	254	241

Revenue Requirements Model - Calculati
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Manual input	26	27	28	29	30	31	32	33	34	35	36	37	38
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	8	8	7	7	7	7	6	6	6	5	5	5	5
Hybrids	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Interest Expense	8	8	8	7	7	7	7	6	6	6	5	5	5
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	22	21	20	20	19	18	17	17	16	15	14	14	13
Income Taxes													
Income Before Pref Dividends	22	22	21	20	19	19	18	17	16	15	15	14	13
Income Before Taxes (including ITC)	30	29	28	27	26	25	24	23	22	21	20	19	18
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	30	29	28	27	26	25	24	23	22	21	20	19	18
Federal Income Tax	6	6	6	5	5	5	5	5	4	4	4	4	4
State Income Tax	2	2	2	2	2	1	1	1	1	1	1	1	1
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	2	2	2	2	2	1	1	1	1	1	1	1	1
Total Taxes	8	7	7	7	7	6	6	6	6	5	5	5	5
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0623**	**0.0609**	**0.0595**	**0.0580**	**0.0566**	**0.0552**	**0.0538**	**0.0523**	**0.0509**	**0.0495**	**0.0481**	**0.0466**	**0.0452**
Revenue Requirement	**62**	**61**	**59**	**58**	**57**	**55**	**54**	**52**	**51**	**49**	**48**	**47**	**45**
Revenue Taxes	6	5	5	5	5	5	5	5	5	4	4	4	4
Income Before Depr, Int, Inc Tax	57	55	54	53	52	50	49	48	46	45	44	43	41
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	8	8	8	7	7	7	7	6	6	6	5	5	5
Income Before Income Taxes	30	29	28	27	26	25	24	23	22	21	20	19	18
Income Taxes - Federal	6	6	6	5	5	5	5	5	4	4	4	4	4
Income Taxes - State	2	2	2	2	2	1	1	1	1	1	1	1	1
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	8	7	7	7	7	6	6	6	6	5	5	5	5
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	22	21	20	20	19	18	17	17	16	15	14	14	13
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
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Manual input	39	40	41	42	43	44	45	46	47	48	49	50	51
O&M													
Escalation Rate	2.12	2.16	2.21	2.25	2.30	2.34	2.39	2.44	2.49	2.54	2.59	2.64	2.69
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
Accumulated Depreciation	704	722	741	759	778	796	815	833	852	870	889	907	926
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	704	722	741	759	778	796	815	833	852	870	889	907	926
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(296)	(278)	(259)	(241)	(222)	(204)	(185)	(167)	(148)	(130)	(111)	(93)	(74)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(76)	(72)	(67)	(62)	(57)	(52)	(48)	(43)	(38)	(33)	(29)	(24)	(19)
Deferred Tax Base	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)
Deferred Taxes - Federal	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Change in Deferred Taxes	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Accumulated Deferred Taxes	76	72	67	62	57	52	48	43	38	33	29	24	19
check	-	-	-	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	704	722	741	759	778	796	815	833	852	870	889	907	926
Accumulated Deferred Taxes	76	72	67	62	57	52	48	43	38	33	29	24	19
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	220	206	192	179	165	151	137	124	110	96	82	69	55
Average Net Investment	227	213	199	186	172	158	144	131	117	103	89	76	62
Average Financing:													
Short Term Debt	1	1	1	1	1	1	1	1	1	1	1	0	0
Long Term Debt (Revenue Bonds)	92	87	81	75	70	64	59	53	47	42	36	31	25
Taxable Debt	2	2	2	1	1	1	1	1	1	1	1	1	0
Preferred Stock	3	2	2	2	2	2	2	2	1	1	1	1	1
Common Equity	129	121	113	105	98	90	82	74	66	59	51	43	35
Total Financing	227	213	199	186	172	158	144	131	117	103	89	76	62

Revenue Requirements Model - Calculati
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Manual input	39	40	41	42	43	44	45	46	47	48	49	50	51
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	4	4	4	4	3	3	3	3	2	2	2	1	1
Hybrids	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Interest Expense	5	4	4	4	3	3	3	3	2	2	2	2	1
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	12	12	11	10	9	9	8	7	6	6	5	4	3
Income Taxes													
Income Before Pref Dividends	12	12	11	10	9	9	8	7	6	6	5	4	3
Income Before Taxes (including ITC)	17	16	15	14	13	12	11	10	9	8	7	6	5
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	17	16	15	14	13	12	11	10	9	8	7	6	5
Federal Income Tax	3	3	3	3	3	2	2	2	2	2	1	1	1
State Income Tax	1	1	1	1	1	1	1	1	1	0	0	0	0
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	1	1	1	1	1	1	1	1	1	0	0	0	0
Total Taxes	4	4	4	4	3	3	3	2	2	2	2	1	1
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0438**	**0.0424**	**0.0410**	**0.0395**	**0.0381**	**0.0367**	**0.0353**	**0.0338**	**0.0324**	**0.0310**	**0.0296**	**0.0282**	**0.0267**
Revenue Requirement	**44**	**42**	**41**	**40**	**38**	**37**	**35**	**34**	**32**	**31**	**30**	**28**	**27**
Revenue Taxes	4	4	4	4	3	3	3	3	3	3	3	3	2
Income Before Depr, Int, Inc Tax	40	39	37	36	35	33	32	31	30	28	27	26	24
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	5	4	4	4	3	3	3	3	2	2	2	2	1
Income Before Income Taxes	17	16	15	14	13	12	11	10	9	8	7	6	5
Income Taxes - Federal	3	3	3	3	3	2	2	2	2	2	1	1	1
Income Taxes - State	1	1	1	1	1	1	1	1	1	0	0	0	0
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	4	4	4	4	3	3	3	2	2	2	2	1	1
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	12	12	11	10	9	9	8	7	6	6	5	4	3
	-	-	-	-	-	-	-	-	-	-	-	-	*(0)*

Resilience Project/Program
Revenue Requirements Model - Calculatio
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Manual input	52	53	54	55	56	57	58	59	60	Total
O&M										
Escalation Rate	2.75	2.80	2.86	2.91	2.97	3.03	3.09	3.15	3.22	
O&M	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation										
Book Depreciation										
Book Depreciation Rates	1.852%	1.852%	1.852%	1.852%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Depreciation Expense	19	19	19	19	-	-	-	-	-	1,000
Accumulated Depreciation	944	963	981	1,000	1,000	1,000	1,000	1,000	1,000	
Tax Depreciation										
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	1,000
Tax Depreciation	-	-	-	-	-	-	-	-	-	1,000
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
State Investment Tax Credit (ITC)										
Book										
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	40
Accumulated Amortization	40	40	40	40	40	40	40	40	40	
Deferred ITC	-	-	-	-	-	-	-	-	-	
Tax										
Deferred Tax Calculation										
Book Accumulated Depreciation	944	963	981	1,000	1,000	1,000	1,000	1,000	1,000	
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Book/Tax Acc Depr Difference	(56)	(37)	(19)	-	-	-	-	-	-	
Deferred ITC	-	-	-	-	-	-	-	-	-	
Net Deferred Tax Asset (Liability)	(14)	(10)	(5)	-	-	-	-	-	-	
Deferred Tax Base	(19)	(19)	(19)	(19)	-	-	-	-	-	
Deferred Taxes - Federal	(4)	(4)	(4)	(4)	-	-	-	-	-	
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	-	-	-	-	-	
Change in Deferred Taxes	(5)	(5)	(5)	(5)	-	-	-	-	-	
Accumulated Deferred Taxes	14	10	5	(0)	(0)	(0)	(0)	(0)	(0)	
check	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	
	-	-	-	-	-	-	-	-	-	
Rate Base and Financing										
Investment: (Rate Base)										
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Accumulated Depreciation	944	963	981	1,000	1,000	1,000	1,000	1,000	1,000	
Accumulated Deferred Taxes	14	10	5	(0)	(0)	(0)	(0)	(0)	(0)	
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	
Ending Net Investment	41	27	14	0	0	0	0	0	0	
Average Net Investment	48	34	21	7	0	0	0	0	0	
Average Financing:										
Short Term Debt	0	0	0	0	0	0	0	0	0	
Long Term Debt (Revenue Bonds)	20	14	8	3	0	0	0	0	0	
Taxable Debt	0	0	0	0	0	0	0	0	0	
Preferred Stock	1	0	0	0	0	0	0	0	0	
Common Equity	27	20	12	4	0	0	0	0	0	
Total Financing	48	34	21	7	0	0	0	0	0	

Revenue Requirements Model - Calculati
Distribution - Station Equipment - Substa

Manual input	52	53	54	55	56	57	58	59	60	Total
Return on Investment										
Short Term Debt	0	0	0	0	0	0	0	0	0	
Long Term Debt (Taxable Debt)	1	1	0	0	0	0	0	0	0	
Hybrids	0	0	0	0	0	0	0	0	0	
Total Interest Expense	1	1	0	0	0	0	0	0	0	
Preferred Dividends	0	0	0	0	0	0	0	0	0	
Net Income on Common	3	2	1	0	0	0	0	0	0	
Income Taxes										
Income Before Pref Dividends	3	2	1	0	0	0	0	0	0	
Income Before Taxes (including ITC)	4	3	2	1	0	0	0	0	0	
Investment Tax Credit	-	-	-	-	-	-	-	-	-	
Income Before Taxes (excluding ITC)	4	3	2	1	0	0	0	0	0	
Federal Income Tax	1	1	0	0	0	0	0	0	0	
State Income Tax	0	0	0	0	0	0	0	0	0	
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	
Total State Tax	0	0	0	0	0	0	0	0	0	
Total Taxes	1	1	0	0	0	0	0	0	0	
Revenue Requirement Calculation										
Revenue Requirement Factors	**0.0253**	**0.0239**	**0.0225**	**0.0210**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	
Revenue Requirement	**25**	**24**	**22**	**21**	**0**	**0**	**0**	**0**	**0**	
Revenue Taxes	2	2	2	2	0	0	0	0	0	
Income Before Depr, Int, Inc Tax	23	22	20	19	0	0	0	0	0	
Depreciation Expense	19	19	19	19	-	-	-	-	-	
O&M	-	-	-	-	-	-	-	-	-	
Interest Expense	1	1	0	0	0	0	0	0	0	
Income Before Income Taxes	4	3	2	1	0	0	0	0	0	
Income Taxes - Federal	1	1	0	0	0	0	0	0	0	
Income Taxes - State	0	0	0	0	0	0	0	0	0	
State ITC	-	-	-	-	-	-	-	-	-	
Total Income Taxes	1	1	0	0	0	0	0	0	0	
Preferred Dividends	0	0	0	0	0	0	0	0	0	
Net Income for Common	3	2	1	0	0	0	0	0	0	
	-	*-*	*(0)*	*(0)*	*-*	*-*	*-*	*-*	*-*	

Resilience Project/Program
Revenue Requirements Model - Calculations ME Transmission
Transmission - Poles and Fixtures

Manual input		1	2	3	4	5	6	7	8	9	10	11	12
O&M													
Escalation Rate		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24
O&M													
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates		0.000%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%
Depreciation Expense		-	18	18	18	18	18	18	18	18	18	18	18
Accumulated Depreciation		-	18	35	53	70	88	105	123	140	158	175	193
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	**20**	2.500%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%
Tax Basis (S/L)	0.0%	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	**15**	5.000%	9.500%	8.550%	7.700%	6.930%	6.230%	5.900%	5.900%	5.910%	5.900%	5.910%	5.900%
NonRB Financed Tax Basis (MACRS)	100.0%	50	95	86	77	69	62	59	59	59	59	59	59
Tax Depreciation		50	95	86	77	69	62	59	59	59	59	59	59
Accumulated Tax Depreciation		50	145	231	308	377	439	498	557	616	675	734	793
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate		0.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	0.000%
Amortization of State ITC	4.00%	-	4	4	4	4	4	4	4	4	4	4	-
Accumulated Amortization		-	4	8	12	16	20	24	28	32	36	40	40
Deferred ITC		40	36	32	28	24	20	16	12	8	4	-	-
Tax		40											
Deferred Tax Calculation													
Book Accumulated Depreciation		-	18	35	53	70	88	105	123	140	158	175	193
Tax Accumulated Depreciation		50	145	231	308	377	439	498	557	616	675	734	793
Book/Tax Acc Depr Difference		(50)	(127)	(195)	(255)	(307)	(351)	(393)	(434)	(476)	(517)	(559)	(600)
Deferred ITC		40	36	32	28	24	20	16	12	8	4	-	-
Net Deferred Tax Asset (Liability)		(3)	(24)	(42)	(58)	(73)	(85)	(97)	(109)	(120)	(132)	(144)	(155)
Deferred Tax Base		10	81	72	63	56	49	45	45	46	45	46	41
Deferred Taxes - Federal		2	16	14	13	11	10	9	9	9	9	9	8
Deferred Taxes - State excluding credit		1	5	4	4	3	3	3	3	3	3	3	2
Change in Deferred Taxes		3	21	19	16	14	13	12	12	12	12	12	11
Accumulated Deferred Taxes		3	24	42	58	73	85	97	109	120	132	144	155
check		-	-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC		40	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
		40	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant		1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation		-	18	35	53	70	88	105	123	140	158	175	193
Accumulated Deferred Taxes		3	24	42	58	73	85	97	109	120	132	144	155
Accumulated Deferred ITC		40	36	32	28	24	20	16	12	8	4	-	-
Ending Net Investment	1,000	957	923	891	861	833	807	782	756	731	706	681	652
Average Net Investment		-	940	907	876	847	820	794	769	744	719	693	667
Average Financing:													
Short Term Debt	1.37%	-	13	12	12	12	11	11	11	10	10	9	9
Long Term Debt (Revenue Bonds)	38.68%	-	364	351	339	328	317	307	297	288	278	268	258
Taxable Debt	1.96%	-	18	18	17	17	16	16	15	15	14	14	13
Preferred Stock	0.98%	-	9	9	9	8	8	8	8	7	7	7	7
Common Equity	57.02%	-	536	517	499	483	468	453	438	424	410	395	380
Total Financing		-	940	907	876	847	820	794	769	744	719	693	667

Revenue Requirements Model - Calculations ME Transmission
Transmission - Poles and Fixtures

Manual input		1	2	3	4	5	6	7	8	9	10	11	12
Return on Investment													
Short Term Debt	3.00%	-	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	4.54%	-	17	16	15	15	14	14	14	13	13	12	12
Hybrids	7.16%	-	1	1	1	1	1	1	1	1	1	1	1
Total Interest Expense		-	18	18	17	16	16	15	15	14	14	13	13
Preferred Dividends	8.15%	-	1	1	1	1	1	1	1	1	1	1	1
Net Income on Common	9.50%	-	51	49	47	46	44	43	42	40	39	38	36
Income Taxes													
Income Before Pref Dividends		-	52	50	48	47	45	44	42	41	39	38	37
Income Before Taxes (including ITC)		-	70	67	65	63	61	59	57	55	53	51	49
Investment Tax Credit		-	4	4	4	4	4	4	4	4	4	4	-
Income Before Taxes (excluding ITC)		-	66	63	61	59	57	55	53	51	49	47	49
Federal Income Tax		-	14	13	13	12	12	12	11	11	10	10	10
State Income Tax		-	4	4	4	4	4	4	3	3	3	3	3
State Investment Tax Credit		-	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
Total State Tax		-	0	0	(0)	(0)	(0)	(0)	(1)	(1)	(1)	(1)	3
Total Taxes		-	14	13	13	12	12	11	11	10	10	9	13
Revenue Requirement Calculation													
Revenue Requirement Factors		**-**	**0.1112**	**0.1078**	**0.1047**	**0.1017**	**0.0989**	**0.0963**	**0.0937**	**0.0911**	**0.0885**	**0.0859**	**0.0876**
Revenue Requirement		**-**	**111**	**108**	**105**	**102**	**99**	**96**	**94**	**91**	**89**	**86**	**88**
Revenue Taxes		-	10	10	9	9	9	9	8	8	8	8	8
Income Before Depr, Int, Inc Tax		-	101	98	95	93	90	88	85	83	81	78	80
Depreciation Expense		-	18	18	18	18	18	18	18	18	18	18	18
O&M		-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense		-	18	18	17	16	16	15	15	14	14	13	13
Income Before Income Taxes		-	66	63	61	59	57	55	53	51	49	47	49
Income Taxes - Federal		-	14	13	13	12	12	12	11	11	10	10	10
Income Taxes - State		-	4	4	4	4	4	4	3	3	3	3	3
State ITC		-	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
Total Income Taxes		-	14	13	13	12	12	11	11	10	10	9	13
Preferred Dividends		-	1	1	1	1	1	1	1	1	1	1	1
Net Income for Common		-	51	49	47	46	44	43	42	40	39	38	36
check		-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Transmission - Poles and Fixtures

Manual input	13	14	15	16	17	18	19	20	21	22	23	24	25
O&M													
Escalation Rate	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46	1.49	1.52	1.55	1.58	1.61
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%
Depreciation Expense	18	18	18	18	18	18	18	18	18	18	18	18	18
Accumulated Depreciation	211	228	246	263	281	298	316	333	351	368	386	404	421
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	2.500%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	5.910%	5.900%	5.910%	2.950%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	59	59	59	30	-	-	-	-	-	-	-	-	-
Tax Depreciation	59	59	59	30	-	-	-	-	-	-	-	-	-
Accumulated Tax Depreciation	852	911	971	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	211	228	246	263	281	298	316	333	351	368	386	404	421
Tax Accumulated Depreciation	852	911	971	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(642)	(683)	(725)	(737)	(719)	(702)	(684)	(667)	(649)	(632)	(614)	(596)	(579)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(165)	(176)	(187)	(190)	(185)	(181)	(176)	(172)	(167)	(163)	(158)	(154)	(149)
Deferred Tax Base	42	41	42	12	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)
Deferred Taxes - Federal	8	8	8	2	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Deferred Taxes - State excluding credit	2	2	2	1	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Change in Deferred Taxes	11	11	11	3	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Accumulated Deferred Taxes	165	176	187	190	185	181	176	172	167	163	158	154	149
check	-	-	-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	211	228	246	263	281	298	316	333	351	368	386	404	421
Accumulated Deferred Taxes	165	176	187	190	185	181	176	172	167	163	158	154	149
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	624	596	568	547	534	521	508	495	482	469	456	443	430
Average Net Investment	638	610	582	557	541	528	515	502	488	475	462	449	436
Average Financing:													
Short Term Debt	9	8	8	8	7	7	7	7	7	7	6	6	6
Long Term Debt (Revenue Bonds)	247	236	225	216	209	204	199	194	189	184	179	174	169
Taxable Debt	12	12	11	11	11	10	10	10	10	9	9	9	9
Preferred Stock	6	6	6	5	5	5	5	5	5	5	5	4	4
Common Equity	364	348	332	318	308	301	293	286	279	271	264	256	249
Total Financing	638	610	582	557	541	528	515	502	488	475	462	449	436

Revenue Requirements Model - Calculati
Transmission - Poles and Fixtures

Manual input	13	14	15	16	17	18	19	20	21	22	23	24	25
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	11	11	10	10	9	9	9	9	9	8	8	8	8
Hybrids	1	1	1	1	1	1	1	1	1	1	1	1	1
Total Interest Expense	12	12	11	11	10	10	10	10	9	9	9	9	8
Preferred Dividends	1	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	35	33	32	30	29	29	28	27	26	26	25	24	24
Income Taxes													
Income Before Pref Dividends	35	34	32	31	30	29	28	28	27	26	25	25	24
Income Before Taxes (including ITC)	47	45	43	41	40	39	38	37	36	35	34	33	32
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	47	45	43	41	40	39	38	37	36	35	34	33	32
Federal Income Tax	9	9	9	8	8	8	8	7	7	7	7	7	6
State Income Tax	3	3	3	2	2	2	2	2	2	2	2	2	2
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	3	3	3	2	2	2	2	2	2	2	2	2	2
Total Taxes	12	12	11	11	10	10	10	10	9	9	9	9	8
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0847**	**0.0818**	**0.0789**	**0.0764**	**0.0747**	**0.0733**	**0.0720**	**0.0707**	**0.0693**	**0.0680**	**0.0667**	**0.0653**	**0.0640**
Revenue Requirement	**85**	**82**	**79**	**76**	**75**	**73**	**72**	**71**	**69**	**68**	**67**	**65**	**64**
Revenue Taxes	8	7	7	7	7	7	6	6	6	6	6	6	6
Income Before Depr, Int, Inc Tax	77	75	72	70	68	67	66	64	63	62	61	60	58
Depreciation Expense	18	18	18	18	18	18	18	18	18	18	18	18	18
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	12	12	11	11	10	10	10	10	9	9	9	9	8
Income Before Income Taxes	47	45	43	41	40	39	38	37	36	35	34	33	32
Income Taxes - Federal	9	9	9	8	8	8	8	7	7	7	7	7	6
Income Taxes - State	3	3	3	2	2	2	2	2	2	2	2	2	2
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	12	12	11	11	10	10	10	10	9	9	9	9	8
Preferred Dividends	1	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	35	33	32	30	29	29	28	27	26	26	25	24	24
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Transmission - Poles and Fixtures

Manual input	26	27	28	29	30	31	32	33	34	35	36	37	38
O&M													
Escalation Rate	1.64	1.67	1.71	1.74	1.78	1.81	1.85	1.88	1.92	1.96	2.00	2.04	2.08
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%
Depreciation Expense	18	18	18	18	18	18	18	18	18	18	18	18	18
Accumulated Depreciation	439	456	474	491	509	526	544	561	579	596	614	632	649
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	439	456	474	491	509	526	544	561	579	596	614	632	649
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(561)	(544)	(526)	(509)	(491)	(474)	(456)	(439)	(421)	(404)	(386)	(368)	(351)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(145)	(140)	(136)	(131)	(127)	(122)	(117)	(113)	(108)	(104)	(99)	(95)	(90)
Deferred Tax Base	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)
Deferred Taxes - Federal	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Change in Deferred Taxes	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Accumulated Deferred Taxes	145	140	136	131	127	122	117	113	108	104	99	95	90
check	-	-	-	-	-	-	-	-	-	-	-	-	0
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	439	456	474	491	509	526	544	561	579	596	614	632	649
Accumulated Deferred Taxes	145	140	136	131	127	122	117	113	108	104	99	95	90
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	417	404	391	378	365	352	339	326	313	300	287	274	261
Average Net Investment	423	410	397	384	371	358	345	332	319	306	293	280	267
Average Financing:													
Short Term Debt	6	6	5	5	5	5	5	5	4	4	4	4	4
Long Term Debt (Revenue Bonds)	164	159	154	149	144	139	134	128	123	118	113	108	103
Taxable Debt	8	8	8	8	7	7	7	6	6	6	6	5	5
Preferred Stock	4	4	4	4	4	4	3	3	3	3	3	3	3
Common Equity	241	234	227	219	212	204	197	189	182	175	167	160	152
Total Financing	423	410	397	384	371	358	345	332	319	306	293	280	267

Revenue Requirements Model - Calculati
Transmission - Poles and Fixtures

Manual input	26	27	28	29	30	31	32	33	34	35	36	37	38
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	7	7	7	7	7	6	6	6	6	5	5	5	5
Hybrids	1	1	1	1	1	1	0	0	0	0	0	0	0
Total Interest Expense	8	8	8	7	7	7	7	6	6	6	6	5	5
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	23	22	22	21	20	19	19	18	17	17	16	15	14
Income Taxes													
Income Before Pref Dividends	23	23	22	21	20	20	19	18	18	17	16	15	15
Income Before Taxes (including ITC)	31	30	29	28	27	27	26	25	24	23	22	21	20
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	31	30	29	28	27	27	26	25	24	23	22	21	20
Federal Income Tax	6	6	6	6	5	5	5	5	5	4	4	4	4
State Income Tax	2	2	2	2	2	2	2	1	1	1	1	1	1
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	2	2	2	2	2	2	2	1	1	1	1	1	1
Total Taxes	8	8	8	7	7	7	7	6	6	6	6	5	5
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0627**	**0.0613**	**0.0600**	**0.0586**	**0.0573**	**0.0560**	**0.0546**	**0.0533**	**0.0520**	**0.0506**	**0.0493**	**0.0480**	**0.0466**
Revenue Requirement	**63**	**61**	**60**	**59**	**57**	**56**	**55**	**53**	**52**	**51**	**49**	**48**	**47**
Revenue Taxes	6	5	5	5	5	5	5	5	5	4	4	4	4
Income Before Depr, Int, Inc Tax	57	56	55	53	52	51	50	49	47	46	45	44	42
Depreciation Expense	18	18	18	18	18	18	18	18	18	18	18	18	18
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	8	8	8	7	7	7	7	6	6	6	6	5	5
Income Before Income Taxes	31	30	29	28	27	27	26	25	24	23	22	21	20
Income Taxes - Federal	6	6	6	6	5	5	5	5	5	4	4	4	4
Income Taxes - State	2	2	2	2	2	2	2	1	1	1	1	1	1
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	8	8	8	7	7	7	7	6	6	6	6	5	5
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	23	22	22	21	20	19	19	18	17	17	16	15	14
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Transmission - Poles and Fixtures

Manual input	39	40	41	42	43	44	45	46	47	48	49	50	51
O&M													
Escalation Rate	2.12	2.16	2.21	2.25	2.30	2.34	2.39	2.44	2.49	2.54	2.59	2.64	2.69
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%
Depreciation Expense	18	18	18	18	18	18	18	18	18	18	18	18	18
Accumulated Depreciation	667	684	702	719	737	754	772	789	807	825	842	860	877
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	667	684	702	719	737	754	772	789	807	825	842	860	877
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(333)	(316)	(298)	(281)	(263)	(246)	(228)	(211)	(193)	(175)	(158)	(140)	(123)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(86)	(81)	(77)	(72)	(68)	(63)	(59)	(54)	(50)	(45)	(41)	(36)	(32)
Deferred Tax Base	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)
Deferred Taxes - Federal	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Change in Deferred Taxes	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Accumulated Deferred Taxes	86	81	77	72	68	63	59	54	50	45	41	36	32
check	0	0	0	0	0	0	0	0	0	0	0	0	0
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	667	684	702	719	737	754	772	789	807	825	842	860	877
Accumulated Deferred Taxes	86	81	77	72	68	63	59	54	50	45	41	36	32
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	247	234	221	208	195	182	169	156	143	130	117	104	91
Average Net Investment	254	241	228	215	202	189	176	163	150	137	124	111	98
Average Financing:													
Short Term Debt	3	3	3	3	3	3	2	2	2	2	2	2	1
Long Term Debt (Revenue Bonds)	98	93	88	83	78	73	68	63	58	53	48	43	38
Taxable Debt	5	5	4	4	4	4	3	3	3	3	2	2	2
Preferred Stock	2	2	2	2	2	2	2	2	1	1	1	1	1
Common Equity	145	137	130	123	115	108	100	93	85	78	71	63	56
Total Financing	254	241	228	215	202	189	176	163	150	137	124	111	98

Revenue Requirements Model - Calculati
Transmission - Poles and Fixtures

Manual input	39	40	41	42	43	44	45	46	47	48	49	50	51
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	4	4	4	4	4	3	3	3	3	2	2	2	2
Hybrids	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Interest Expense	5	5	4	4	4	4	3	3	3	3	2	2	2
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	14	13	12	12	11	10	10	9	8	7	7	6	5
Income Taxes													
Income Before Pref Dividends	14	13	13	12	11	10	10	9	8	8	7	6	5
Income Before Taxes (including ITC)	19	18	17	16	15	14	13	12	11	10	9	8	7
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	19	18	17	16	15	14	13	12	11	10	9	8	7
Federal Income Tax	4	4	3	3	3	3	3	2	2	2	2	2	1
State Income Tax	1	1	1	1	1	1	1	1	1	1	1	0	0
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	1	1	1	1	1	1	1	1	1	1	1	0	0
Total Taxes	5	5	4	4	4	4	3	3	3	3	2	2	2
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0453**	**0.0440**	**0.0426**	**0.0413**	**0.0400**	**0.0386**	**0.0373**	**0.0359**	**0.0346**	**0.0333**	**0.0319**	**0.0306**	**0.0293**
Revenue Requirement	**45**	**44**	**43**	**41**	**40**	**39**	**37**	**36**	**35**	**33**	**32**	**31**	**29**
Revenue Taxes	4	4	4	4	4	3	3	3	3	3	3	3	3
Income Before Depr, Int, Inc Tax	41	40	39	38	36	35	34	33	32	30	29	28	27
Depreciation Expense	18	18	18	18	18	18	18	18	18	18	18	18	18
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	5	5	4	4	4	4	3	3	3	3	2	2	2
Income Before Income Taxes	19	18	17	16	15	14	13	12	11	10	9	8	7
Income Taxes - Federal	4	4	3	3	3	3	3	2	2	2	2	2	1
Income Taxes - State	1	1	1	1	1	1	1	1	1	1	1	0	0
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	5	5	4	4	4	4	3	3	3	3	2	2	2
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	14	13	12	12	11	10	10	9	8	7	7	6	5
	-	-	-	-	-	-	-	-	-	*(0)*	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Transmission - Poles and Fixtures

Manual input	52	53	54	55	56	57	58	59	60	Total
O&M										
Escalation Rate	2.75	2.80	2.86	2.91	2.97	3.03	3.09	3.15	3.22	
O&M	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation										
Book Depreciation										
Book Depreciation Rates	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	1.754%	0.000%	0.000%	100.00%
Depreciation Expense	18	18	18	18	18	18	18	-	-	1,000
Accumulated Depreciation	895	912	930	947	965	982	1,000	1,000	1,000	
Tax Depreciation										
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	1,000
Tax Depreciation	-	-	-	-	-	-	-	-	-	1,000
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
State Investment Tax Credit (ITC)										
Book										
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	40
Accumulated Amortization	40	40	40	40	40	40	40	40	40	
Deferred ITC	-	-	-	-	-	-	-	-	-	
Tax										
Deferred Tax Calculation										
Book Accumulated Depreciation	895	912	930	947	965	982	1,000	1,000	1,000	
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Book/Tax Acc Depr Difference	(105)	(88)	(70)	(53)	(35)	(18)	-	-	-	
Deferred ITC	-	-	-	-	-	-	-	-	-	
Net Deferred Tax Asset (Liability)	(27)	(23)	(18)	(14)	(9)	(5)	-	-	-	
Deferred Tax Base	(18)	(18)	(18)	(18)	(18)	(18)	(18)	-	-	
Deferred Taxes - Federal	(3)	(3)	(3)	(3)	(3)	(3)	(3)	-	-	
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	(1)	(1)	(1)	-	-	
Change in Deferred Taxes	(5)	(5)	(5)	(5)	(5)	(5)	(5)	-	-	
Accumulated Deferred Taxes	27	23	18	14	9	5	0	0	0	
check	0	0	0	0	0	0	0	0	0	
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	
	-	-	-	-	-	-	-	-	-	
Rate Base and Financing										
Investment: (Rate Base)										
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Accumulated Depreciation	895	912	930	947	965	982	1,000	1,000	1,000	
Accumulated Deferred Taxes	27	23	18	14	9	5	0	0	0	
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	
Ending Net Investment	78	65	52	39	26	13	(0)	(0)	(0)	
Average Net Investment	85	72	59	46	33	20	7	(0)	(0)	
Average Financing:										
Short Term Debt	1	1	1	1	0	0	0	(0)	(0)	
Long Term Debt (Revenue Bonds)	33	28	23	18	13	8	3	(0)	(0)	
Taxable Debt	2	1	1	1	1	0	0	(0)	(0)	
Preferred Stock	1	1	1	0	0	0	0	(0)	(0)	
Common Equity	48	41	33	26	19	11	4	(0)	(0)	
Total Financing	85	72	59	46	33	20	7	(0)	(0)	

Revenue Requirements Model - Calculati
Transmission - Poles and Fixtures

Manual input	52	53	54	55	56	57	58	59	60	Total
Return on Investment										
Short Term Debt	0	0	0	0	0	0	0	(0)	(0)	
Long Term Debt (Taxable Debt)	1	1	1	1	1	0	0	(0)	(0)	
Hybrids	0	0	0	0	0	0	0	(0)	(0)	
Total Interest Expense	2	1	1	1	1	0	0	(0)	(0)	
Preferred Dividends	0	0	0	0	0	0	0	(0)	(0)	
Net Income on Common	5	4	3	2	2	1	0	(0)	(0)	
Income Taxes										
Income Before Pref Dividends	5	4	3	3	2	1	0	(0)	(0)	
Income Before Taxes (including ITC)	6	5	4	3	2	1	0	(0)	(0)	
Investment Tax Credit	-	-	-	-	-	-	-	-	-	
Income Before Taxes (excluding ITC)	6	5	4	3	2	1	0	(0)	(0)	
Federal Income Tax	1	1	1	1	0	0	0	(0)	(0)	
State Income Tax	0	0	0	0	0	0	0	(0)	(0)	
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	
Total State Tax	0	0	0	0	0	0	0	(0)	(0)	
Total Taxes	2	1	1	1	1	0	0	(0)	(0)	
Revenue Requirement Calculation										
Revenue Requirement Factors	**0.0279**	**0.0266**	**0.0253**	**0.0239**	**0.0226**	**0.0213**	**0.0199**	**(0.0000)**	**(0.0000)**	
Revenue Requirement	**28**	**27**	**25**	**24**	**23**	**21**	**20**	**(0)**	**(0)**	
Revenue Taxes	2	2	2	2	2	2	2	(0)	(0)	
Income Before Depr, Int, Inc Tax	25	24	23	22	21	19	18	(0)	(0)	
Depreciation Expense	18	18	18	18	18	18	18	-	-	
O&M	-	-	-	-	-	-	-	-	-	
Interest Expense	2	1	1	1	1	0	0	(0)	(0)	
Income Before Income Taxes	6	5	4	3	2	1	0	(0)	(0)	
Income Taxes - Federal	1	1	1	1	0	0	0	(0)	(0)	
Income Taxes - State	0	0	0	0	0	0	0	(0)	(0)	
State ITC	-	-	-	-	-	-	-	-	-	
Total Income Taxes	2	1	1	1	1	0	0	(0)	(0)	
Preferred Dividends	0	0	0	0	0	0	0	(0)	(0)	
Net Income for Common	5	4	3	2	2	1	0	(0)	(0)	
	-	*-*	*-*	*-*	*(0)*	*(0)*	*0*	*-*	*-*	

Resilience Project/Program
Revenue Requirements Model - Calculations ME Distribution
Distribution - Poles, Towers, and Fixtures

Manual input		1	2	3	4	5	6	7	8	9	10	11	12
O&M													
Escalation Rate		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24
O&M		-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates		0.000%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%
Depreciation Expense		-	23	23	23	23	23	23	23	23	23	23	23
Accumulated Depreciation		-	23	45	68	91	114	136	159	182	205	227	250
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	**20**	2.500%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%
Tax Basis (S/L)	0.0%	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	**20**	3.750%	7.219%	6.677%	6.177%	5.713%	5.285%	4.888%	4.522%	4.462%	4.461%	4.462%	4.461%
NonRB Financed Tax Basis (MACRS)	100.0%	38	72	67	62	57	53	49	45	45	45	45	45
Tax Depreciation		38	72	67	62	57	53	49	45	45	45	45	45
Accumulated Tax Depreciation		38	110	176	238	295	348	397	442	487	532	576	621
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate		0.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	0.000%
Amortization of State ITC	4.00%	-	4	4	4	4	4	4	4	4	4	4	-
Accumulated Amortization		-	4	8	12	16	20	24	28	32	36	40	40
Deferred ITC		40	36	32	28	24	20	16	12	8	4	-	-
Tax		40											
Deferred Tax Calculation													
Book Accumulated Depreciation		-	23	45	68	91	114	136	159	182	205	227	250
Tax Accumulated Depreciation		38	110	176	238	295	348	397	442	487	532	576	621
Book/Tax Acc Depr Difference		(38)	(87)	(131)	(170)	(204)	(235)	(261)	(283)	(305)	(327)	(349)	(371)
Deferred ITC		40	36	32	28	24	20	16	12	8	4	-	-
Net Deferred Tax Asset (Liability)		1	(13)	(25)	(37)	(46)	(55)	(63)	(70)	(77)	(83)	(90)	(95)
Deferred Tax Base		(3)	53	48	43	38	34	30	26	26	26	26	22
Deferred Taxes - Federal		(0)	11	9	8	8	7	6	5	5	5	5	4
Deferred Taxes - State excluding credit		(0)	3	3	3	2	2	2	2	2	2	2	1
Change in Deferred Taxes		(1)	14	12	11	10	9	8	7	7	7	7	6
Accumulated Deferred Taxes		(1)	13	25	37	46	55	63	70	77	83	90	95
check		-	-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC		40	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
		40	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant		1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation		-	23	45	68	91	114	136	159	182	205	227	250
Accumulated Deferred Taxes		(1)	13	25	37	46	55	63	70	77	83	90	95
Accumulated Deferred ITC		40	36	32	28	24	20	16	12	8	4	-	-
Ending Net Investment	1,000	961	928	897	867	839	811	785	759	734	708	683	655
Average Net Investment		-	944	913	882	853	825	798	772	746	721	696	669
Average Financing:													
Short Term Debt	1.37%	-	13	12	12	12	11	11	11	10	10	10	9
Long Term Debt (Revenue Bonds)	38.68%	-	365	353	341	330	319	309	299	289	279	269	259
Taxable Debt	1.96%	-	18	18	17	17	16	16	15	15	14	14	13
Preferred Stock	0.98%	-	9	9	9	8	8	8	8	7	7	7	7
Common Equity	57.02%	-	538	520	503	486	470	455	440	426	411	397	381
Total Financing		-	944	913	882	853	825	798	772	746	721	696	669

Revenue Requirements Model - Calculations ME Distribution
Distribution - Poles, Towers, and Fixtures

Manual input		1	2	3	4	5	6	7	8	9	10	11	12
Return on Investment													
Short Term Debt	3.00%	-	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	4.54%	-	17	16	15	15	14	14	14	13	13	12	12
Hybrids	7.16%	-	1	1	1	1	1	1	1	1	1	1	1
Total Interest Expense		-	18	18	17	17	16	15	15	14	14	13	13
Preferred Dividends	8.15%	-	1	1	1	1	1	1	1	1	1	1	1
Net Income on Common	9.50%	-	51	49	48	46	45	43	42	40	39	38	36
Income Taxes													
Income Before Pref Dividends		-	52	50	48	47	45	44	42	41	40	38	37
Income Before Taxes (including ITC)		-	70	68	65	63	61	59	57	55	53	51	50
Investment Tax Credit		-	4	4	4	4	4	4	4	4	4	4	-
Income Before Taxes (excluding ITC)		-	66	64	61	59	57	55	53	51	49	47	50
Federal Income Tax		-	14	13	13	12	12	12	11	11	11	10	10
State Income Tax		-	4	4	4	4	4	4	3	3	3	3	3
State Investment Tax Credit		-	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
Total State Tax		-	0	0	(0)	(0)	(0)	(0)	(1)	(1)	(1)	(1)	3
Total Taxes		-	14	13	13	12	12	11	11	10	10	9	13
Revenue Requirement Calculation													
Revenue Requirement Factors		**-**	**0.1174**	**0.1141**	**0.1110**	**0.1080**	**0.1051**	**0.1023**	**0.0997**	**0.0971**	**0.0945**	**0.0919**	**0.0935**
Revenue Requirement		**-**	**117**	**114**	**111**	**108**	**105**	**102**	**100**	**97**	**94**	**92**	**93**
Revenue Taxes		-	10	10	10	10	9	9	9	9	8	8	8
Income Before Depr, Int, Inc Tax		-	107	104	101	98	96	93	91	88	86	84	85
Depreciation Expense		-	23	23	23	23	23	23	23	23	23	23	23
O&M		-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense		-	18	18	17	17	16	15	15	14	14	13	13
Income Before Income Taxes		-	66	64	61	59	57	55	53	51	49	47	50
Income Taxes - Federal		-	14	13	13	12	12	12	11	11	11	10	10
Income Taxes - State		-	4	4	4	4	4	4	3	3	3	3	3
State ITC		-	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
Total Income Taxes		-	14	13	13	12	12	11	11	10	10	9	13
Preferred Dividends		-	1	1	1	1	1	1	1	1	1	1	1
Net Income for Common		-	51	49	48	46	45	43	42	40	39	38	36
check		-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Distribution - Poles, Towers, and Fixtures

Manual input	13	14	15	16	17	18	19	20	21	22	23	24	25
O&M													
Escalation Rate	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46	1.49	1.52	1.55	1.58	1.61
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%
Depreciation Expense	23	23	23	23	23	23	23	23	23	23	23	23	23
Accumulated Depreciation	273	295	318	341	364	386	409	432	455	477	500	523	545
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	2.500%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	4.462%	4.461%	4.462%	4.461%	4.462%	4.461%	4.462%	4.461%	2.231%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	45	45	45	45	45	45	45	45	22	-	-	-	-
Tax Depreciation	45	45	45	45	45	45	45	45	22	-	-	-	-
Accumulated Tax Depreciation	665	710	755	799	844	888	933	978	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	273	295	318	341	364	386	409	432	455	477	500	523	545
Tax Accumulated Depreciation	665	710	755	799	844	888	933	978	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(393)	(415)	(436)	(458)	(480)	(502)	(524)	(546)	(545)	(523)	(500)	(477)	(455)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(101)	(107)	(112)	(118)	(124)	(129)	(135)	(141)	(140)	(135)	(129)	(123)	(117)
Deferred Tax Base	22	22	22	22	22	22	22	22	(0)	(23)	(23)	(23)	(23)
Deferred Taxes - Federal	4	4	4	4	4	4	4	4	(0)	(4)	(4)	(4)	(4)
Deferred Taxes - State excluding credit	1	1	1	1	1	1	1	1	(0)	(1)	(1)	(1)	(1)
Change in Deferred Taxes	6	6	6	6	6	6	6	6	(0)	(6)	(6)	(6)	(6)
Accumulated Deferred Taxes	101	107	112	118	124	129	135	141	140	135	129	123	117
check	-	-	-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	273	295	318	341	364	386	409	432	455	477	500	523	545
Accumulated Deferred Taxes	101	107	112	118	124	129	135	141	140	135	129	123	117
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	626	598	569	541	513	484	456	428	405	388	371	354	337
Average Net Investment	640	612	584	555	527	499	470	442	416	397	380	363	346
Average Financing:													
Short Term Debt	9	8	8	8	7	7	6	6	6	5	5	5	5
Long Term Debt (Revenue Bonds)	248	237	226	215	204	193	182	171	161	153	147	140	134
Taxable Debt	13	12	11	11	10	10	9	9	8	8	7	7	7
Preferred Stock	6	6	6	5	5	5	5	4	4	4	4	4	3
Common Equity	365	349	333	317	300	284	268	252	237	226	216	207	197
Total Financing	640	612	584	555	527	499	470	442	416	397	380	363	346

Revenue Requirements Model - Calculati
Distribution - Poles, Towers, and Fixture

Manual input	13	14	15	16	17	18	19	20	21	22	23	24	25
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	11	11	10	10	9	9	8	8	7	7	7	6	6
Hybrids	1	1	1	1	1	1	1	1	1	1	1	1	0
Total Interest Expense	12	12	11	11	10	10	9	9	8	8	7	7	7
Preferred Dividends	1	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	35	33	32	30	29	27	25	24	23	21	21	20	19
Income Taxes													
Income Before Pref Dividends	35	34	32	31	29	27	26	24	23	22	21	20	19
Income Before Taxes (including ITC)	47	45	43	41	39	37	35	33	31	29	28	27	26
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	47	45	43	41	39	37	35	33	31	29	28	27	26
Federal Income Tax	9	9	9	8	8	7	7	6	6	6	6	5	5
State Income Tax	3	3	3	2	2	2	2	2	2	2	2	2	2
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	3	3	3	2	2	2	2	2	2	2	2	2	2
Total Taxes	12	12	11	11	10	10	9	8	8	8	7	7	7
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0906**	**0.0877**	**0.0848**	**0.0819**	**0.0790**	**0.0760**	**0.0731**	**0.0702**	**0.0676**	**0.0656**	**0.0639**	**0.0621**	**0.0604**
Revenue Requirement	**91**	**88**	**85**	**82**	**79**	**76**	**73**	**70**	**68**	**66**	**64**	**62**	**60**
Revenue Taxes	8	8	8	7	7	7	6	6	6	6	6	6	5
Income Before Depr, Int, Inc Tax	83	80	77	75	72	69	67	64	62	60	58	57	55
Depreciation Expense	23	23	23	23	23	23	23	23	23	23	23	23	23
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	12	12	11	11	10	10	9	9	8	8	7	7	7
Income Before Income Taxes	47	45	43	41	39	37	35	33	31	29	28	27	26
Income Taxes - Federal	9	9	9	8	8	7	7	6	6	6	6	5	5
Income Taxes - State	3	3	3	2	2	2	2	2	2	2	2	2	2
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	12	12	11	11	10	10	9	8	8	8	7	7	7
Preferred Dividends	1	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	35	33	32	30	29	27	25	24	23	21	21	20	19
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Distribution - Poles, Towers, and Fixtures

Manual input	26	27	28	29	30	31	32	33	34	35	36	37	38
O&M													
Escalation Rate	1.64	1.67	1.71	1.74	1.78	1.81	1.85	1.88	1.92	1.96	2.00	2.04	2.08
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%
Depreciation Expense	23	23	23	23	23	23	23	23	23	23	23	23	23
Accumulated Depreciation	568	591	614	636	659	682	705	727	750	773	795	818	841
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	568	591	614	636	659	682	705	727	750	773	795	818	841
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(432)	(409)	(386)	(364)	(341)	(318)	(295)	(273)	(250)	(227)	(205)	(182)	(159)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(111)	(105)	(99)	(94)	(88)	(82)	(76)	(70)	(64)	(59)	(53)	(47)	(41)
Deferred Tax Base	(23)	(23)	(23)	(23)	(23)	(23)	(23)	(23)	(23)	(23)	(23)	(23)	(23)
Deferred Taxes - Federal	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Change in Deferred Taxes	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)
Accumulated Deferred Taxes	111	105	99	94	88	82	76	70	64	59	53	47	41
check	-	0	0	0	0	0	0	0	0	0	0	0	0
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	568	591	614	636	659	682	705	727	750	773	795	818	841
Accumulated Deferred Taxes	111	105	99	94	88	82	76	70	64	59	53	47	41
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	321	304	287	270	253	236	219	202	186	169	152	135	118
Average Net Investment	329	312	295	278	262	245	228	211	194	177	160	143	127
Average Financing:													
Short Term Debt	5	4	4	4	4	3	3	3	3	2	2	2	2
Long Term Debt (Revenue Bonds)	127	121	114	108	101	95	88	82	75	69	62	55	49
Taxable Debt	6	6	6	5	5	5	4	4	4	3	3	3	2
Preferred Stock	3	3	3	3	3	2	2	2	2	2	2	1	1
Common Equity	188	178	168	159	149	140	130	120	111	101	91	82	72
Total Financing	329	312	295	278	262	245	228	211	194	177	160	143	127

Revenue Requirements Model - Calculati
Distribution - Poles, Towers, and Fixture

Manual input	26	27	28	29	30	31	32	33	34	35	36	37	38
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	6	5	5	5	5	4	4	4	3	3	3	3	2
Hybrids	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Interest Expense	6	6	6	5	5	5	4	4	4	3	3	3	2
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	18	17	16	15	14	13	12	11	11	10	9	8	7
Income Taxes													
Income Before Pref Dividends	18	17	16	15	14	13	13	12	11	10	9	8	7
Income Before Taxes (including ITC)	24	23	22	21	19	18	17	16	14	13	12	11	9
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	24	23	22	21	19	18	17	16	14	13	12	11	9
Federal Income Tax	5	5	4	4	4	4	3	3	3	3	2	2	2
State Income Tax	1	1	1	1	1	1	1	1	1	1	1	1	1
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	1	1	1	1	1	1	1	1	1	1	1	1	1
Total Taxes	6	6	6	5	5	5	4	4	4	3	3	3	2
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0587**	**0.0569**	**0.0552**	**0.0535**	**0.0518**	**0.0500**	**0.0483**	**0.0466**	**0.0448**	**0.0431**	**0.0414**	**0.0396**	**0.0379**
Revenue Requirement	**59**	**57**	**55**	**53**	**52**	**50**	**48**	**47**	**45**	**43**	**41**	**40**	**38**
Revenue Taxes	5	5	5	5	5	4	4	4	4	4	4	4	3
Income Before Depr, Int, Inc Tax	53	52	50	49	47	46	44	42	41	39	38	36	35
Depreciation Expense	23	23	23	23	23	23	23	23	23	23	23	23	23
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	6	6	6	5	5	5	4	4	4	3	3	3	2
Income Before Income Taxes	24	23	22	21	19	18	17	16	14	13	12	11	9
Income Taxes - Federal	5	5	4	4	4	4	3	3	3	3	2	2	2
Income Taxes - State	1	1	1	1	1	1	1	1	1	1	1	1	1
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	6	6	6	5	5	5	4	4	4	3	3	3	2
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	18	17	16	15	14	13	12	11	11	10	9	8	7
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Distribution - Poles, Towers, and Fixtures

Manual input	39	40	41	42	43	44	45	46	47	48	49	50	51
O&M													
Escalation Rate	2.12	2.16	2.21	2.25	2.30	2.34	2.39	2.44	2.49	2.54	2.59	2.64	2.69
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	2.273%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Depreciation Expense	23	23	23	23	23	23	23	-	-	-	-	-	-
Accumulated Depreciation	864	886	909	932	955	977	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	864	886	909	932	955	977	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(136)	(114)	(91)	(68)	(45)	(23)	-	-	-	-	-	-	-
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(35)	(29)	(23)	(18)	(12)	(6)	-	-	-	-	-	-	-
Deferred Tax Base	(23)	(23)	(23)	(23)	(23)	(23)	(23)	-	-	-	-	-	-
Deferred Taxes - Federal	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-	-	-	-	-	-
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	(1)	(1)	(1)	-	-	-	-	-	-
Change in Deferred Taxes	(6)	(6)	(6)	(6)	(6)	(6)	(6)	-	-	-	-	-	-
Accumulated Deferred Taxes	35	29	23	18	12	6	0	0	0	0	0	0	0
check	0	0	0	0	0	0	0	0	0	0	0	0	0
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	864	886	909	932	955	977	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Deferred Taxes	35	29	23	18	12	6	0	0	0	0	0	0	0
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	101	84	67	51	34	17	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Average Net Investment	110	93	76	59	42	25	8	(0)	(0)	(0)	(0)	(0)	(0)
Average Financing:													
Short Term Debt	2	1	1	1	1	0	0	(0)	(0)	(0)	(0)	(0)	(0)
Long Term Debt (Revenue Bonds)	42	36	29	23	16	10	3	(0)	(0)	(0)	(0)	(0)	(0)
Taxable Debt	2	2	1	1	1	0	0	(0)	(0)	(0)	(0)	(0)	(0)
Preferred Stock	1	1	1	1	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)
Common Equity	63	53	43	34	24	14	5	(0)	(0)	(0)	(0)	(0)	(0)
Total Financing	110	93	76	59	42	25	8	(0)	(0)	(0)	(0)	(0)	(0)

Revenue Requirements Model - Calculati
Distribution - Poles, Towers, and Fixtures

Manual input	39	40	41	42	43	44	45	46	47	48	49	50	51
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)
Long Term Debt (Taxable Debt)	2	2	1	1	1	0	0	(0)	(0)	(0)	(0)	(0)	(0)
Hybrids	0	0	0	0	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)
Total Interest Expense	2	2	1	1	1	0	0	(0)	(0)	(0)	(0)	(0)	(0)
Preferred Dividends	0	0	0	0	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)
Net Income on Common	6	5	4	3	2	1	0	(0)	(0)	(0)	(0)	(0)	(0)
Income Taxes													
Income Before Pref Dividends	6	5	4	3	2	1	0	(0)	(0)	(0)	(0)	(0)	(0)
Income Before Taxes (including ITC)	8	7	6	4	3	2	1	(0)	(0)	(0)	(0)	(0)	(0)
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	8	7	6	4	3	2	1	(0)	(0)	(0)	(0)	(0)	(0)
Federal Income Tax	2	1	1	1	1	0	0	(0)	(0)	(0)	(0)	(0)	(0)
State Income Tax	0	0	0	0	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	0	0	0	0	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)
Total Taxes	2	2	1	1	1	0	0	(0)	(0)	(0)	(0)	(0)	(0)
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0362**	**0.0345**	**0.0327**	**0.0310**	**0.0293**	**0.0275**	**0.0258**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**
Revenue Requirement	**36**	**34**	**33**	**31**	**29**	**28**	**26**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**
Revenue Taxes	3	3	3	3	3	3	2	(0)	(0)	(0)	(0)	(0)	(0)
Income Before Depr, Int, Inc Tax	33	31	30	28	27	25	24	(0)	(0)	(0)	(0)	(0)	(0)
Depreciation Expense	23	23	23	23	23	23	23	-	-	-	-	-	-
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	2	2	1	1	1	0	0	(0)	(0)	(0)	(0)	(0)	(0)
Income Before Income Taxes	8	7	6	4	3	2	1	(0)	(0)	(0)	(0)	(0)	(0)
Income Taxes - Federal	2	1	1	1	1	0	0	(0)	(0)	(0)	(0)	(0)	(0)
Income Taxes - State	0	0	0	0	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	2	2	1	1	1	0	0	(0)	(0)	(0)	(0)	(0)	(0)
Preferred Dividends	0	0	0	0	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)
Net Income for Common	6	5	4	3	2	1	0	(0)	(0)	(0)	(0)	(0)	(0)
	-	-	-	-	*(0)*	-	*(0)*	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculatio
Distribution - Poles, Towers, and Fixtures

Manual input	52	53	54	55	56	57	58	59	60	Total
O&M										
Escalation Rate	2.75	2.80	2.86	2.91	2.97	3.03	3.09	3.15	3.22	
O&M	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation										
Book Depreciation										
Book Depreciation Rates	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Depreciation Expense	-	-	-	-	-	-	-	-	-	1,000
Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Tax Depreciation										
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	1,000
Tax Depreciation	-	-	-	-	-	-	-	-	-	1,000
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
State Investment Tax Credit (ITC)										
Book										
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	40
Accumulated Amortization	40	40	40	40	40	40	40	40	40	
Deferred ITC	-	-	-	-	-	-	-	-	-	
Tax										
Deferred Tax Calculation										
Book Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Book/Tax Acc Depr Difference	-	-	-	-	-	-	-	-	-	
Deferred ITC	-	-	-	-	-	-	-	-	-	
Net Deferred Tax Asset (Liability)	-	-	-	-	-	-	-	-	-	
Deferred Tax Base	-	-	-	-	-	-	-	-	-	
Deferred Taxes - Federal	-	-	-	-	-	-	-	-	-	
Deferred Taxes - State excluding credit	-	-	-	-	-	-	-	-	-	
Change in Deferred Taxes	-	-	-	-	-	-	-	-	-	
Accumulated Deferred Taxes	0	0	0	0	0	0	0	0	0	
check	0	0	0	0	0	0	0	0	0	
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	
	-	-	-	-	-	-	-	-	-	
Rate Base and Financing										
Investment: (Rate Base)										
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Accumulated Deferred Taxes	0	0	0	0	0	0	0	0	0	
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	
Ending Net Investment	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Average Net Investment	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Average Financing:										
Short Term Debt	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Long Term Debt (Revenue Bonds)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Taxable Debt	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Preferred Stock	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Common Equity	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Total Financing	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	

Revenue Requirements Model - Calculati
Distribution - Poles, Towers, and Fixtures

Manual input	52	53	54	55	56	57	58	59	60	Total
Return on Investment										
Short Term Debt	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Long Term Debt (Taxable Debt)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Hybrids	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Total Interest Expense	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Preferred Dividends	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Net Income on Common	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Taxes										
Income Before Pref Dividends	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Before Taxes (including ITC)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Investment Tax Credit	-	-	-	-	-	-	-	-	-	
Income Before Taxes (excluding ITC)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Federal Income Tax	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
State Income Tax	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	
Total State Tax	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Total Taxes	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Revenue Requirement Calculation										
Revenue Requirement Factors	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	
Revenue Requirement	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	
Revenue Taxes	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Before Depr, Int, Inc Tax	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Depreciation Expense	-	-	-	-	-	-	-	-	-	
O&M	-	-	-	-	-	-	-	-	-	
Interest Expense	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Before Income Taxes	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Taxes - Federal	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Taxes - State	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
State ITC	-	-	-	-	-	-	-	-	-	
Total Income Taxes	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Preferred Dividends	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Net Income for Common	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
	-	-	-	-	-	-	-	-	-	

Resilience Project/Program
Revenue Requirements Model - Calculations ME Distribution
Distribution - Overhead Conductors and Devices

Manual input		1	2	3	4	5	6	7	8	9	10	11	12
O&M													
Escalation Rate		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24
O&M		-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates		0.000%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%
Depreciation Expense		-	19	19	19	19	19	19	19	19	19	19	19
Accumulated Depreciation		-	19	38	58	77	96	115	135	154	173	192	212
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	**20**	2.500%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%
Tax Basis (S/L)	0.0%	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	**20**	3.750%	7.219%	6.677%	6.177%	5.713%	5.285%	4.888%	4.522%	4.462%	4.461%	4.462%	4.461%
NonRB Financed Tax Basis (MACRS)	100.0%	38	72	67	62	57	53	49	45	45	45	45	45
Tax Depreciation		38	72	67	62	57	53	49	45	45	45	45	45
Accumulated Tax Depreciation		38	110	176	238	295	348	397	442	487	532	576	621
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate		0.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	0.000%
Amortization of State ITC	4.00%	-	4	4	4	4	4	4	4	4	4	4	-
Accumulated Amortization		-	4	8	12	16	20	24	28	32	36	40	40
Deferred ITC		40	36	32	28	24	20	16	12	8	4	-	-
Tax		40											
Deferred Tax Calculation													
Book Accumulated Depreciation		-	19	38	58	77	96	115	135	154	173	192	212
Tax Accumulated Depreciation		38	110	176	238	295	348	397	442	487	532	576	621
Book/Tax Acc Depr Difference		(38)	(90)	(138)	(181)	(218)	(252)	(282)	(308)	(333)	(358)	(384)	(409)
Deferred ITC		40	36	32	28	24	20	16	12	8	4	-	-
Net Deferred Tax Asset (Liability)		1	(14)	(27)	(39)	(50)	(60)	(68)	(76)	(84)	(91)	(99)	(105)
Deferred Tax Base		(3)	57	52	47	42	38	34	30	29	29	29	25
Deferred Taxes - Federal		(0)	11	10	9	8	7	7	6	6	6	6	5
Deferred Taxes - State excluding credit		(0)	3	3	3	3	2	2	2	2	2	2	2
Change in Deferred Taxes		(1)	15	13	12	11	10	9	8	8	8	8	7
Accumulated Deferred Taxes		(1)	14	27	39	50	60	68	76	84	91	99	105
check		-	-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC		40	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
		40	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant		1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation		-	19	38	58	77	96	115	135	154	173	192	212
Accumulated Deferred Taxes		(1)	14	27	39	50	60	68	76	84	91	99	105
Accumulated Deferred ITC		40	36	32	28	24	20	16	12	8	4	-	-
Ending Net Investment	1,000	961	931	902	875	849	824	800	777	754	732	709	683
Average Net Investment		-	946	916	889	862	837	812	789	766	743	720	696
Average Financing:													
Short Term Debt	1.37%	-	13	13	12	12	11	11	11	10	10	10	10
Long Term Debt (Revenue Bonds)	38.68%	-	366	354	344	333	324	314	305	296	287	279	269
Taxable Debt	1.96%	-	18	18	17	17	16	16	15	15	15	14	14
Preferred Stock	0.98%	-	9	9	9	8	8	8	8	8	7	7	7
Common Equity	57.02%	-	539	523	507	491	477	463	450	437	424	411	397
Total Financing		-	946	916	889	862	837	812	789	766	743	720	696

Revenue Requirements Model - Calculations ME Distribution
Distribution - Overhead Conductors and Devices

Manual input		1	2	3	4	5	6	7	8	9	10	11	12
Return on Investment													
Short Term Debt	3.00%	-	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	4.54%	-	17	16	16	15	15	14	14	13	13	13	12
Hybrids	7.16%	-	1	1	1	1	1	1	1	1	1	1	1
Total Interest Expense		-	18	18	17	17	16	16	15	15	14	14	13
Preferred Dividends	8.15%	-	1	1	1	1	1	1	1	1	1	1	1
Net Income on Common	9.50%	-	51	50	48	47	45	44	43	41	40	39	38
Income Taxes													
Income Before Pref Dividends		-	52	50	49	47	46	45	43	42	41	40	38
Income Before Taxes (including ITC)		-	70	68	66	64	62	60	58	57	55	53	52
Investment Tax Credit		-	4	4	4	4	4	4	4	4	4	4	-
Income Before Taxes (excluding ITC)		-	66	64	62	60	58	56	54	53	51	49	52
Federal Income Tax		-	14	13	13	13	12	12	12	11	11	11	10
State Income Tax		-	4	4	4	4	4	4	4	3	3	3	3
State Investment Tax Credit		-	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
Total State Tax		-	0	0	(0)	(0)	(0)	(0)	(0)	(1)	(1)	(1)	3
Total Taxes		-	14	13	13	12	12	11	11	11	10	10	13
Revenue Requirement Calculation													
Revenue Requirement Factors		**-**	**0.1137**	**0.1107**	**0.1078**	**0.1051**	**0.1025**	**0.1000**	**0.0976**	**0.0952**	**0.0929**	**0.0906**	**0.0925**
Revenue Requirement		**-**	**114**	**111**	**108**	**105**	**102**	**100**	**98**	**95**	**93**	**91**	**92**
Revenue Taxes		-	10	10	10	9	9	9	9	8	8	8	8
Income Before Depr, Int, Inc Tax		-	104	101	98	96	93	91	89	87	85	83	84
Depreciation Expense		-	19	19	19	19	19	19	19	19	19	19	19
O&M		-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense		-	18	18	17	17	16	16	15	15	14	14	13
Income Before Income Taxes		-	66	64	62	60	58	56	54	53	51	49	52
Income Taxes - Federal		-	14	13	13	13	12	12	12	11	11	11	10
Income Taxes - State		-	4	4	4	4	4	4	4	3	3	3	3
State ITC		-	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
Total Income Taxes		-	14	13	13	12	12	11	11	11	10	10	13
Preferred Dividends		-	1	1	1	1	1	1	1	1	1	1	1
Net Income for Common		-	51	50	48	47	45	44	43	41	40	39	38
check		-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Distribution - Overhead Conductors and I

Manual input	13	14	15	16	17	18	19	20	21	22	23	24	25
O&M													
Escalation Rate	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46	1.49	1.52	1.55	1.58	1.61
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
Accumulated Depreciation	231	250	269	288	308	327	346	365	385	404	423	442	462
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	2.500%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	4.462%	4.461%	4.462%	4.461%	4.462%	4.461%	4.462%	4.461%	2.231%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	45	45	45	45	45	45	45	45	22	-	-	-	-
Tax Depreciation	45	45	45	45	45	45	45	45	22	-	-	-	-
Accumulated Tax Depreciation	665	710	755	799	844	888	933	978	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	231	250	269	288	308	327	346	365	385	404	423	442	462
Tax Accumulated Depreciation	665	710	755	799	844	888	933	978	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(435)	(460)	(485)	(511)	(536)	(562)	(587)	(612)	(615)	(596)	(577)	(558)	(538)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(112)	(118)	(125)	(132)	(138)	(145)	(151)	(158)	(158)	(154)	(149)	(144)	(139)
Deferred Tax Base	25	25	25	25	25	25	25	25	3	(19)	(19)	(19)	(19)
Deferred Taxes - Federal	5	5	5	5	5	5	5	5	1	(4)	(4)	(4)	(4)
Deferred Taxes - State excluding credit	2	2	2	2	2	2	2	2	0	(1)	(1)	(1)	(1)
Change in Deferred Taxes	7	7	7	7	7	7	7	7	1	(5)	(5)	(5)	(5)
Accumulated Deferred Taxes	112	118	125	132	138	145	151	158	158	154	149	144	139
check	-	-	-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	231	250	269	288	308	327	346	365	385	404	423	442	462
Accumulated Deferred Taxes	112	118	125	132	138	145	151	158	158	154	149	144	139
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	657	632	606	580	554	528	503	477	457	443	428	414	400
Average Net Investment	670	644	619	593	567	541	516	490	467	450	435	421	407
Average Financing:													
Short Term Debt	9	9	8	8	8	7	7	7	6	6	6	6	6
Long Term Debt (Revenue Bonds)	259	249	239	229	219	209	199	189	181	174	168	163	157
Taxable Debt	13	13	12	12	11	11	10	10	9	9	9	8	8
Preferred Stock	7	6	6	6	6	5	5	5	5	4	4	4	4
Common Equity	382	367	353	338	323	309	294	279	266	256	248	240	232
Total Financing	670	644	619	593	567	541	516	490	467	450	435	421	407

Revenue Requirements Model - Calculati
Distribution - Overhead Conductors and I

Manual input	13	14	15	16	17	18	19	20	21	22	23	24	25
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	12	11	11	10	10	10	9	9	8	8	8	7	7
Hybrids	1	1	1	1	1	1	1	1	1	1	1	1	1
Total Interest Expense	13	12	12	11	11	10	10	9	9	9	8	8	8
Preferred Dividends	1	1	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	36	35	34	32	31	29	28	27	25	24	24	23	22
Income Taxes													
Income Before Pref Dividends	37	35	34	33	31	30	28	27	26	25	24	23	22
Income Before Taxes (including ITC)	50	48	46	44	42	40	38	36	35	33	32	31	30
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	50	48	46	44	42	40	38	36	35	33	32	31	30
Federal Income Tax	10	9	9	9	8	8	8	7	7	7	6	6	6
State Income Tax	3	3	3	3	3	2	2	2	2	2	2	2	2
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	3	3	3	3	3	2	2	2	2	2	2	2	2
Total Taxes	13	12	12	11	11	10	10	9	9	9	8	8	8
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0898**	**0.0872**	**0.0845**	**0.0819**	**0.0792**	**0.0766**	**0.0740**	**0.0713**	**0.0690**	**0.0672**	**0.0658**	**0.0643**	**0.0628**
Revenue Requirement	**90**	**87**	**85**	**82**	**79**	**77**	**74**	**71**	**69**	**67**	**66**	**64**	**63**
Revenue Taxes	8	8	8	7	7	7	7	6	6	6	6	6	6
Income Before Depr, Int, Inc Tax	82	79	77	75	72	70	67	65	63	61	60	59	57
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	13	12	12	11	11	10	10	9	9	9	8	8	8
Income Before Income Taxes	50	48	46	44	42	40	38	36	35	33	32	31	30
Income Taxes - Federal	10	9	9	9	8	8	8	7	7	7	6	6	6
Income Taxes - State	3	3	3	3	3	2	2	2	2	2	2	2	2
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	13	12	12	11	11	10	10	9	9	9	8	8	8
Preferred Dividends	1	1	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	36	35	34	32	31	29	28	27	25	24	24	23	22
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Distribution - Overhead Conductors and I

Manual input	26	27	28	29	30	31	32	33	34	35	36	37	38
O&M													
Escalation Rate	1.64	1.67	1.71	1.74	1.78	1.81	1.85	1.88	1.92	1.96	2.00	2.04	2.08
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
Accumulated Depreciation	481	500	519	538	558	577	596	615	635	654	673	692	712
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	481	500	519	538	558	577	596	615	635	654	673	692	712
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(519)	(500)	(481)	(462)	(442)	(423)	(404)	(385)	(365)	(346)	(327)	(308)	(288)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(134)	(129)	(124)	(119)	(114)	(109)	(104)	(99)	(94)	(89)	(84)	(79)	(74)
Deferred Tax Base	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)
Deferred Taxes - Federal	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Change in Deferred Taxes	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Accumulated Deferred Taxes	134	129	124	119	114	109	104	99	94	89	84	79	74
check	-	-	-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	481	500	519	538	558	577	596	615	635	654	673	692	712
Accumulated Deferred Taxes	134	129	124	119	114	109	104	99	94	89	84	79	74
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	386	371	357	343	328	314	300	286	271	257	243	228	214
Average Net Investment	393	378	364	350	336	321	307	293	278	264	250	236	221
Average Financing:													
Short Term Debt	5	5	5	5	5	4	4	4	4	4	3	3	3
Long Term Debt (Revenue Bonds)	152	146	141	135	130	124	119	113	108	102	97	91	86
Taxable Debt	8	7	7	7	7	6	6	6	5	5	5	5	4
Preferred Stock	4	4	4	3	3	3	3	3	3	3	2	2	2
Common Equity	224	216	208	199	191	183	175	167	159	151	142	134	126
Total Financing	393	378	364	350	336	321	307	293	278	264	250	236	221

Revenue Requirements Model - Calculati
Distribution - Overhead Conductors and I

Manual input	26	27	28	29	30	31	32	33	34	35	36	37	38
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	7	7	6	6	6	6	5	5	5	5	4	4	4
Hybrids	1	1	1	0	0	0	0	0	0	0	0	0	0
Total Interest Expense	8	7	7	7	7	6	6	6	5	5	5	5	4
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	21	20	20	19	18	17	17	16	15	14	14	13	12
Income Taxes													
Income Before Pref Dividends	22	21	20	19	18	18	17	16	15	15	14	13	12
Income Before Taxes (including ITC)	29	28	27	26	25	24	23	22	21	20	18	17	16
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	29	28	27	26	25	24	23	22	21	20	18	17	16
Federal Income Tax	6	6	5	5	5	5	4	4	4	4	4	3	3
State Income Tax	2	2	2	2	1	1	1	1	1	1	1	1	1
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	2	2	2	2	1	1	1	1	1	1	1	1	1
Total Taxes	7	7	7	7	6	6	6	6	5	5	5	4	4
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0614**	**0.0599**	**0.0584**	**0.0570**	**0.0555**	**0.0540**	**0.0526**	**0.0511**	**0.0496**	**0.0482**	**0.0467**	**0.0453**	**0.0438**
Revenue Requirement	**61**	**60**	**58**	**57**	**56**	**54**	**53**	**51**	**50**	**48**	**47**	**45**	**44**
Revenue Taxes	5	5	5	5	5	5	5	5	4	4	4	4	4
Income Before Depr, Int, Inc Tax	56	55	53	52	51	49	48	47	45	44	43	41	40
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	8	7	7	7	7	6	6	6	5	5	5	5	4
Income Before Income Taxes	29	28	27	26	25	24	23	22	21	20	18	17	16
Income Taxes - Federal	6	6	5	5	5	5	4	4	4	4	4	3	3
Income Taxes - State	2	2	2	2	1	1	1	1	1	1	1	1	1
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	7	7	7	7	6	6	6	6	5	5	5	4	4
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	21	20	20	19	18	17	17	16	15	14	14	13	12
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Distribution - Overhead Conductors and I

Manual input	39	40	41	42	43	44	45	46	47	48	49	50	51
O&M													
Escalation Rate	2.12	2.16	2.21	2.25	2.30	2.34	2.39	2.44	2.49	2.54	2.59	2.64	2.69
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%	1.923%
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
Accumulated Depreciation	731	750	769	788	808	827	846	865	885	904	923	942	962
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	731	750	769	788	808	827	846	865	885	904	923	942	962
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(269)	(250)	(231)	(212)	(192)	(173)	(154)	(135)	(115)	(96)	(77)	(58)	(38)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(69)	(64)	(59)	(54)	(50)	(45)	(40)	(35)	(30)	(25)	(20)	(15)	(10)
Deferred Tax Base	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)
Deferred Taxes - Federal	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Change in Deferred Taxes	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Accumulated Deferred Taxes	69	64	59	54	50	45	40	35	30	25	20	15	10
check	-	-	0	0	0	0	0	0	0	0	0	0	0
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	731	750	769	788	808	827	846	865	885	904	923	942	962
Accumulated Deferred Taxes	69	64	59	54	50	45	40	35	30	25	20	15	10
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	200	186	171	157	143	129	114	100	86	71	57	43	29
Average Net Investment	207	193	178	164	150	136	121	107	93	79	64	50	36
Average Financing:													
Short Term Debt	3	3	2	2	2	2	2	1	1	1	1	1	0
Long Term Debt (Revenue Bonds)	80	75	69	64	58	52	47	41	36	30	25	19	14
Taxable Debt	4	4	3	3	3	3	2	2	2	2	1	1	1
Preferred Stock	2	2	2	2	1	1	1	1	1	1	1	0	0
Common Equity	118	110	102	94	85	77	69	61	53	45	37	28	20
Total Financing	207	193	178	164	150	136	121	107	93	79	64	50	36

Revenue Requirements Model - Calculati
Distribution - Overhead Conductors and I

Manual input	39	40	41	42	43	44	45	46	47	48	49	50	51
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	4	3	3	3	3	2	2	2	2	1	1	1	1
Hybrids	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Interest Expense	4	4	3	3	3	3	2	2	2	2	1	1	1
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	11	10	10	9	8	7	7	6	5	4	3	3	2
Income Taxes													
Income Before Pref Dividends	11	11	10	9	8	7	7	6	5	4	4	3	2
Income Before Taxes (including ITC)	15	14	13	12	11	10	9	8	7	6	5	4	3
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	15	14	13	12	11	10	9	8	7	6	5	4	3
Federal Income Tax	3	3	3	2	2	2	2	2	1	1	1	1	1
State Income Tax	1	1	1	1	1	1	1	0	0	0	0	0	0
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	1	1	1	1	1	1	1	0	0	0	0	0	0
Total Taxes	4	4	3	3	3	3	2	2	2	1	1	1	1
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0423**	**0.0409**	**0.0394**	**0.0379**	**0.0365**	**0.0350**	**0.0335**	**0.0321**	**0.0306**	**0.0292**	**0.0277**	**0.0262**	**0.0248**
Revenue Requirement	**42**	**41**	**39**	**38**	**36**	**35**	**34**	**32**	**31**	**29**	**28**	**26**	**25**
Revenue Taxes	4	4	4	3	3	3	3	3	3	3	2	2	2
Income Before Depr, Int, Inc Tax	39	37	36	35	33	32	31	29	28	27	25	24	23
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	4	4	3	3	3	3	2	2	2	2	1	1	1
Income Before Income Taxes	15	14	13	12	11	10	9	8	7	6	5	4	3
Income Taxes - Federal	3	3	3	2	2	2	2	2	1	1	1	1	1
Income Taxes - State	1	1	1	1	1	1	1	0	0	0	0	0	0
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	4	4	3	3	3	3	2	2	2	1	1	1	1
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	11	10	10	9	8	7	7	6	5	4	3	3	2
	-	-	-	-	-	-	-	-	-	-	-	*(0)*	-

Resilience Project/Program
Revenue Requirements Model - Calculatio
Distribution - Overhead Conductors and I

Manual input	52	53	54	55	56	57	58	59	60	Total
O&M										
Escalation Rate	2.75	2.80	2.86	2.91	2.97	3.03	3.09	3.15	3.22	
O&M	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation										
Book Depreciation										
Book Depreciation Rates	1.923%	1.923%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Depreciation Expense	19	19	-	-	-	-	-	-	-	1,000
Accumulated Depreciation	981	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Tax Depreciation										
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	1,000
Tax Depreciation	-	-	-	-	-	-	-	-	-	1,000
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
State Investment Tax Credit (ITC)										
Book										
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	40
Accumulated Amortization	40	40	40	40	40	40	40	40	40	
Deferred ITC	-	-	-	-	-	-	-	-	-	
Tax										
Deferred Tax Calculation										
Book Accumulated Depreciation	981	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Book/Tax Acc Depr Difference	(19)	0	0	0	0	0	0	0	0	
Deferred ITC	-	-	-	-	-	-	-	-	-	
Net Deferred Tax Asset (Liability)	(5)	0	0	0	0	0	0	0	0	
Deferred Tax Base	(19)	(19)	-	-	-	-	-	-	-	
Deferred Taxes - Federal	(4)	(4)	-	-	-	-	-	-	-	
Deferred Taxes - State excluding credit	(1)	(1)	-	-	-	-	-	-	-	
Change in Deferred Taxes	(5)	(5)	-	-	-	-	-	-	-	
Accumulated Deferred Taxes	5	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
check	0	0	0	0	0	0	0	0	0	
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	
	-	-	-	-	-	-	-	-	-	
Rate Base and Financing										
Investment: (Rate Base)										
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Accumulated Depreciation	981	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Accumulated Deferred Taxes	5	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	
Ending Net Investment	14	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Average Net Investment	21	7	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Average Financing:										
Short Term Debt	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Long Term Debt (Revenue Bonds)	8	3	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Taxable Debt	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Preferred Stock	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Common Equity	12	4	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Total Financing	21	7	(0)	(0)	(0)	(0)	(0)	(0)	(0)	

Revenue Requirements Model - Calculati
Distribution - Overhead Conductors and I

Manual input	52	53	54	55	56	57	58	59	60	Total
Return on Investment										
Short Term Debt	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Long Term Debt (Taxable Debt)	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Hybrids	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Total Interest Expense	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Preferred Dividends	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Net Income on Common	1	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Taxes										
Income Before Pref Dividends	1	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Before Taxes (including ITC)	2	1	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Investment Tax Credit	-	-	-	-	-	-	-	-	-	
Income Before Taxes (excluding ITC)	2	1	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Federal Income Tax	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
State Income Tax	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	
Total State Tax	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Total Taxes	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Revenue Requirement Calculation										
Revenue Requirement Factors	**0.0233**	**0.0218**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	**(0.0000)**	
Revenue Requirement	**23**	**22**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	
Revenue Taxes	2	2	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Before Depr, Int, Inc Tax	21	20	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Depreciation Expense	19	19	-	-	-	-	-	-	-	
O&M	-	-	-	-	-	-	-	-	-	
Interest Expense	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Before Income Taxes	2	1	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Taxes - Federal	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Income Taxes - State	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
State ITC	-	-	-	-	-	-	-	-	-	
Total Income Taxes	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Preferred Dividends	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Net Income for Common	1	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
	(0)	*0*	-	-	-	-	-	-	-	

Resilience Project/Program
Revenue Requirements Model - Calculations ME Distribution
Distribution - Station Equipment - Substations

		1	2	3	4	5	6	7	8	9	10	11	12
Manual input													
O&M													
Escalation Rate		1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24
O&M		-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates		0.000%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%
Depreciation Expense		-	19	19	19	19	19	19	19	19	19	19	19
Accumulated Depreciation		-	19	37	56	74	93	111	130	148	167	185	204
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	**20**	2.500%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%
Tax Basis (S/L)	0.0%	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	**20**	3.750%	7.219%	6.677%	6.177%	5.713%	5.285%	4.888%	4.522%	4.462%	4.461%	4.462%	4.461%
NonRB Financed Tax Basis (MACRS)	100.0%	38	72	67	62	57	53	49	45	45	45	45	45
Tax Depreciation		38	72	67	62	57	53	49	45	45	45	45	45
Accumulated Tax Depreciation		38	110	176	238	295	348	397	442	487	532	576	621
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate		0.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	10.000%	0.000%
Amortization of State ITC	4.00%	-	4	4	4	4	4	4	4	4	4	4	-
Accumulated Amortization		-	4	8	12	16	20	24	28	32	36	40	40
Deferred ITC		40	36	32	28	24	20	16	12	8	4	-	-
Tax		40											
Deferred Tax Calculation													
Book Accumulated Depreciation		-	19	37	56	74	93	111	130	148	167	185	204
Tax Accumulated Depreciation		38	110	176	238	295	348	397	442	487	532	576	621
Book/Tax Acc Depr Difference		(38)	(91)	(139)	(183)	(221)	(256)	(286)	(313)	(339)	(365)	(391)	(417)
Deferred ITC		40	36	32	28	24	20	16	12	8	4	-	-
Net Deferred Tax Asset (Liability)		1	(14)	(28)	(40)	(51)	(61)	(70)	(77)	(85)	(93)	(101)	(107)
Deferred Tax Base		(3)	58	52	47	43	38	34	31	30	30	30	26
Deferred Taxes - Federal		(0)	11	10	9	8	8	7	6	6	6	6	5
Deferred Taxes - State excluding credit		(0)	3	3	3	3	2	2	2	2	2	2	2
Change in Deferred Taxes		(1)	15	13	12	11	10	9	8	8	8	8	7
Accumulated Deferred Taxes		(1)	14	28	40	51	61	70	77	85	93	101	107
check		-	-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC		40	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
		40	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant		1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation		-	19	37	56	74	93	111	130	148	167	185	204
Accumulated Deferred Taxes		(1)	14	28	40	51	61	70	77	85	93	101	107
Accumulated Deferred ITC		40	36	32	28	24	20	16	12	8	4	-	-
Ending Net Investment	1,000	961	931	903	877	851	827	803	781	759	736	714	689
Average Net Investment		-	946	917	890	864	839	815	792	770	748	725	702
Average Financing:													
Short Term Debt	1.37%	-	13	13	12	12	11	11	11	11	10	10	10
Long Term Debt (Revenue Bonds)	38.68%	-	366	355	344	334	324	315	306	298	289	281	271
Taxable Debt	1.96%	-	18	18	17	17	16	16	15	15	15	14	14
Preferred Stock	0.98%	-	9	9	9	8	8	8	8	8	7	7	7
Common Equity	57.02%	-	539	523	507	493	478	465	452	439	426	414	400
Total Financing		-	946	917	890	864	839	815	792	770	748	725	702

Revenue Requirements Model - Calculations ME Distribution
Distribution - Station Equipment - Substations

Manual input		1	2	3	4	5	6	7	8	9	10	11	12
Return on Investment													
Short Term Debt	3.00%	-	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	4.54%	-	17	16	16	15	15	14	14	14	13	13	12
Hybrids	7.16%	-	1	1	1	1	1	1	1	1	1	1	1
Total Interest Expense		-	18	18	17	17	16	16	15	15	14	14	14
Preferred Dividends	8.15%	-	1	1	1	1	1	1	1	1	1	1	1
Net Income on Common	9.50%	-	51	50	48	47	45	44	43	42	40	39	38
Income Taxes													
Income Before Pref Dividends		-	52	50	49	47	46	45	44	42	41	40	39
Income Before Taxes (including ITC)		-	70	68	66	64	62	60	59	57	55	54	52
Investment Tax Credit		-	4	4	4	4	4	4	4	4	4	4	-
Income Before Taxes (excluding ITC)		-	66	64	62	60	58	56	55	53	51	50	52
Federal Income Tax		-	14	13	13	13	12	12	12	11	11	11	10
State Income Tax		-	4	4	4	4	4	4	4	3	3	3	3
State Investment Tax Credit		-	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
Total State Tax		-	0	0	(0)	(0)	(0)	(0)	(0)	(1)	(1)	(1)	3
Total Taxes		-	14	13	13	12	12	12	11	11	10	10	13
Revenue Requirement Calculation													
Revenue Requirement Factors		**-**	**0.1129**	**0.1100**	**0.1072**	**0.1045**	**0.1019**	**0.0995**	**0.0971**	**0.0949**	**0.0926**	**0.0903**	**0.0922**
Revenue Requirement		**-**	**113**	**110**	**107**	**104**	**102**	**99**	**97**	**95**	**93**	**90**	**92**
Revenue Taxes		-	10	10	10	9	9	9	9	8	8	8	8
Income Before Depr, Int, Inc Tax		-	103	100	98	95	93	91	89	86	84	82	84
Depreciation Expense		-	19	19	19	19	19	19	19	19	19	19	19
O&M		-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense		-	18	18	17	17	16	16	15	15	14	14	14
Income Before Income Taxes		-	66	64	62	60	58	56	55	53	51	50	52
Income Taxes - Federal		-	14	13	13	13	12	12	12	11	11	11	10
Income Taxes - State		-	4	4	4	4	4	4	4	3	3	3	3
State ITC		-	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	-
Total Income Taxes		-	14	13	13	12	12	12	11	11	10	10	13
Preferred Dividends		-	1	1	1	1	1	1	1	1	1	1	1
Net Income for Common		-	51	50	48	47	45	44	43	42	40	39	38
check		-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Distribution - Station Equipment - Substa

Manual input	13	14	15	16	17	18	19	20	21	22	23	24	25
O&M													
Escalation Rate	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46	1.49	1.52	1.55	1.58	1.61
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
Accumulated Depreciation	222	241	259	278	296	315	333	352	370	389	407	426	444
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	5.000%	2.500%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	4.462%	4.461%	4.462%	4.461%	4.462%	4.461%	4.462%	4.461%	2.231%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	45	45	45	45	45	45	45	45	22	-	-	-	-
Tax Depreciation	45	45	45	45	45	45	45	45	22	-	-	-	-
Accumulated Tax Depreciation	665	710	755	799	844	888	933	978	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	222	241	259	278	296	315	333	352	370	389	407	426	444
Tax Accumulated Depreciation	665	710	755	799	844	888	933	978	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(443)	(469)	(495)	(521)	(548)	(574)	(600)	(626)	(630)	(611)	(593)	(574)	(556)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(114)	(121)	(128)	(134)	(141)	(148)	(154)	(161)	(162)	(157)	(153)	(148)	(143)
Deferred Tax Base	26	26	26	26	26	26	26	26	4	(19)	(19)	(19)	(19)
Deferred Taxes - Federal	5	5	5	5	5	5	5	5	1	(4)	(4)	(4)	(4)
Deferred Taxes - State excluding credit	2	2	2	2	2	2	2	2	0	(1)	(1)	(1)	(1)
Change in Deferred Taxes	7	7	7	7	7	7	7	7	1	(5)	(5)	(5)	(5)
Accumulated Deferred Taxes	114	121	128	134	141	148	154	161	162	157	153	148	143
check	-	-	-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	222	241	259	278	296	315	333	352	370	389	407	426	444
Accumulated Deferred Taxes	114	121	128	134	141	148	154	161	162	157	153	148	143
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	664	638	613	588	563	537	512	487	467	454	440	426	412
Average Net Investment	676	651	626	601	575	550	525	500	477	461	447	433	419
Average Financing:													
Short Term Debt	9	9	9	8	8	8	7	7	7	6	6	6	6
Long Term Debt (Revenue Bonds)	262	252	242	232	223	213	203	193	185	178	173	168	162
Taxable Debt	13	13	12	12	11	11	10	10	9	9	9	8	8
Preferred Stock	7	6	6	6	6	5	5	5	5	5	4	4	4
Common Equity	386	371	357	342	328	314	299	285	272	263	255	247	239
Total Financing	676	651	626	601	575	550	525	500	477	461	447	433	419

Revenue Requirements Model - Calculati
Distribution - Station Equipment - Substa

Manual input	13	14	15	16	17	18	19	20	21	22	23	24	25
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	12	11	11	11	10	10	9	9	8	8	8	8	7
Hybrids	1	1	1	1	1	1	1	1	1	1	1	1	1
Total Interest Expense	13	13	12	12	11	11	10	10	9	9	9	8	8
Preferred Dividends	1	1	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	37	35	34	33	31	30	28	27	26	25	24	23	23
Income Taxes													
Income Before Pref Dividends	37	36	34	33	32	30	29	27	26	25	25	24	23
Income Before Taxes (including ITC)	50	48	46	44	43	41	39	37	35	34	33	32	31
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	50	48	46	44	43	41	39	37	35	34	33	32	31
Federal Income Tax	10	10	9	9	8	8	8	7	7	7	7	6	6
State Income Tax	3	3	3	3	3	2	2	2	2	2	2	2	2
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	3	3	3	3	3	2	2	2	2	2	2	2	2
Total Taxes	13	12	12	11	11	10	10	10	9	9	9	8	8
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0897**	**0.0871**	**0.0845**	**0.0819**	**0.0793**	**0.0767**	**0.0741**	**0.0715**	**0.0692**	**0.0675**	**0.0661**	**0.0647**	**0.0633**
Revenue Requirement	**90**	**87**	**84**	**82**	**79**	**77**	**74**	**72**	**69**	**68**	**66**	**65**	**63**
Revenue Taxes	8	8	8	7	7	7	7	6	6	6	6	6	6
Income Before Depr, Int, Inc Tax	82	79	77	75	72	70	68	65	63	62	60	59	58
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	13	13	12	12	11	11	10	10	9	9	9	8	8
Income Before Income Taxes	50	48	46	44	43	41	39	37	35	34	33	32	31
Income Taxes - Federal	10	10	9	9	8	8	8	7	7	7	7	6	6
Income Taxes - State	3	3	3	3	3	2	2	2	2	2	2	2	2
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	13	12	12	11	11	10	10	10	9	9	9	8	8
Preferred Dividends	1	1	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	37	35	34	33	31	30	28	27	26	25	24	23	23
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Distribution - Station Equipment - Substa

Manual input	26	27	28	29	30	31	32	33	34	35	36	37	38
O&M													
Escalation Rate	1.64	1.67	1.71	1.74	1.78	1.81	1.85	1.88	1.92	1.96	2.00	2.04	2.08
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
Accumulated Depreciation	463	481	500	519	537	556	574	593	611	630	648	667	685
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	463	481	500	519	537	556	574	593	611	630	648	667	685
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(537)	(519)	(500)	(481)	(463)	(444)	(426)	(407)	(389)	(370)	(352)	(333)	(315)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(138)	(134)	(129)	(124)	(119)	(114)	(110)	(105)	(100)	(95)	(91)	(86)	(81)
Deferred Tax Base	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)
Deferred Taxes - Federal	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Change in Deferred Taxes	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Accumulated Deferred Taxes	138	134	129	124	119	114	110	105	100	95	91	86	81
check	-	-	-	-	-	-	-	-	-	-	-	-	-
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	463	481	500	519	537	556	574	593	611	630	648	667	685
Accumulated Deferred Taxes	138	134	129	124	119	114	110	105	100	95	91	86	81
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	399	385	371	357	344	330	316	302	289	275	261	247	234
Average Net Investment	406	392	378	364	351	337	323	309	296	282	268	254	241
Average Financing:													
Short Term Debt	6	5	5	5	5	5	4	4	4	4	4	3	3
Long Term Debt (Revenue Bonds)	157	152	146	141	136	130	125	120	114	109	104	98	93
Taxable Debt	8	8	7	7	7	7	6	6	6	6	5	5	5
Preferred Stock	4	4	4	4	3	3	3	3	3	3	3	2	2
Common Equity	231	223	216	208	200	192	184	176	169	161	153	145	137
Total Financing	406	392	378	364	351	337	323	309	296	282	268	254	241

Revenue Requirements Model - Calculati
Distribution - Station Equipment - Substa

Manual input	26	27	28	29	30	31	32	33	34	35	36	37	38
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	7	7	7	6	6	6	6	5	5	5	5	4	4
Hybrids	1	1	1	1	0	0	0	0	0	0	0	0	0
Total Interest Expense	8	8	7	7	7	7	6	6	6	5	5	5	5
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	22	21	20	20	19	18	18	17	16	15	15	14	13
Income Taxes													
Income Before Pref Dividends	22	22	21	20	19	19	18	17	16	15	15	14	13
Income Before Taxes (including ITC)	30	29	28	27	26	25	24	23	22	21	20	19	18
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	30	29	28	27	26	25	24	23	22	21	20	19	18
Federal Income Tax	6	6	6	5	5	5	5	5	4	4	4	4	4
State Income Tax	2	2	2	2	2	1	1	1	1	1	1	1	1
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	2	2	2	2	2	1	1	1	1	1	1	1	1
Total Taxes	8	7	7	7	7	6	6	6	6	5	5	5	5
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0619**	**0.0605**	**0.0591**	**0.0577**	**0.0563**	**0.0549**	**0.0534**	**0.0520**	**0.0506**	**0.0492**	**0.0478**	**0.0464**	**0.0450**
Revenue Requirement	**62**	**60**	**59**	**58**	**56**	**55**	**53**	**52**	**51**	**49**	**48**	**46**	**45**
Revenue Taxes	6	5	5	5	5	5	5	5	4	4	4	4	4
Income Before Depr, Int, Inc Tax	56	55	54	53	51	50	49	47	46	45	44	42	41
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	8	8	7	7	7	7	6	6	6	5	5	5	5
Income Before Income Taxes	30	29	28	27	26	25	24	23	22	21	20	19	18
Income Taxes - Federal	6	6	6	5	5	5	5	5	4	4	4	4	4
Income Taxes - State	2	2	2	2	2	1	1	1	1	1	1	1	1
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	8	7	7	7	7	6	6	6	6	5	5	5	5
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	22	21	20	20	19	18	18	17	16	15	15	14	13
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculati
Distribution - Station Equipment - Substa

Manual input	39	40	41	42	43	44	45	46	47	48	49	50	51
O&M													
Escalation Rate	2.12	2.16	2.21	2.25	2.30	2.34	2.39	2.44	2.49	2.54	2.59	2.64	2.69
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation													
Book Depreciation													
Book Depreciation Rates	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%	1.852%
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
Accumulated Depreciation	704	722	741	759	778	796	815	833	852	870	889	907	926
Tax Depreciation													
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
State Investment Tax Credit (ITC)													
Book													
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization	40	40	40	40	40	40	40	40	40	40	40	40	40
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax													
Deferred Tax Calculation													
Book Accumulated Depreciation	704	722	741	759	778	796	815	833	852	870	889	907	926
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Book/Tax Acc Depr Difference	(296)	(278)	(259)	(241)	(222)	(204)	(185)	(167)	(148)	(130)	(111)	(93)	(74)
Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Deferred Tax Asset (Liability)	(76)	(72)	(67)	(62)	(57)	(52)	(48)	(43)	(38)	(33)	(29)	(24)	(19)
Deferred Tax Base	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)
Deferred Taxes - Federal	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Change in Deferred Taxes	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Accumulated Deferred Taxes	76	72	67	62	57	52	48	43	38	33	29	24	19
check	-	-	-	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Rate Base and Financing													
Investment: (Rate Base)													
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Accumulated Depreciation	704	722	741	759	778	796	815	833	852	870	889	907	926
Accumulated Deferred Taxes	76	72	67	62	57	52	48	43	38	33	29	24	19
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Ending Net Investment	220	206	192	179	165	151	137	124	110	96	82	69	55
Average Net Investment	227	213	199	186	172	158	144	131	117	103	89	76	62
Average Financing:													
Short Term Debt	3	3	3	3	2	2	2	2	2	1	1	1	1
Long Term Debt (Revenue Bonds)	88	82	77	72	66	61	56	51	45	40	35	29	24
Taxable Debt	4	4	4	4	3	3	3	3	2	2	2	1	1
Preferred Stock	2	2	2	2	2	2	1	1	1	1	1	1	1
Common Equity	129	122	114	106	98	90	82	74	67	59	51	43	35
Total Financing	227	213	199	186	172	158	144	131	117	103	89	76	62

Revenue Requirements Model - Calculati
Distribution - Station Equipment - Substa

Manual input	39	40	41	42	43	44	45	46	47	48	49	50	51
Return on Investment													
Short Term Debt	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Debt (Taxable Debt)	4	4	4	3	3	3	3	2	2	2	2	1	1
Hybrids	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Interest Expense	4	4	4	4	3	3	3	3	2	2	2	1	1
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income on Common	12	12	11	10	9	9	8	7	6	6	5	4	3
Income Taxes													
Income Before Pref Dividends	12	12	11	10	9	9	8	7	6	6	5	4	3
Income Before Taxes (including ITC)	17	16	15	14	13	12	11	10	9	8	7	6	5
Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Before Taxes (excluding ITC)	17	16	15	14	13	12	11	10	9	8	7	6	5
Federal Income Tax	3	3	3	3	3	2	2	2	2	2	1	1	1
State Income Tax	1	1	1	1	1	1	1	1	1	0	0	0	0
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	-	-	-	-
Total State Tax	1	1	1	1	1	1	1	1	1	0	0	0	0
Total Taxes	4	4	4	4	3	3	3	2	2	2	2	1	1
Revenue Requirement Calculation													
Revenue Requirement Factors	**0.0436**	**0.0422**	**0.0408**	**0.0394**	**0.0379**	**0.0365**	**0.0351**	**0.0337**	**0.0323**	**0.0309**	**0.0295**	**0.0281**	**0.0267**
Revenue Requirement	**44**	**42**	**41**	**39**	**38**	**37**	**35**	**34**	**32**	**31**	**29**	**28**	**27**
Revenue Taxes	4	4	4	3	3	3	3	3	3	3	3	2	2
Income Before Depr, Int, Inc Tax	40	38	37	36	35	33	32	31	29	28	27	26	24
Depreciation Expense	19	19	19	19	19	19	19	19	19	19	19	19	19
O&M	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	4	4	4	4	3	3	3	3	2	2	2	1	1
Income Before Income Taxes	17	16	15	14	13	12	11	10	9	8	7	6	5
Income Taxes - Federal	3	3	3	3	3	2	2	2	2	2	1	1	1
Income Taxes - State	1	1	1	1	1	1	1	1	1	0	0	0	0
State ITC	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income Taxes	4	4	4	4	3	3	3	2	2	2	2	1	1
Preferred Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income for Common	12	12	11	10	9	9	8	7	6	6	5	4	3
	-	-	-	-	-	-	-	-	-	-	-	-	-

Resilience Project/Program
Revenue Requirements Model - Calculatio
Distribution - Station Equipment - Substa

Manual input	52	53	54	55	56	57	58	59	60	Total
O&M										
Escalation Rate	2.75	2.80	2.86	2.91	2.97	3.03	3.09	3.15	3.22	
O&M	-	-	-	-	-	-	-	-	-	-
Plant Asset Depreciation										
Book Depreciation										
Book Depreciation Rates	1.852%	1.852%	1.852%	1.852%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Depreciation Expense	19	19	19	19	-	-	-	-	-	1,000
Accumulated Depreciation	944	963	981	1,000	1,000	1,000	1,000	1,000	1,000	
Tax Depreciation										
Tax Depreciation Rates (Straight Line)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Tax Basis (S/L)	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
NonRB Financed Tax Basis (MACRS)	-	-	-	-	-	-	-	-	-	1,000
Tax Depreciation	-	-	-	-	-	-	-	-	-	1,000
Accumulated Tax Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
State Investment Tax Credit (ITC)										
Book										
State ITC Amortization Rate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.00%
Amortization of State ITC	-	-	-	-	-	-	-	-	-	40
Accumulated Amortization	40	40	40	40	40	40	40	40	40	
Deferred ITC	-	-	-	-	-	-	-	-	-	
Tax										
Deferred Tax Calculation										
Book Accumulated Depreciation	944	963	981	1,000	1,000	1,000	1,000	1,000	1,000	
Tax Accumulated Depreciation	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Book/Tax Acc Depr Difference	(56)	(37)	(19)	-	-	-	-	-	-	
Deferred ITC	-	-	-	-	-	-	-	-	-	
Net Deferred Tax Asset (Liability)	(14)	(10)	(5)	-	-	-	-	-	-	
Deferred Tax Base	(19)	(19)	(19)	(19)	-	-	-	-	-	
Deferred Taxes - Federal	(4)	(4)	(4)	(4)	-	-	-	-	-	
Deferred Taxes - State excluding credit	(1)	(1)	(1)	(1)	-	-	-	-	-	
Change in Deferred Taxes	(5)	(5)	(5)	(5)	-	-	-	-	-	
Accumulated Deferred Taxes	14	10	5	(0)	(0)	(0)	(0)	(0)	(0)	
check	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Change in Deferred ITC	-	-	-	-	-	-	-	-	-	
	-	-	-	-	-	-	-	-	-	
Rate Base and Financing										
Investment: (Rate Base)										
Gross Plant	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Accumulated Depreciation	944	963	981	1,000	1,000	1,000	1,000	1,000	1,000	
Accumulated Deferred Taxes	14	10	5	(0)	(0)	(0)	(0)	(0)	(0)	
Accumulated Deferred ITC	-	-	-	-	-	-	-	-	-	
Ending Net Investment	41	27	14	0	0	0	0	0	0	
Average Net Investment	48	34	21	7	0	0	0	0	0	
Average Financing:										
Short Term Debt	1	0	0	0	0	0	0	0	0	
Long Term Debt (Revenue Bonds)	19	13	8	3	0	0	0	0	0	
Taxable Debt	1	1	0	0	0	0	0	0	0	
Preferred Stock	0	0	0	0	0	0	0	0	0	
Common Equity	27	20	12	4	0	0	0	0	0	
Total Financing	48	34	21	7	0	0	0	0	0	

Revenue Requirements Model - Calculati
Distribution - Station Equipment - Substa

Manual input	52	53	54	55	56	57	58	59	60	Total
Return on Investment										
Short Term Debt	0	0	0	0	0	0	0	0	0	
Long Term Debt (Taxable Debt)	1	1	0	0	0	0	0	0	0	
Hybrids	0	0	0	0	0	0	0	0	0	
Total Interest Expense	1	1	0	0	0	0	0	0	0	
Preferred Dividends	0	0	0	0	0	0	0	0	0	
Net Income on Common	3	2	1	0	0	0	0	0	0	
Income Taxes										
Income Before Pref Dividends	3	2	1	0	0	0	0	0	0	
Income Before Taxes (including ITC)	4	3	2	1	0	0	0	0	0	
Investment Tax Credit	-	-	-	-	-	-	-	-	-	
Income Before Taxes (excluding ITC)	4	3	2	1	0	0	0	0	0	
Federal Income Tax	1	1	0	0	0	0	0	0	0	
State Income Tax	0	0	0	0	0	0	0	0	0	
State Investment Tax Credit	-	-	-	-	-	-	-	-	-	
Total State Tax	0	0	0	0	0	0	0	0	0	
Total Taxes	1	1	0	0	0	0	0	0	0	
Revenue Requirement Calculation										
Revenue Requirement Factors	**0.0253**	**0.0238**	**0.0224**	**0.0210**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	
Revenue Requirement	**25**	**24**	**22**	**21**	**0**	**0**	**0**	**0**	**0**	
Revenue Taxes	2	2	2	2	0	0	0	0	0	
Income Before Depr, Int, Inc Tax	23	22	20	19	0	0	0	0	0	
Depreciation Expense	19	19	19	19	-	-	-	-	-	
O&M	-	-	-	-	-	-	-	-	-	
Interest Expense	1	1	0	0	0	0	0	0	0	
Income Before Income Taxes	4	3	2	1	0	0	0	0	0	
Income Taxes - Federal	1	1	0	0	0	0	0	0	0	
Income Taxes - State	0	0	0	0	0	0	0	0	0	
State ITC	-	-	-	-	-	-	-	-	-	
Total Income Taxes	1	1	0	0	0	0	0	0	0	
Preferred Dividends	0	0	0	0	0	0	0	0	0	
Net Income for Common	3	2	1	0	0	0	0	0	0	
	(0)	*(0)*	-	*(0)*	-	-	-	-	-	

Bill Impact Inputs from Reliability and Resilience Dept
File: S:\Budgets&Financial\FinancialDivision\Financial Analysis Misc\CAPITAL PROJECTS\Resilience Project\Support\Pivots_220526.xlsx

	Capital/O&M	**Asset Class**	**Service Life**	**2023**	**2024**	**2025**	**2026**	**2027**
Hawaii Island	Capital	Transmission - Poles and Fixtures	58	$ -	$ 1,626,675.24	$ 1,233,341.96	$ 3,475,196.73	$ 6,050,348.63
	Capital	Distribution - Poles Towers and Fixtures	45	$ -	$ 1,984,304.93	$ 2,850,353.84	$ 4,738,110.07	$ 6,737,611.59
	Capital	Distribution - Overhead Conductors and Device	53	$ -	$ 239,633.87	$ 172,797.95	$ 1,034,967.86	$ 1,069,815.77
	Capital	Distribution - Station Equipment - Substations	55	$ -	$ 174,350.59	$ 145,654.87	$ 152,441.12	$ 160,412.49
	Capital	**Capital Total**		**$ -**	**$ 4,024,964.63**	**$ 4,402,148.62**	**$ 9,400,715.78**	**$ 14,018,188.47**
	O&M	**O&M Expense**		**$ 372,164.38**	**$ 2,513,873.03**	**$ 2,590,131.88**	**$ 2,663,755.72**	**$ 2,742,126.33**
Maui County	Capital	Transmission - Poles and Fixtures	58	$ -	$ 640,261.72	$ 1,099,690.01	$ 2,265,855.48	$ 4,427,054.68
	Capital	Distribution - Poles Towers and Fixtures	45	$ -	$ 1,804,038.29	$ 2,649,141.34	$ 3,684,348.36	$ 4,683,083.59
	Capital	Distribution - Overhead Conductors and Device	53	$ -	$ 962,207.39	$ 1,247,789.54	$ 3,481,772.63	$ 895,639.11
	Capital	Distribution - Station Equipment - Substations	55	$ -	$ 337,422.05	$ 246,618.31	$ 255,976.89	$ 168,389.95
	Capital	**Capital Total**		**$ -**	**$ 3,743,929.46**	**$ 5,243,239.20**	**$ 9,687,953.37**	**$ 10,174,167.33**
	O&M	**O&M Expense**		**$ 294,520.23**	**$ 2,655,089.13**	**$ 2,735,400.16**	**$ 2,813,157.80**	**$ 2,895,929.30**
Oahu	Capital	Transmission - Poles and Fixtures	58	$ -	$ -	$ 9,823,804.31	$ 17,068,127.77	$ 27,302,073.51
	Capital	Distribution - Poles Towers and Fixtures	45	$ -	$ 2,069,066.91	$ 5,033,359.92	$ 9,417,244.21	$ 15,027,829.33
	Capital	Distribution - Overhead Conductors and Device	53	$ -	$ 1,045,587.79	$ 2,083,958.90	$ 1,084,009.79	$ 1,127,561.67
	Capital	Distribution - Station Equipment - Substations	55	$ -	$ 178,700.35	$ 152,265.65	$ 160,499.64	$ 171,141.41
	Capital	Distribution - Underground Conduit	60	$ -	$ 643,513.23	$ 600,768.85	$ 620,497.27	$ 642,486.93
	Capital	Distribution - Underground Conductors and Dev	55	$ -	$ 321,756.62	$ 300,384.43	$ 310,248.63	$ 321,243.46
	Capital	Distribution - Line Transformers	30	$ -	$ 107,252.21	$ 100,128.14	$ 103,416.21	$ 107,081.15
	Capital	**Capital Total**		**$ -**	**$ 4,365,877.11**	**$ 18,094,670.21**	**$ 28,764,043.52**	**$ 44,699,417.47**
	O&M	**O&M Expense**		**$ 399,003.90**	**$ 2,492,678.58**	**$ 2,572,053.04**	**$ 2,645,123.67**	**$ 2,722,902.11**

Hawaiian Electric Co., Inc.
TOTAL GWH SALES FORECAST (INCLUDING FUTURE LAYERS)
IGP Aug 2021 Forecast

Year	Total GWh Sales
2020	5,804.4
2021	6,227.1
2022	6,278.3
2023	6,273.2
2024	6,331.1
2025	6,406.7
2026	6,482.2
2027	6,492.7
2028	6,524.0
2029	6,560.4
2030	6,631.9
2031	6,665.7
2032	6,702.4
2033	6,758.8
2034	6,805.4
2035	6,863.4
2036	6,948.6
2037	7,006.1
2038	7,085.1
2039	7,189.7
2040	7,340.1
2041	7,426.5
2042	7,557.3
2043	7,702.5
2044	7,876.2
2045	8,016.2
2046	8,178.8
2047	8,342.7
2048	8,524.3
2049	8,650.3
2050	8,780.5

Hawaii Electric Light
IGP August 2021 Sales Forecast (MWh)

	Total Sales
2020	982,773
2021	977,669
2022	986,929
2023	985,809
2024	987,578
2025	985,740
2026	979,703
2027	974,267
2028	976,052
2029	969,467
2030	966,704
2031	964,273
2032	964,623
2033	961,027
2034	962,705
2035	969,771
2036	979,370
2037	985,212
2038	994,060
2039	1,004,937
2040	1,020,345
2041	1,030,993
2042	1,047,968
2043	1,067,693
2044	1,090,134
2045	1,110,199
2046	1,133,859
2047	1,160,394
2048	1,189,843
2049	1,214,221
2050	1,243,569

Maui Electric Company, Ltd. - Consolidated
IGP August 2021 Sales Forecast (MWh)
Years 2020-2050
MWh Sales

Year	Total
2020	985,461
2021	1,018,789
2022	993,402
2023	976,322
2024	979,363
2025	981,821
2026	989,168
2027	996,591
2028	1,002,783
2029	1,004,108
2030	1,009,866
2031	1,017,121
2032	1,031,550
2033	1,047,358
2034	1,064,533
2035	1,083,505
2036	1,107,380
2037	1,125,609
2038	1,149,043
2039	1,172,701
2040	1,199,822
2041	1,219,619
2042	1,244,543
2043	1,269,614
2044	1,295,594
2045	1,316,106
2046	1,339,353
2047	1,362,540
2048	1,389,429
2049	1,409,077
2050	1,433,122

Exhibit E

Climate Adaptation Transmission and Distribution Resilience Program Application

Exceptional Project Recovery

INTERIM RECOVERY[1]

As part of the Climate Adaptation Transmission and Distribution Resilience Program Application, the Hawaiian Electric Companies[2] are requesting recovery of costs related to the proposed investments in (1) critical transmission line hardening, (2) critical pole hardening, (3) critical customer circuit hardening, (4) substation flood monitoring, (5) distribution feeder ties (Maui only), (6) lateral undergrounding (Oʻahu only), (7) hazard tree removal, (8) resilience modeling, and (9) wildfire prevention & mitigation (collectively referred to as the "Project") through the Exceptional Project Recovery Mechanism ("EPRM" or "Mechanism").

In particular, the Companies are requesting recovery of the Capital ("Capital") and Operations and Maintenance ("O&M") costs totaling $189.7 million through the EPRM Mechanism until new rates become effective that provide cost recovery for the Capital costs and O&M costs for the Project for each company.

Here, the Project arose out of and is consistent with the recommendations, objectives, and policy set forth in ongoing planning and investigative dockets (including IGP, PSIP, and PBR) as contemplated by Section III.B.1(d) of the EPRM Guidelines. Ultimately, critical resilience investments such as those proposed by the Project are not adequately addressed through the ARA and should be allowed through the EPRM.

Accordingly, the Companies are requesting to utilize the EPRM adjustment mechanism to recover Project costs during the Multi-Year Rate Period. The proposed recovery will conform with the EPRM Guidelines approved in Decision and Order No. 37507 ("D&O 37507) in Docket No. 2018-0088, unless excepted as described in this Application.

I. BACKGROUND

The EPRM Guidelines established by the Commission in D&O 37507 in the PBR proceeding provide a mechanism for recovery of revenues for net costs of approved eligible projects placed in service during a Multi-Year Rate Period, that is not provided for by other effective tariffs, the Annual Revenue Adjustment ("ARA"), Performance Incentive Mechanisms, or Shared Savings Mechanisms.

On April 18, 2018, the Commission issued Order No. 35411 to initiate a proceeding to investigate performance-based regulation ("PBR") in Docket No. 2018-0088. In the Staff Proposal for Updated Performance-Based Regulations issued on February 7, 2019 ("Staff Proposal") in Phase 1 of the PBR proceeding, the Commission Staff pointed out that "lumpy" investments cannot feasibly be addressed by an externally-indexed attrition relief mechanism ("ARM") formula designed to determine changes in total revenues over many years of a MRP

[1] Note: References to exhibits in this document refer to exhibits included in the accompanying Application unless otherwise noted.
[2] The "Hawaiian Electric Companies" or "Companies" are Hawaiian Electric Company, Inc. ("Hawaiian Electric"), Maui Electric Company, Limited ("Maui Electric") and Hawaiʻi Electric Light Company, Inc. ("Hawaiʻi Electric Light").

control period. Nor can large project capital expenditures be feasibly predicted for extended future periods"[3]

In Decision and Order No. 36326 ("D&O 36326"), the Commission stated that it "agrees that preserving the MPIR adjustment mechanism for extraordinary projects is appropriate, to the extent that it may not be feasible to effectively address all such investments during the MRP period exclusively through an externally-indexed revenue formula." [4]

On December 23, 2020, the Commission issued D&O 37507 in the PBR proceeding. Regarding the MPIR mechanism, the Commission stated that "Certain projects represent 'lumpy' investments that may not be considered 'business as usual' costs manageable under annual revenues derived from an index-driven revenue formula, and MPIR-like relief may be appropriate to address such projects, subject to Commission approval."

The Commission further stated that the general purpose of the MPIR will remain and the MPIR Guidelines can remain largely intact, with relatively few substantive modifications, and changed the title of the MPIR to the Exceptional Project Recovery Mechanism ("EPRM").[5] Thus, the purpose of the MPIR and EPRM mechanisms has not changed from what the Commission expressed in previous orders: that is, to provide a means for recovery of "lumpy" investments during the MRP so that the Companies would not be deprived of the opportunity to recover any prudently incurred expenditures or limit orderly recovery of its major projects and programs.

The Commission concluded the following:[6]

> Accordingly, while the Commission appreciates the robust discussion and range of modifications proposed by the Parties, the Commission will not incorporate monetary threshold requirements, expansive new definitions, or additional stakeholder review requirements to the EPRM Guidelines. While representing valuable considerations, the addition of too many requirements and strictly-defined terms and concepts may inadvertently hinder the efficacy of the EPRM by creating confusion as to the potential eligibility of a proposed EPRM project, limiting the Commission's discretion to review and approve EPRM applications, and/or increasing the time and resources associated with review of EPRM applications.
>
> Instead, the Commission concludes that the more prudent course of action, in keeping with the EPRM's intent to limit relief to only exceptional projects, is to establish broader principles that are then applied by the Commission on a case-by-case basis. This will allow the Commission to take into account the unique

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[3] Staff Proposal, Docket No. 2018-0088, at 30.
[4] D&O 36326, Docket No. 2018-0088, at 34. Footnote excluded.
[5] D&O 37507, Docket No. 2018-0088, at 83-84.
[6] *Id*. at 85-86. Emphasis added.

circumstances of a particular application, which may reflect conditions that are unforeseen or unknowable at this time.

Among the principles that the Commission stated it will utilize in determining whether to approve EPRM relief were the following:[7]

- EPRM relief should be sought sparingly, and shall be reserved for projects which are extraordinary in nature and do not reflect "business as usual" investments or expenses.
- In certain instances, EPRM relief may be appropriate for projects or programs previously reviewed by the Commission and prospectively found to be extraordinary or worthy of EPRM relief.
- EPRM relief should not perpetuate bias toward capital expenditures.

The Commission terminated the MPIR Guidelines and made the EPRM guidelines (in Appendix A to D&O 37507, with a redline version in Appendix B) effective as of the date of the decision and order, December 23, 2020, with the exception that any pending application for MPIR relief submitted by the Companies prior to this date would be grandfathered under the MPIR Guidelines. However, D&O 37507 allowed the Companies to make an affirmative written request in the appropriate docket for the Commission to review a pending MPIR application under the EPRM Guidelines.[8]

The Commission did not intend to limit the applicability of the MPIR or the EPRM to certain defined types of projects but retained the discretion to determine eligibility on a case-by-case basis. The EPRM Guidelines define "Eligible Projects" as "approved Major Projects, Deferred Cost Projects, or O&M Projects eligible for revenue recovery through the EPRM adjustment mechanism as provided in these Guidelines," and "Major Project" as "a resource plant addition subject to application and review in accordance with the applicable provisions of the Commission's General Order No. 7.

II. RESILIENCE INVESTMENTS SUCH AS THOSE PROPOSED BY THE PROJECT ARE NOT ADEQUATELY ADDRESSED THROUGH THE ARA AND SHOULD BE ALLOWED THROUGH THE EPRM

In the PBR docket, the Consumer Advocate noted how "resilience investments are not adequately addressed through the ARA, existing PIMs, or proposed PIMs. Further, the economic pressure created by the ARA might encourage utilities to downplay resilience-related investments. The Consumer Advocate believes that the utilities should be making more progress to prepare for the increasing frequency and magnitude of storms that can wreak havoc on the electric utility system and the Hawaii economy."[9]

The ARA does provide incremental revenues each year but these incremental revenues are delinked and not explicitly tied to the level of the Companies' investments, let alone the

[7] *Id*. at 87.
[8] *Id*. at 89.
[9] See *Consumer Advocate Comments On Staff Proposal For Development Of Priority Performance Mechanisms*, page 10, filed on September 30, 2021 in Docket No. 2018-0088.

investments for any particular project, or expenses in a given year. These incremental revenues would have to recover cost increases due to inflation, increases in salaries, including those tied to the collective bargaining agreement, and the larger share of plant additions that include baseline projects (i.e., less than $2.5 million) and major projects not eligible for EPRM recovery. Some of the major projects that will not be eligible for EPRM recovery but would have to be covered through revenues through the ARA include the following (with estimated plant additions): Waiau 46kV Substation ($73.3 million), Archer 46kV Substation ($32.9 million), Wahiawa-Waimano 46kV Relocation ($8.4 million), W9 Turbine Rotor Replacement ($5.6 million), W10 Turbine Blade/Rotor/Compressor Blade Replacements ($10.4 million), and Kulanihakoi Substation ($18.1 million).[10]

Since these incremental revenues are fixed by the ARA formula, there is an incentive for the Companies to reduce project investments and other costs to maintain adequate returns during the five-year multi-year rate plan. However, the Companies continue to invest in needed infrastructure because of the obligations as public utilities to provide electrical service to all customers on a non-discriminatory basis and to implement state energy policy consistent with state statute and Commission orders. Without the prospect of a resetting for an increase in base rates for five years, there is an incentive under the ARA for the Companies to control costs and become efficient but there will still be a need to recover large, lumpy capital or expense-based projects through the EPRM that would be difficult to recover through an index-based ARA, as the Commission foresaw.

III. THE PROJECT QUALIFIES FOR EPRM RECOVERY

1. EPRM Recovery of the Project Costs Will Not be Duplicative

Section II.B.3 of the EPRM Guidelines prohibits duplicative cost recovery and states the following:

> Notwithstanding any other specific provisions in these Guidelines, the EPRM adjustment mechanism shall not collect or recover revenues for costs or expenses recovered through other effective tariffs or revenue recovery mechanisms, including but not limited to revenues collected through the ARA, PIMs, or SSMs. The utility shall have the burden of proof in an application for recovery of revenues through the EPRM adjustment mechanism that recovered revenues should not be duplicative.[11]

The Companies' Application does not seek duplicative cost recovery. The Project's costs are incremental costs that were not embedded in the rates approved for the Maui Electric 2018, Hawai'i Electric Light 2019, or Hawaiian Electric 2017 or 2020 test year rate cases, nor recovered through any recovery mechanism that is currently in effect. Stated differently, the Project's revenue requirements are not recovered through current target revenues or other cost recovery mechanisms, and the recovery of the Project's revenue requirements under the EPRM

[10] The substation projects listed would not be eligible for EPRM recovery because they are not expected to provide service to new service areas.
[11] *Id.*, Section II at 2.

will not significantly dilute the cost control incentives enacted by the Commission in the PBR Docket.

2. The Project is an Eligible EPRM Project

Section III.B.1 of the EPRM Guidelines states that projects and costs that may be eligible for recovery through the EPRM Mechanism are Eligible Projects, including but not restricted to the following illustrative examples, subject to the Commission's approval in accordance with the EPRM Guidelines:

(a) Infrastructure that is necessary to connect renewable energy projects. Infrastructure projects such as transmission lines, interconnection equipment and substations, which are necessary to bring renewable energy to the system. For example, renewable energy projects, such as wind farms, solar farms, biomass plants and hydroelectric plants, not located in proximity to the electric grid must overcome the additional economic barrier of constructing transmission lines, a switching station and other interconnection equipment. Building infrastructure to these projects will encourage additional renewable generation on the grid;

(b) Projects that make it possible to accept more renewable energy. Projects that can assist in the integration of more renewable energy onto the electrical grid. For example, new firm generation or modifications to firm generation to accept more variable renewable generation or energy storage and pumped hydroelectric storage facilities that allow a utility to accept and accommodate more as-available renewable energy;

(c) Projects that encourage clean energy choices and/or customer control to shift or conserve their energy use. Projects that can encourage renewable choices, facilitate conservation' and efficient energy use, and/or otherwise allow customers to control their own energy use. For example, smart meters would allow customers to monitor their own consumption and use of electricity and allow for future time-based pricing programs. Systems such as automated appliance switching would provide an incentive to customers to allow a utility to mitigate sudden declines in power production inherent in as-available energy;

(d) Approved or Accepted Plans, Initiatives, and Programs. Capital investment projects and programs, including those transformational projects identified within the Companies' ongoing planning and investigative dockets, as such plans may be approved, modified, or accepted by the Commission, and projects consistent with objectives established in investigative dockets;

(e) Utility Scale Generation and Energy Storage. Electric utilities may seek recovery through the EPRM adjustment mechanism for the costs of a utility scale renewable generation or energy storage project, or a generation or energy storage project, that can assist in the integration of more renewable energy onto the electrical grid;

(f) Grid Modernization projects. Projects such as smart meters, inverters, energy storage, and distribution automation to enable demand response.

(g) Service Contracts. Company contracts with third-parties that (1) provide facilities or functionality that could otherwise be provided by a utility capital project and (2) provide services that directly and predominantly support another express EPRM Eligible Projects category.

Importantly, while the EPRM Guidelines list examples of certain types of projects that would be eligible for EPRM recovery, this is not an exhaustive list. The Commission has therefore retained discretion to decide EPRM eligibility on a case-by-case basis.

Here, as contemplated by Section III.B.1(d), the Project is consistent with objectives established as part of the Integrated Grid Planning ("IGP") Resilience Working Group ("RWG") process.[12] As described more fully in the RWG Report for IGP, issued April 29, 2020 ("RWG Report"), the goals of the RWG are to:

- Identify and prioritize resilience threat scenarios and potential grid impacts;
- Identify key customer and infrastructure sector capabilities and needs following a severe event and loss of power;
- Identify gaps and priorities in grid and customer capabilities following a severe event and loss of power;
- Provide recommendations and inputs for the IGP to address resilience needs; and
- Recommend additional grid and customer actions to close gaps in capabilities following severe events.[13]

[12] The RWG's members represent a broad range of state and national agencies, commercial and industrial customers, not-for-profit interest groups, and the Commission.
[13] Exhibit B: Resilience Working Group Report for Integrated Grid Planning, page 5.

In particular, the RWG identified the following objectives for key customers/sectors during a severe emergency:

- Maintain critical functions and services
- Limit fatalities and human suffering
- Limit infrastructure damage
- Limit property damage
- Limit cost and economic impacts
- Limit environmental impacts

It was clear during the severe event scenarios discussed during breakout sessions that loss of electricity in critical customer and infrastructure sectors, whether utility-supplied power or customer-owned backup power, could have severe impacts, including severe disruption to mission critical services, impacts to life and health of the public, damage to infrastructure and property, environmental impacts, and immense cost and economic implications. The RWG developed a framework for prioritizing customers and infrastructure sectors from a perspective of importance to supporting (1) national security and/or public safety and health and 2) power system recovery.

Consistent with these goals and objectives, the Application focuses primarily on mitigating the effects of hurricanes (including both high winds and flooding), and preventing ignition of, or contribution to, wildfires by the Companies' facilities. Further consistent with the RWG goals, the Application proposes utility actions that prioritize identified critical customer sectors for targeted resilience enhancements.

Moreover, the RWG provided a number of recommendations that should be considered outside of the IGP process. Some of these recommendations include the following:

- Utilities plan for enhanced vegetation management, particularly in critical grid areas susceptible to damage from wind and falling or flying debris

- Utilities continue hardening or reinforcing critical transmission circuits, including upgrading wind criteria and flood mitigation, upgrading structures, and using enhanced construction methods and materials

- Utilities continue planning for expanding underground cables (water resistant) and locating equipment outside flood prone areas

- Utilities consider alternative paths for transmission circuits to increase diversity of location and enhance performance during severe events

- Utilities establish one or more priority circuits with enhanced restoration capabilities and greater hardening[14]

[14] *Id.* at 67.

The RWG stressed that its list of recommendations was "not meant to be a comprehensive list but rather a starting point for further evaluation."[15] In developing its plans for the proposed Project, the Companies incorporated some of the RWG's recommendations in addition to other compatible actions based on industry best-practice and lessons learned from other utilities who have made significant investments in resilience.

In addition, the Commission has recognized the need for a resilient electric grid due to the State of Hawai'i's isolated island location, vulnerability to natural hazards, and history of disasters, as evidenced in Order No. 34696 of the PSIP docket in which the Commission reiterated the Department of Business and Economic Development's recommendation that future planning processes should be refined "to ensure resulting plans are resilient to uncertainty".[16]

Further, in the Commission's PBR proceeding, the Commission Staff called attention to the importance of monitoring the resilience of Hawai'i's electric system. Staff's proposal in the proceeding defined resilience as, "the ability of a system or its components to adapt to changing conditions, as well as withstand and rapidly recover from disruptions."[17] The Staff Proposal further noted that resilience is increasing in importance for Hawai'i given its geographic isolation, the increasing threat of natural disasters and climate change, as well as many other risk factors such as cybersecurity attacks and aging infrastructure. D&O No. 37507 continued to identify Resilience as an emergent and prioritized outcome that is ripe for discussion and development of Reported Metrics to be included in the PBR Framework's initial portfolio.

The Project therefore arose out of and is consistent with the recommendations, objectives, and policy set forth in ongoing planning and investigative dockets (including IGP, PSIP, and PBR) as contemplated by Section III.B.1(d) of the EPRM Guidelines.

3. <u>The Project Application Complies with Section III.C.3. of the EPRM Guidelines</u>

Section III.C.3.(a) through (j) of the EPRM Guidelines establish certain requirements for applications seeking recovery through the EPRM Mechanism. As discussed below, the Project satisfies each of these requirements.

a. ***<u>Burden of Proof – Project Does Not Involve Routine Replacements</u>***

<u>Section III.C.3.a of the EPRM Guidelines provides:</u>

> With respect to applications seeking approval to utilize the EPRM adjustment mechanism for cost recovery, the electric utility bears the burden of proof that all project costs proposed for EPRM treatment meet the criteria specified herein and are not routine replacements of existing equipment or systems with like kind assets,

[15] *Id.* at 8.
[16] Order No. 34696 at 16, issued on July 14, 2017, in Docket No. 2014-0183.
[17] Staff Proposal, Appendix A at 5.

> relocations of existing facilities, restorations of existing facilities, or other kinds of business-as-usual investments.

The Project does not involve "routine replacements of existing equipment or systems with like kind assets, relocations of existing facilities, restorations of existing facilities or other kinds of business as usual investments."

As discussed in Section IV of Exhibit K (*Importance of a Resilient Grid*), the activities proposed for recovery in this Application are distinct from ongoing asset sustainment efforts. The Companies' ongoing asset sustainment programs and projects include routine replacements and restoration of existing assets at end-of-life. By contrast, upgrades of existing assets proposed under the Project (such as in Critical Transmission Line Hardening, Critical Pole Hardening, Critical Customer Circuit Hardening, and Wildfire Prevention & Mitigation) are targeted to assets that are critical for system resilience rather than assets at end-of-life. Furthermore, the Project intends to upgrade identified assets to exceed normal design standards and will not include replacements with like kind assets.

Some activities under the Project will include relocations of existing assets. These are not routine relocations driven by customer requests or public works projects. Rather, any relocations identified by the Project are being pursued for resilience enhancement purposes, such as for enabling expedient access to critical infrastructure to reduce restoration time and cost following severe events.

As the application explains, the Hazard Tree Removal initiative proposed under the Project is not duplicative of the Companies' existing vegetation management efforts. For this initiative, the Companies plan to complete surveys for each Company to identify and prioritize hazard trees (i.e., trees that are not in the right-of-way that are dead, diseased, or structurally compromised, and are tall enough to fall into power lines and cause significant damage during severe events) for removal. Current vegetation management programs do not include the removal of trees outside of the Companies' right-of-way as this initiative would.

As described in Section XII.H of the Application, the Resilience Modeling project the Companies intend to pursue involves cutting-edge modeling and technology development to support evaluation of system resilience and performance-based options analysis for resilience planning. This type of modeling and technology is in its early stages in the industry and is not a business-as-usual investment.

The Companies' proposed Wildfire Prevention & Mitigation initiative includes proactive upgrades of assets (e.g., pole upgrades, replacement of copper conductor with aluminum) which are distinct from asset sustainment (as described above) and not common historical practice or business-as-usual. The proposed wildfire prevention and mitigation activities also include the deployment of new devices and equipment such as video cameras and weather stations to address wildfire risk and are not business-as-usual investments.

The Companies' Substation Flood Monitoring initiative includes the deployment of new flood monitoring devices for the sole purpose of reducing damage from extreme flood events. These investments are not business-as-usual.

b. G.O. 7 Application

Section III.3.b. of the EPRM Guidelines provides:

> Application for recovery of revenues through the EPRM adjustment mechanism shall be made in conjunction with and as part of an application (1) pursuant to General Order No. 7, (2) for deferred accounting treatment, or (3) for other specific project or program authorization or approval. Absent a requirement to file an application for such project or program authorization or approval, the utility may file a separate independent application for recovery of costs through the EPRM adjustment mechanism.

The Companies' application for recovery of revenues through the EPRM adjustment mechanism is submitted in conjunction with and as part of the accompanying Application, which seeks General Order No. 7 ("G.O.7") approval, and Project authorization and approval.

c. Costs Net of Benefits

Section III.C.3.c. of the EPRM Guidelines provides:

> Costs recovered through the EPRM adjustment mechanism shall be offset by all known and measurable operational net savings and benefits resulting from the Eligible Projects (including accumulated depreciation and accumulated Deferred income tax reserves, reductions in operating and maintenance expenses, related additional revenues, etc.), to the extent such savings or benefits are not passed on to ratepayers through energy cost or other adjustment clause mechanisms, and to the extent that such savings or benefits can reasonably be quantified. Net savings and benefits shall be offset as they are realized to the extent feasible. A business case study shall be submitted with each application identifying and quantifying all operational and financial impacts of the Eligible Project and illustrating the cost/benefit tradeoffs that justify proceeding with the project to the extent that such impacts can reasonably be determined.

The benefits of a more resilient system are many for utility systems in areas prone to major events and include:

- Critical facilities are less likely to be interrupted.
- If critical facilities are interrupted, they can be restored much more quickly.
- The total length of restoration ("TLR") can be dramatically reduced, resulting in far fewer customers being out of power for extended periods of time.

- The local economy returns to normal much more quickly, minimizing the loss of gross domestic product ("GDP") due to businesses being without power.
- Storm restoration costs are dramatically reduced.
- Storm inventory levels can be reduced.
- Daily reliability is typically improved.

Based on GDP impact alone, as discussed in Section 7.3 of Exhibit C (*Project Business Case*), the calculated break-even values for TLR reduction are 13% for O'ahu County, 31% for Maui County, and 37% for Hawai'i Island. The lower value for O'ahu is primarily based on much higher customer density, which allows hardening costs to be spread across a higher number of customers.

It should be noted that hurricanes are anticipated to become more frequent and severe in the future due to climate change. If hurricanes are more frequent and/or severe than this analysis assumed (based on historical data), this would increase the relative value of the proposed resilience investments.

In addition to expected GDP benefits, significant customer value will be realized through other benefits, which were not quantified:

1. Reduced storm restoration costs
2. Reduced customer interruption costs
3. Reduced food spoilage
4. Societal benefits of reduced interruptions and restoration times for hardened critical customer circuits, enabling quicker stabilization of community lifeline functions
5. Benefits related to other events such as prevention and/or mitigation of wildfires

In addition, as discussed in Section 7.3 of Exhibit C (*Project Business Case*), estimated GDP benefits of the proposed investments may exceed their costs even if only one severe storm hits the islands. For O'ahu, it was estimated that a single Category 2 hurricane would fully pay for the O'ahu resilience investments, while a single Category 3 hurricane would fully pay for the respective Maui County and Hawai'i Island investments. As in the previous analysis, only GDP benefits were considered, and a comprehensive consideration of all benefits (if it were feasible) would be expected to yield even more favorable cost-benefit characteristics.

Accordingly, anticipated benefits to the broader community clearly justify the proposed resilience investments. However, these are broader, societal benefits and not benefits to the Companies that can be quantified and offset against Project costs to customers. The Companies have not identified reasonably quantifiable net savings that can offset costs recovered through the EPRM.

d. ***EPRM Eligibility***

Section III.C.3.d. of the EPRM Guidelines provides:

> Application for Eligible Projects hereunder shall be made, pursuant to General Order No. 7 procedures, or other applicable authority or procedure. Applications shall explain each basis for claimed EPRM eligibility, indicating the linkage of the project to any previously submitted planning studies, previously submitted construction budgets and any relevant active Commission dockets. Applications shall also include the information set forth in the following paragraphs (e) through (i).

As discussed above, the Application has been filed pursuant to G.O. 7 procedures; in addition, also as discussed above, and in the Application, the Project is consistent with the objectives and policy in recent planning and investigative dockets, including IGP, PSIP, and PBR. As a result, the Project is exceptional. This application has described the importance of resilience and the attention it has garnered in federal, state and county governments and in these Commission proceedings. And as the Companies have explained, this Project involves the installation of facilities and other initiatives that go beyond business as usual investments or expenses. The Project is thus eligible for EPRM recovery for the reasons stated herein and, in the Application, and other Exhibits thereto.

e. ***Project Business Case***

Section III.C.3.e. of the EPRM Guidelines provides:

> A detailed business case study shall be included, covering all aspects of the planned investments and activities, indicating all expected costs, benefits, scheduling and all reasonably anticipated operational impacts. The business case shall reasonably document and quantify the cost/benefit characteristics of the investments and activities, indicating each criterion used to evaluate and justify the project, including consideration of expected risks and ratepayer impacts.
>
> The business case should also clearly outline how it will advance transformational efforts with appropriate quantifications, to the extent such quantifications can reasonably be determined.

The Companies have provided the detailed business case in Exhibit C (*Project Business Case*).

f. ***Project Schedule and Budget***

Section III.C.3.f. of the EPRM Guidelines provides:

> A detailed schedule and budget for each element of the planned investment and activities shall be submitted, quantifying any

> contingencies, risks, and uncertainties, and indicating planned accounting and ratemaking procedures and expected net customer impacts.

Please refer to the Application regarding the Accounting and Ratemaking Treatment, Exhibit A (*Project Cost Estimate*), Exhibit D (*Revenue Requirements and Bill Impact Calculation*), Exhibit C (*Project Business Case*) Section 4 regarding the Project schedule, and Exhibit C Section 6 regarding project risks and uncertainties.

g. __Criteria for Used and Useful Status__

<u>Section III.C.3.g. of the EPRM Guidelines provides:</u>

> Applications must state the specific criteria that are proposed for determination of used and useful status of the project, to ensure that no costs are Deferred or recovered for new assets that are merely commercially available but are not being used to provide service to ratepayers.

In general, as the Companies plan to construct and install the capital for the various initiatives over the course of each year, the components of the Project are considered completed and placed into service when: 1) construction is for the most part complete, 2) the facilities have been tested, and 3) the facilities are ready for use (i.e., they are able to perform their intended function, and can be energized, pending completion of any related facility(ies), without a significant amount of additional costs incurred).

The used and useful criteria for each of Project's component initiatives are described below:

1. Critical Transmission Line Hardening

    a. Critical Transmission Line Hardening includes the installation of transmission structures and conductors. The Companies will deem transmission structures as used and useful upon installation. Conductors will be deemed used and useful when installed and ready for energization.

2. Critical Pole Hardening

    a. Critical Pole Hardening includes the installation of transmission, sub-transmission, and distribution poles and associated hardware (e.g., anchors, trusses, etc.). The Companies will deem the poles and associated hardware as used and useful upon installation.

3. Critical Customer Circuit Hardening

    a. Critical Customer Circuit Hardening includes the installation of sub-transmission and distribution poles, associated hardware (e.g., anchors, trusses, etc.), and/or electrical devices (e.g., switches, reclosers, etc.). The Companies will deem the poles and associated hardware as used and useful upon installation. Electrical devices will be deemed used and useful upon installation and successful completion of commissioning showing the devices are able to operate as intended.

4. Substation Flood Monitoring

   a. Substation Flood Monitoring includes the installation of flood monitors on, or near, substation control houses, control cabinets, or switchgears. The flood monitors will be deemed used and useful upon installation and successful completion of commissioning showing the devices are able to operate as intended.

5. Distribution Feeder Ties (Maui Island only)

   a. Distribution Feeder Ties includes the installation of distribution equipment (e.g., transformers, voltage regulators, etc.), electrical devices (e.g., switches, relays, etc.), poles, and conductors. Distribution equipment and electrical devices will be deemed used and useful upon installation and successful completion of commissioning. Poles will be deemed used and useful upon installation. Conductors will be deemed used and useful when installed and ready for energization.

6. Lateral Undergrounding (O‘ahu only)

   a. Lateral Undergrounding includes the installation of underground distribution infrastructure (e.g., conductors, conduits, switchgears, transformers, etc.). Underground distribution infrastructure will be deemed used and useful upon installation and successful completion of commissioning.

7. Wildfire Prevention & Mitigation

   a. Wildfire Prevention & Mitigation includes the installation of transmission, sub-transmission, and distribution poles, conductors, and electrical devices such as weather stations and video cameras. Poles will be deemed used and useful upon installation. Conductors will be deemed used and useful when installed and ready for energization. Electrical devices such as weather stations and cameras will be deemed used and useful upon installation and successful completion of commissioning showing the devices are able to operate as intended.

According to the EPRM Guidelines, “Accrual of revenues recovered through the EPRM adjustment mechanism for an Eligible Project shall commence upon certification of the project’s completion and/or in-service date in accordance with terms approved by the Commission at the time cost recovery through the EPRM adjustment mechanism is approved in the underlying proceeding for EPRM relief.”[18] However, since the Companies plan to install the various Projects over the course of the year, to reduce the administrative burden, the Companies propose to simplify the EPRM filing to once a year and will request recovery of actual capital and

[18] D&O 37507, Appendix A at 12.

incremental O&M incurred during the prior year, net of any revenues (less revenue taxes), during the prior year, to be included in and align with the annual MPIR/EPRM revenue adjustment filing in February which will be subject to Commission review as part of the Spring Revenue Report filed in March of the subsequent year. EPRM recovery will be based on actual recorded costs and the depreciation, tax and authorized return rates in place at that time, net of any quantifiable revenues (excluding revenue taxes). Recovery of on-going incremental O&M costs will be based on actual recorded costs for the previous year.

h. Costs Net of Savings

Section III.C.3.h. of the EPRM Guidelines provides:

> Recoverable costs shall be limited to the lesser of actual net incurred project/program costs or Commission-approved amounts, net of savings.

The Companies acknowledge that costs recoverable through the EPRM Mechanism shall be limited to the lesser of the actual net incurred project/program costs or Commission-approved amounts, net of savings. Please see subsection A.3.c (Costs Net of Benefits) above, for a discussion of costs, net of benefits.

Exhibit F

Climate Adaptation Transmission and Distribution Resilience Program Application

Non-Wires Opportunity Evaluation

1 Review of Non-Wires Opportunity Evaluation Methodology

At the Companies' Integrated Grid Planning Distribution Planning Working Group meetings held on July 17, 2019[1] and October 9, 2019,[2] the framework below for evaluating NWA opportunities was presented and discussed with stakeholders, and filed on November 5, 2021 as part of the Hawaiian Electric Companies' Grid Needs Assessment Methodology Review Point – Appendix J (Docket No. 2018-0165).[3] The framework is based upon best practices in the industry.

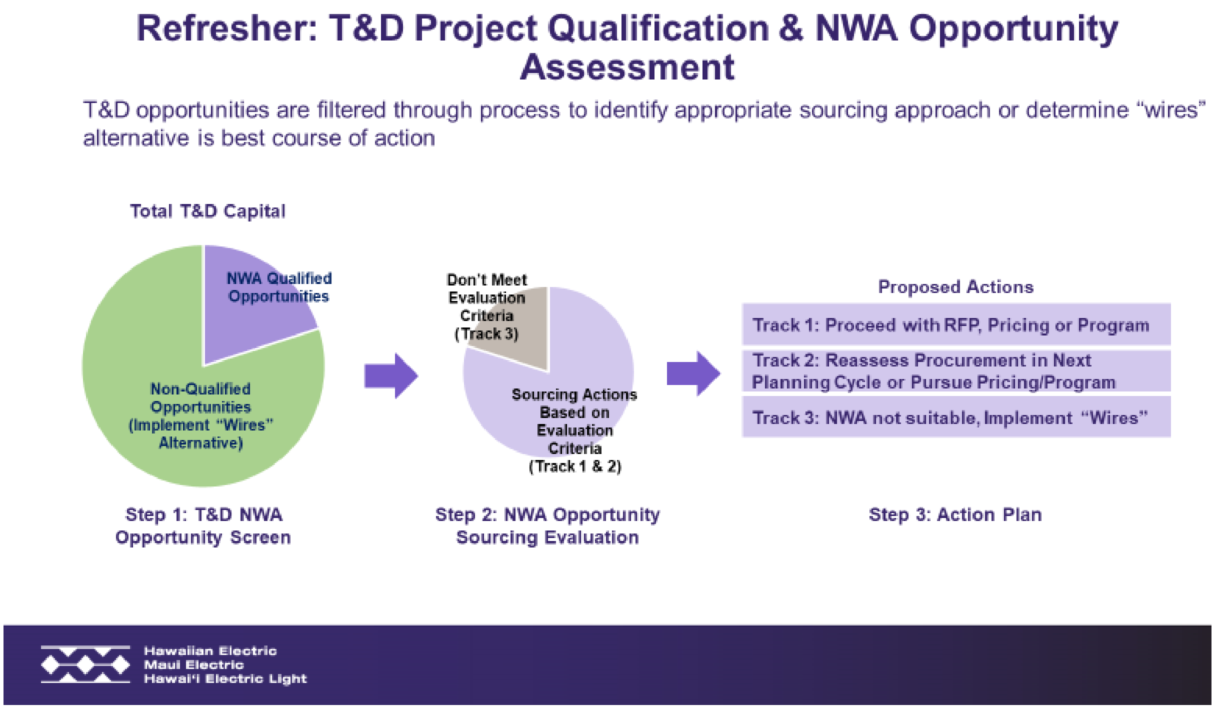

Figure 1: T&D Project Qualification & NWA Opportunity Assessment

[1] *See* meeting notes from July 17, 2019 Distribution Planning Working Group meeting at https://www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning/stakeholder-engagement/working-groups/distribution-planning-and-grid-services-documents
[2] *See* meeting notes from October 9, 2019 Distribution Planning Working Group meeting at https://www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning/stakeholder-engagement/working-groups/distribution-planning-and-grid-services-documents
[3] *See Non-Wires Opportunity Evaluation Methodology* at https://www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning/stakeholder-engagement/working-groups/distribution-planning-and-grid-services-documents

In Step 1, an initial NWA opportunity screen is performed to categorize all T&D capital budget projects as suitable or unsuitable for further NWA opportunity evaluation based on the type of grid need to be addressed. Three grid needs categories were identified as having the greatest NWA opportunity:

1. Expanding distribution system capacity to meet load and/or hosting capacity needs (that is, new substations, new feeders, reconductoring)
2. Ensuring a reliability requirement for circuit back-tie upgrade deferral
3. Enhancing system resilience[4]

Conversely, several grid needs categories were identified as being unlikely to be deferred or avoided by DER:

1. Line/pole relocation or undergrounding due to street widening, relocation clauses, or overhead-to-underground conversions.
2. Emergency and preventative equipment and infrastructure replacement to restore power after outages, avoid outages, avoid catastrophic failures, and ensure public safety.
3. Replacement of physical apparatus, such as circuit breakers, relays, and transformers, because of asset condition
4. Replacement of damaged or failed equipment/poles/conductor
5. New customer requests for new physical connection to the electric grid

These are projects where the distribution infrastructure is not being expanded but simply replaced in kind.

Step 2 of this process then takes qualified opportunities and utilizes evaluation metrics to determine the feasibility of the NWA. The metrics include performance requirements, timing of the need, forecast certainty, market assessment, and economic assessment. Stakeholder feedback that the Companies intend to incorporate into this step includes making the metrics more quantifiable; for example, the timing metric should have at least a two-year lead time, and the economic assessment should have a project cost threshold of $1,000,000.

In Step 3, projects are assigned to one of three action plans:

- **Track 1:** Procurement of large, certain opportunities with high likelihood of success for procurement.
- **Track 2:** Procurement if factors indicate reevaluating in the future for potential procurement; a program if the opportunity is certain with greater than $1M in economic value, is considered cost-effective for customers, and performance can likely be met; and pricing if economic value is less than $1 million and potential timing of need is sufficiently long to account for customer adoption.
- **Track 3:** Non-qualified opportunities that have criteria that cannot reasonably be met by NWA solutions.

2 General Discussion on NWA Opportunities for Resilience Enhancements

Some types of resilience enhancement projects have high potential for NWA opportunities. One archetypal example would be a microgrid to defer or avoid the construction of a second line to serve a community that is currently fed by a long, radial line (i.e., typically rural communities). In general, the NWA framework was intended to identify cost-effective solutions for capital investments that are

[4] Examples of conventional projects within the category include redundant transformers and line extensions to improve resiliency to an area.

primarily driven by the expansion of the distribution system; or in other words where load growth drives additional grid investments to be made. This is not the case here. Therefore, the Companies proposed the resilience framework in the IGP (i.e., bowtie structure), similar to the NWA framework, to vet resilience solutions that include third-party and traditional capital investments (which are not mutually exclusive).

All the proposed enhancements in the Project are aimed at "enhancing system resilience" by reducing the likelihood or impact of damages or outages to the system in a severe event. However, deeper inspection of the grid needs to be met by these enhancements reveals that in most or all cases, there are no viable non-wires alternatives that would avoid these investments. The drivers for most of the proposed enhancements in this Application differ in important ways from the archetypal resilience enhancement scenario in the example above. Most of the proposed enhancements are best characterized as preventive equipment and infrastructure upgrades to avoid outages and avoid catastrophic failures. IGP stakeholders determined that projects addressing these types of grid needs would be unlikely to have viable non-wires alternatives.[5]

As with aging asset replacements, most of the activities proposed in the Project involve investments in existing transmission and distribution infrastructure. These assets are currently being used to fulfill a pre-existing grid need. Generally, the proposed enhancements do not involve building new transmission or distribution lines or installing new substations or transformers. Rather, what is being proposed is to upgrade and harden the critical backbone transmission and distribution infrastructure so it can withstand severe events and/or be quickly restored. While the driver for replacing aging assets is to prevent failure of deteriorated assets, the driver for these resilience enhancements is to prevent the failure of critical assets in severe event scenarios, such as a major storm or hurricane. In either case, the aim of the project is to safeguard the continued operation of an existing asset with a pre-established purpose.

As discussed elsewhere in the Application, the proposed resilience enhancements are intended to strengthen the backbone of the transmission and distribution system. These investments are not intended to compete with DER, microgrids, or renewable energy solutions. On the contrary, these investments are value realization enablers for these non-wired solutions. DER, microgrids, and renewables have additive benefits to system resilience that are more fully realized when the backbone transmission and distribution infrastructure is reliable and resilient.[6]

The "bowtie method" (see Figure 2) is increasingly used in the industry to leverage risk-threat assessments into a structured solution identification process. On the left side of the bowtie are preventive solutions intended to avoid or minimize failures and damage caused by severe events. On the right side of the bowtie are mitigation solutions, which are intended to reduce the impacts of failures and facilitate recovery to reduce the consequences of severe events. Mitigation measures can generally be thought of as addressing residual risks, filling any holes where preventive measures fail, or to address short-term needs until longer-term preventive measures are implemented. California's implementation of its Power Safety Shutoff (PSPS) Mitigation Plan is one such example of this, where PSPS events are used to mitigate wildfire risks until more robust preventive measures have been implemented in an area.[7] These two types of investment categories are not substitutes for one another, but are complementary for improved system resilience. A holistic approach to resilience improvement will require a combination of both preventive and mitigation solutions to create an effective portfolio of resilience solutions.[8]

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[5] *Id.* at 15
[6] *See* discussions in Section 2 of Exhibit C (*Project Business Case*), Section III.C of Exhibit K (*Importance of a Resilient Grid*), and Section XII.A and Section XII.B of the Application.
[7] *See, Distribution Resilience and Reliability Planning*, January 2022, Pacific Northwest National Laboratory, available at https://gridarchitecture.pnnl.gov/media/advanced/Resillience_Solution_Analysis_paper.pdf.
[8] *See* discussion in Section 2 of Exhibit C (*Project Business Case*).

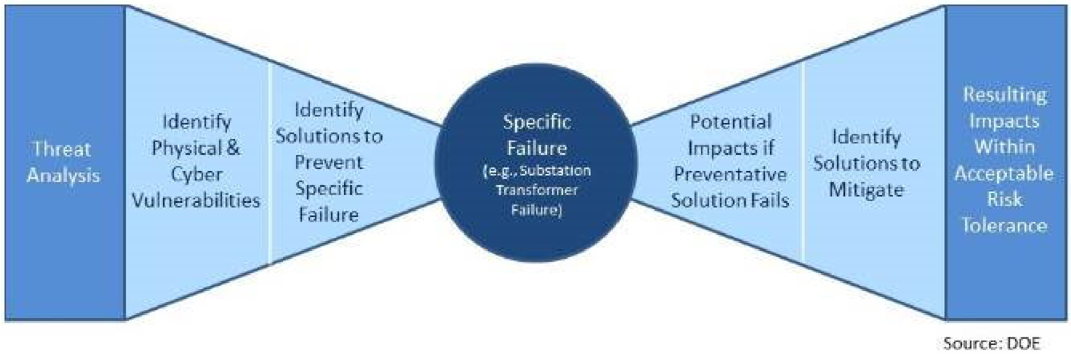

Figure 2: The "Bowtie Method" of Risk Management

The resilience enhancements proposed in this Application are largely preventive measures intended reduce damage and failures (the left side of the bowtie). By contrast, non-wired solutions will generally address the right side of the bowtie by helping to mitigate the consequences of damage and failures that do occur, since it is impossible to completely prevent all failures from all possible severe events. Furthermore, the proposed resilience enhancements will increase the resilience value of future DER, microgrid, and renewable solutions.

An NWA Opportunity Evaluation for each relevant initiative in the Project is detailed below.

3 Critical Transmission Line Hardening

3.1 Step 1 – NWA Opportunity Screen

The Critical Transmission Line Hardening initiative involves hardening existing transmission lines that are most critical to system resilience. The identified grid need is the preventive upgrade of critical infrastructure to avoid outages, avoid catastrophic failures, and enable restoration after a severe event such as a storm or hurricane. As outlined in the NWA Opportunity Evaluation Methodology, projects of this type are unlikely to have viable non-wires alternatives.

3.1.1 Damage to Critical Transmission Lines in a Severe Event Must be Repaired

If critical transmission lines are damaged in a storm or hurricane, they must be repaired. Every minute of restoration time counts after a severe event, and every minute spent on repairing a critical transmission line is a minute delaying other restoration activity, increasing economic and societal costs.
On Hawaiʻi Island, the 6200 line includes a section of line that traverses through a critical habitat area with difficult access. On Maui, the Maʻalaea-Puʻunēnē transmission tie includes a section of line near Kuihelani Substation that travels through farmlands where the Companies have difficulty accessing the lines. On Oʻahu, several identified critical transmission lines, such as those traversing the Koʻolau Mountain Range, are very difficult to access, requiring helicopters. Significant damage after a storm or hurricane in any of these areas would be difficult and time-consuming to repair, hampering system restoration and resulting in downstream negative impacts to customers and society. There are no non-wires solution that would substitute for proactive hardening of existing critical transmission lines in terms of this resilience need.

3.1.2 Critical Transmission Lines are Crucial to the Resilience of the Entire Grid

The critical transmission lines identified for hardening on each island fulfill highly critical system functions (as described in the Application Section XII.A) that cannot be adequately substituted by DER, microgrids, or new grid-scale renewable generation. Strongly integrated transmission networks are crucial for system resilience due to the flexibility they afford in a severe event. Resilience is inherently concerned with uncommon and severe operating scenarios, such those caused by storms and hurricanes, which can suddenly take multiple generation resources and power lines offline. If a grid is unable to rely on a robust transmission system to flexibly compensate for these types of sudden changes in system resources, the grid is more vulnerable to wide-spread outages or system-wide blackout.

Indeed, recent severe events on the continental U.S. have underscored the importance of robust transmission systems for power system resilience. A 2021 report commissioned by the American Council of Renewable Energy analyzed five recent severe events across the U.S. and determined that "all generation sources are vulnerable to severe weather, making increased transmission to broaden the pool of available resources one of the best options for increasing resilience." On Winter Storm Uri, which struck Texas in February 2021, the study determined that "each additional 1 GigaWatt (GW) of transmission ties between the Texas power grid (ERCOT) and the Southeastern U.S. could have saved nearly $1 billion, while keeping the heat on for hundreds of thousands of Texans."[9]

In this Application, the Companies are not proposing to build new transmission lines, but simply to strengthen the most critical transmission lines currently in operation so they can withstand severe events such as storms and hurricanes and provide the flexibility and power transfer capability necessary to help prevent potentially catastrophic consequences of these events. Being isolated island grids, Hawai‘i's energy grids are unable to take advantage of transmission ties to other interconnected power grids as is done on the mainland. Therefore, a robust island-wide transmission system connecting disparate areas within our island grids is even more crucial. Ensuring that existing critical transmission lines are hardened must be a high priority for enhancing system resilience.

3.1.3 Hardening Critical Transmission Lines Facilitates the Resilience Benefits of Renewables, Microgrids, and DER

Hardened critical transmission infrastructure will enable and facilitate the full realization of the resilience benefits of renewables, microgrids, and DER while also enabling economic dispatch of these resources. Transmission lines allow generation resources in one area of an island to make up for generation shortfalls in other areas. This is especially relevant for resilience planning since all generation resources are vulnerable to severe weather.

For example, hardening the 6200 line on Hawai‘i Island and upgrading to the standard conductor size will improve the ability of the system to leverage the Phase 1 & 2 RFP projects, located in West Hawai‘i, to serve load in the east. This is especially relevant considering past events. For example, Hurricane Iselle took out East Hawaii generation along with 3 out of the 4 cross-island transmission ties in 2014. The 6200 line was the only cross-island tie still standing, which enabled West Hawai‘i generation to provide power to East Hawai‘i loads. Furthermore, since resources on the grid are always in flux, hardening this critical transmission line and upgrading the conductor will enable more flexibility under future scenarios.

In summary, since this initiative involves the preventive upgrade of existing critical equipment to prevent damage, avoid outages, and reduce restoration times, this initiative is screened out in Step 1.

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[9] *See* July 2021 report by ACORE: *Transmission Makes the Power System Resilient to Extreme Weather*. https://acore.org/wp-content/uploads/2021/07/GS_Resilient-Transmission_proof.pdf

4 Critical Customer Circuit Hardening

4.1 Step 1 – NWA Opportunity Screen

The Critical Customer Circuit Hardening initiative involves hardening existing distribution and/or sub-transmission circuits that feed critical customers and infrastructure such as hospitals, military facilities, emergency management, and others.

Many critical customers have on-site backup generation. However, on-site backup generators are:

1. A temporary solution. Permanent power will need to be restored eventually. Critical infrastructure providers are also typically only able to operate at reduced capacity with backup generators until grid power is restored, prioritizing their most critical facilities and functions.
2. Limited by fuel availability. Many critical customers with on-site backup generators have very limited fuel supply, as discussed in the RWG.
3. Not always reliable. There are many instances of backup generators failing when called upon after a severe event.

On-site renewable DER solutions and customer microgrids can also be used to provide backup power to critical facilities, but are also stop-gap solutions until permanent power restoration is achieved as they are generally not able to run in islanded mode indefinitely. Damage to the grid must be repaired and permanent power must eventually be restored to these critical customers. Therefore, DER/microgrids for individual customers are complementary to, but cannot substitute for preventively hardening critical distribution infrastructure.

Community microgrids can also be leveraged to provide power to groups of critical customers in the same geographical area. However, the resilience value of this solution in a severe event scenario depends on the strength of the utility's backbone distribution infrastructure upon which the microgrid operates. If there is damage to the distribution infrastructure within the microgrid boundary, the microgrid will be inoperable. Therefore, resilient distribution infrastructure is a prerequisite to enable community microgrid solutions for resilience scenarios. Hardening critical customer circuits can therefore facilitate the development of future community microgrids.

The purpose of Critical Customer Circuit Hardening is the preventive upgrade of critical infrastructure to avoid outages, avoid catastrophic failures, and enable restoration after a severe event such as a storm or hurricane. Therefore, this initiative should be screened out at Step 1.

5 Critical Pole Hardening & Mitigation

5.1 Step 1 – NWA Opportunity Screen

The Critical Pole Hardening & Mitigation initiative involves hardening existing poles that are most critical not to fail in a severe event, such as poles that would disproportionately impact restoration if they failed, as well as addressing poles at imminent risk of sea level rise impacts. For example, critical poles include poles adjacent to major highway overhead crossings. If these poles were to fail in a storm or hurricane, they would impede traffic, potentially including emergency vehicles, and would take significant resources, time, and coordination with other emergency response efforts to make the repairs. . Addressing highway crossings is especially important in areas with limited egress. There are no non-wires solutions that can address these types of resilience needs.

Critical Pole Hardening & Mitigation involves the preventive upgrade of critical infrastructure to avoid outages, avoid catastrophic failures, and enable restoration after a severe event such as a storm or hurricane. Therefore, this initiative should be screened out at Step 1.

6 Substation Flood Monitoring

6.1 Step 1 – NWA Opportunity Screen

The Substation Flood Monitoring initiative involves deploying flood monitors to substations in flood-prone areas. These are very low-cost, low-hanging-fruit investments to mitigate flood impacts to existing substations. These types of investments would not have NWAs, so are screened out at Step 1.

7 Wildfire Prevention & Mitigation

7.1 Step 1 – NWA Opportunity Screen

The Wildfire Prevention & Mitigation initiative will generally involve: 1) proactive pole and hardware upgrades to prevent failures and address clearance issues, 2) proactive replacement of copper conductors with aluminum in wildfire risk areas, 3) installing weather stations and video cameras in strategic locations for situational awareness. The pole, hardware, and conductor upgrades are preventive upgrades of existing equipment in wildfire risk areas to avoid failures that could cause wildfire ignition, and would not have NWAs. This initiative is screened out at Step 1.

8 Lateral Undergrounding

8.1 Step 1 – NWA Opportunity Screen

The Lateral Undergrounding initiative involves targeted undergrounding of single-phase distribution lateral lines to prevent damage and outages caused by wind, vegetation, and flying debris during severe events such as storms and hurricanes. Damage to distribution lateral lines during severe events can be extensive and would need to be repaired. While undergrounding lines will help to prevent interruptions to the customers fed by those lines, the primary focus of this initiative is on reducing damage and therefore the total cost and length of restoration by undergrounding laterals in areas where it would be most cost-effective to do so. There are no NWA solutions that would prevent damage to this backbone infrastructure, though DER can have complementary and additive resilience benefits in combination with targeted undergrounding. Targeted undergrounding of distribution laterals does not preclude future DER investment, but rather helps to increase the resilience benefits of future DER investments by strengthening the wired infrastructure connecting DER to the grid. This initiative's purpose is to prevent damage to existing assets that make up the backbone distribution system and should be screened out at Step 1.

9 Distribution Feeder Ties

9.1 Step 1 – NWA Opportunity Screen

The Distribution Feeder Tie initiative involves creating distribution ties and upgrades to enable currently isolated substations/transformers on the island of Maui to be backed up by other substations/transformers in emergency contingency situations. This investment falls under the grid needs category of "enhancing system resilience."

As far as project timing, the Hana 1 / Hana 2 project is estimated to be placed in-service in 2024 (Red), the Ke'anae project is estimated to be in-serviced in 2025 (Yellow), and the Kula project is estimated to be in-serviced in 2026 (Green).

9.2 Step 2 – NWA Opportunity Sourcing Evaluation

9.2.1 Performance Requirements

Performance requirements are a challenge given the long-duration and high-magnitude need of a substation/transformer N-1 contingency as well as the availability requirements for reliability and resilience scenarios. Figures 3, 4, 5, and 6 below show the historical load profiles for Hana 1, Hana 2, Kula, and Ke'anae circuits, respectively.

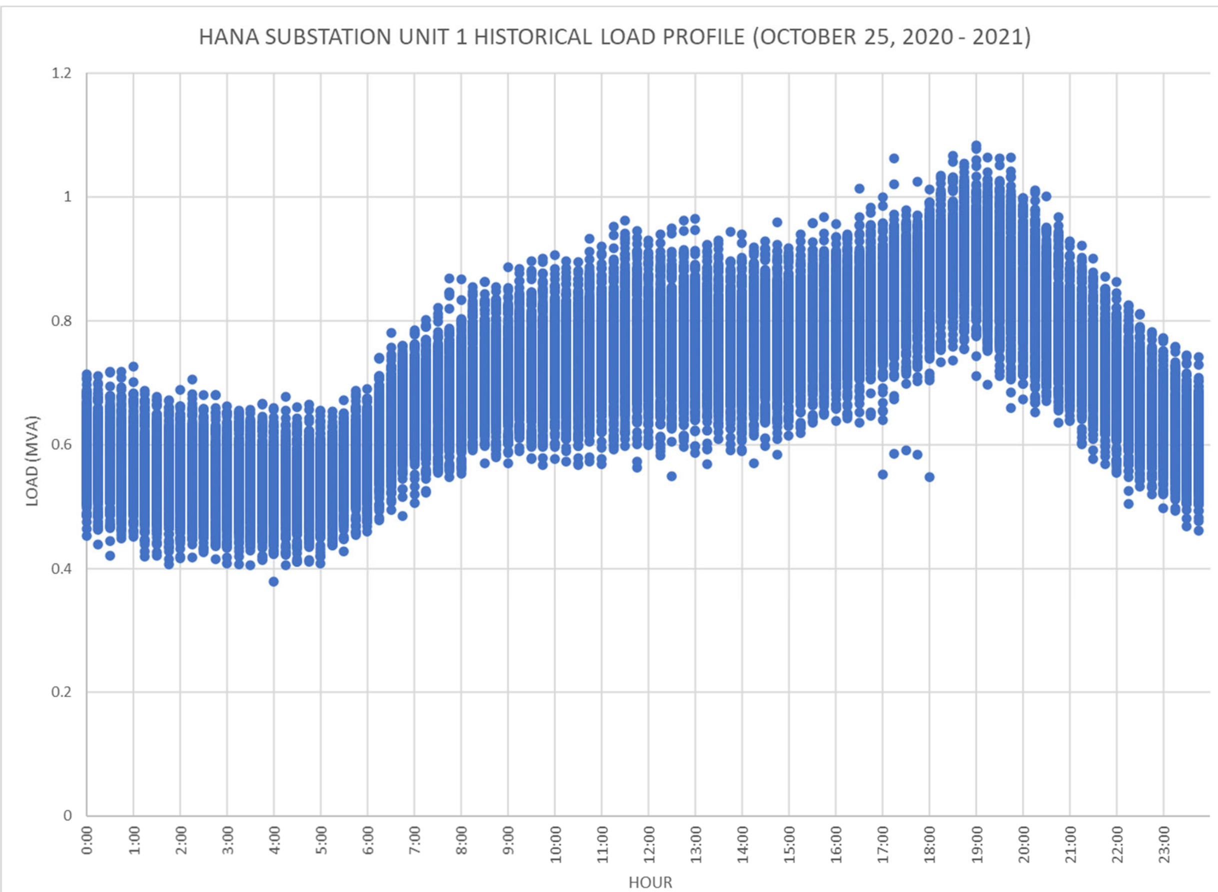

Figure 3: Hana Substation Unit 1 Historical Load Profile

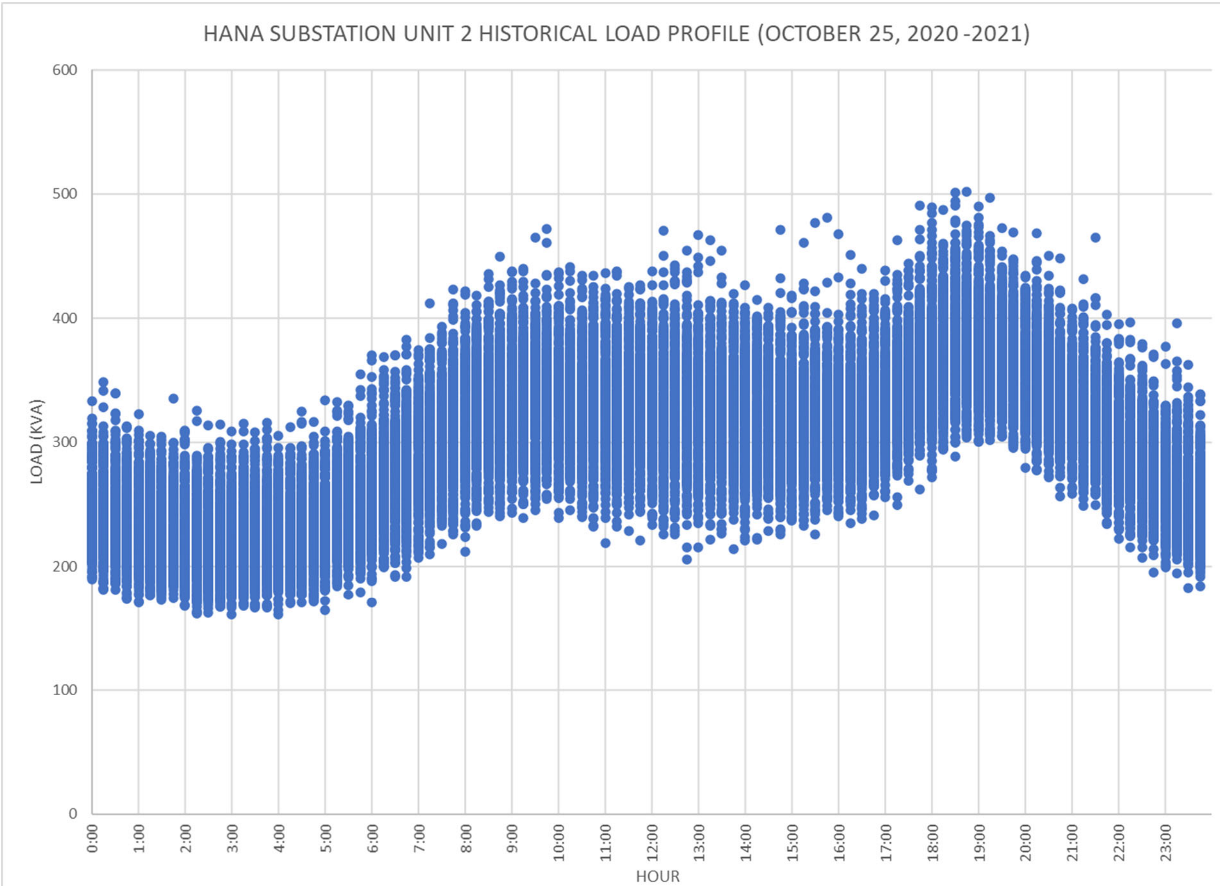

Figure 4: Hana Substation Unit 2 Historical Load Profile

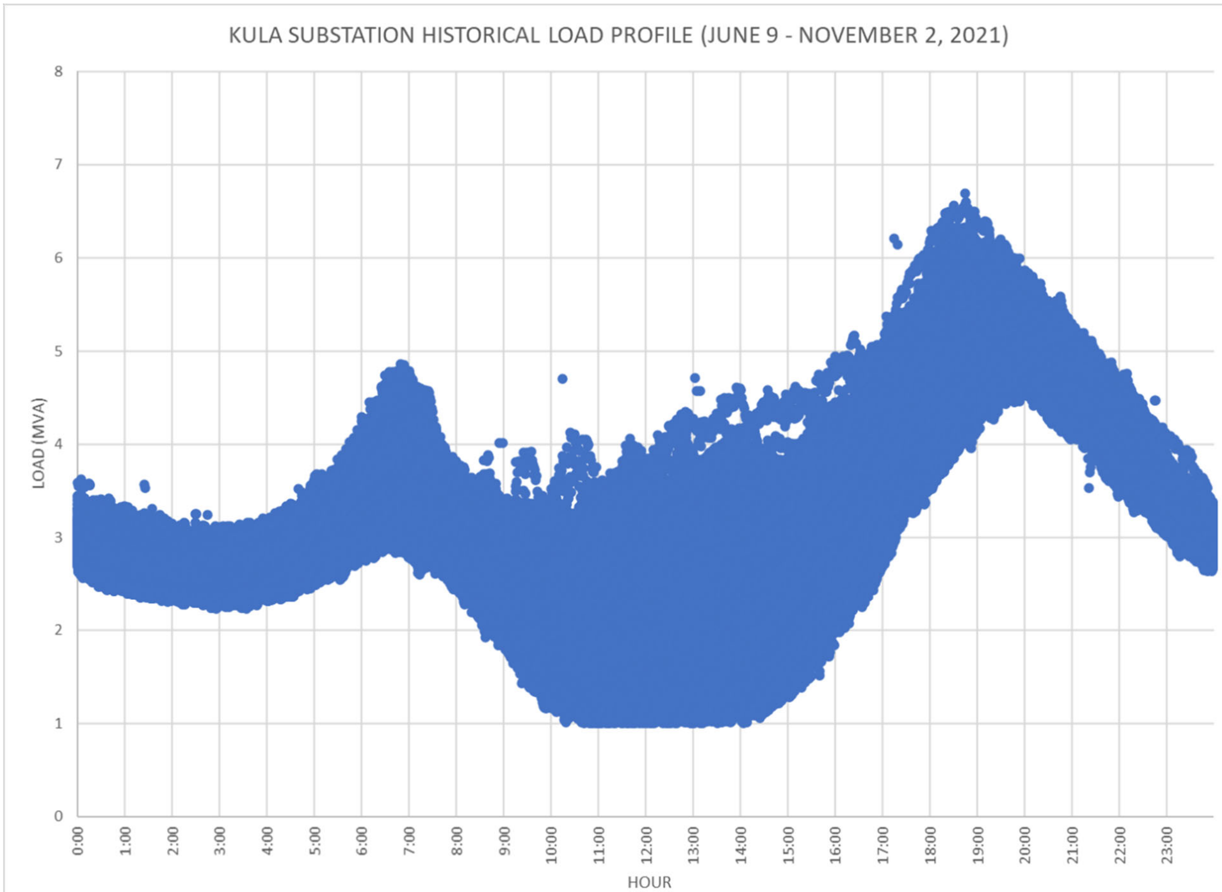

Figure 5: Kula Substation Historical Load Profile

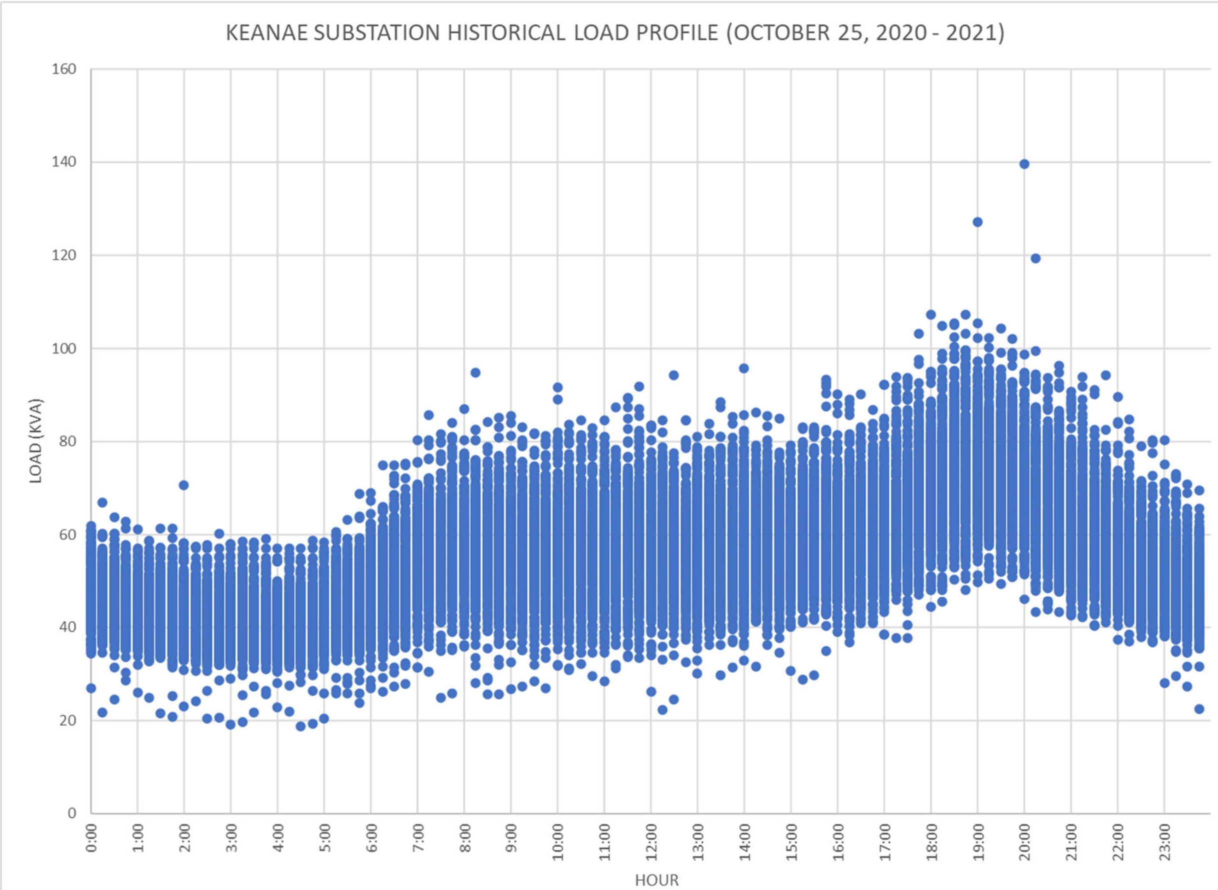

Figure 6: Ke'anae Substation Historical Load Profile

9.2.2 Market Assessment

Since NWA solutions to back up the identified substation transformers would need to be capable of meeting the full load served by the transformers, behind-the-meter solutions alone will not be sufficient to meet the NWA requirements. NWAs for each identified project will require land to site new generation/storage.

9.2.3 Economic Assessment

The estimated costs for each project are as follows:

1. Hana 1 / Hana 2 project: $468,000
2. Ke'anae project: $278,000
3. Kula project: $286,000

Each of the three proposed projects is estimated to be well below the $1M capital project cost threshold.

9.3 Step 3 – Action Plan

Given the low estimated cost of the traditional wired solutions along with the strict performance requirements, forecast uncertainty, and uncertainty of land availability for potential NWA procurements, the Distribution Feeder Tie initiative should be assigned to Track 3 since it is highly unlikely that these projects can be cost-effectively avoided by NWAs.

Table 1: Distribution Feeder Ties NWA Opportunity Evaluation

Track	Grid Need	Performance Requirements	Timing	Forecast Certainty	Market Assessment	Economic Assessment
3	Hana 1 / Hana 2 project	High-magnitude, long duration need. Always available resource.	Less than 2 years	Highly uncertain	Uncertain	Significantly less than $1M
3	Ke‘anae project	High-magnitude, long duration need. Always available resource.	About 2 years	Highly uncertain	Uncertain	Significantly less than $1M
3	Kula project	High-magnitude, long duration need. Always available resource.	2-5 years	Highly uncertain	Uncertain	Significantly less than $1M

Prepared for
Hawaiian Electric Companies

Prepared by
Ramboll US Consulting Inc.
San Francisco, CA

Project Number
1690024047

Date
May 2022

CLIMATE ADAPTATION TRANSMISSION AND DISTRIBUTION RESILIENCE PROGRAM GHG ANALYSIS

HAWAIIAN ELECTRIC COMPANIES

CONTENTS

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ATTACHMENTS

1. INTRODUCTION

The Hawaiian Electric Companies have applied for Public Utility Commission ("Commission") approval for the proposed Climate Adaptation Transmission and Distribution Resilience Program ("Project"), which will involve resilience enhancement activities. This report provides an estimate of the lifecycle emissions of greenhouse gases ("GHG" or "emissions") associated with the proposed Project. The Project includes upgrades and deployment of equipment across the Hawaiian Electric Company, Inc. ("Hawaiian Electric"), Hawaiʻi Electric Light Company, Inc. ("Hawaiʻi Electric Light"), and Maui Electric Company, Limited ("Maui Electric") grids as part of resilience enhancement implementation. This GHG emissions analysis ("analysis") is being provided pursuant to HRS § 269-6(b).

The Companies plan to implement a variety of resilience enhancements to improve the ability of the electric grids to withstand and recover from severe weather events that may threaten the Companies' service territory. The Project scope includes the following activities to be implemented across the Companies, except where noted:

1. **Critical Transmission Line Hardening:** Upgrades of highly critical transmission line infrastructure to withstand extreme winds and enable quicker recovery from severe electric disruptions.
2. **Critical Customer Circuit Hardening:** Upgrades of circuits serving critical customers to increase the overall wind rating of the associated infrastructure. Critical customers are those that provide fundamental services that enable all other aspects of society to function.
3. **Critical Pole Hardening:** Proactive hardening of critical poles to reduce restoration time, cost, and impacts. This will generally involve increasing the wind rating of poles that would be a high priority to replace, difficult to replace, and/or have identified high vulnerability in a severe weather event scenario.
4. **Substation Flood Monitoring:** Installation of flood monitors in substations identified to be at-risk of flooding.
5. **Hazard Tree Removal:** Removal of trees outside the right-of-way that pose risks to electric infrastructure in extreme wind scenarios.
6. **Wildfire Mitigation:** Includes a variety of system hardening and situational awareness investments to prevent or mitigate ignition of wildfires. Examples include pole upgrades or reframing, replacement of copper wires with aluminum conductor, and strategic installation of weather stations and cameras.
7. **Distribution Feeder Ties (Maui Only):** Creation of backup ties for isolated substation transformers on Maui to reduce electric outage durations caused by maintenance or failures.
8. **Lateral Undergrounding (Oʻahu Only):** Targeted undergrounding of distribution lateral lines in areas with high risk of vegetation-caused outages.

2. APPROACH OVERVIEW

Ramboll US Consulting, Inc. ("Ramboll") has conducted an analysis on behalf of the Hawaiian Electric Companies to estimate the projected GHG emissions ("Project GHG emissions").

This analysis evaluates the potential GHG emissions directly attributable to the installation of the proposed resilience infrastructure equipment, as well as the GHG emissions that may be produced at earlier lifecycle stages in the production process of the equipment, such as component and raw material production and transportation. In addition, this analysis evaluates the potential GHG emissions related to the Project's downstream processes, such as decommissioning and disposal of the equipment. Thus, this analysis evaluates upstream and downstream GHG emissions that would result from the Project for the duration of the Project Lifetime. There is no net increase in operations and maintenance expected from the Project; therefore, GHG emissions from Project operations were not quantified.

This analysis is intended to capture both the Project's direct emissions and reasonably foreseeable indirect emissions. Direct GHG emissions are emitted from sources that are owned or operated by the Hawaiian Electric Companies. Indirect GHG emissions are emitted from sources that are not necessarily owned or operated by the Companies, but are a consequence of the Companies' activities, including GHG emissions from raw materials extraction and manufacturing, upstream and downstream transportation, and disposal. The projected Project GHG emissions are based on the best reasonably available public data that has undergone scientific peer-review and are also based on the most current information, including emission factors, available to Ramboll at the time the analysis was completed. Where practicable and reasonably estimable, this information was then localized to account for unique location-specific factors applicable to a project on O'ahu, Hawai'i Island, and Maui, such as significant transportation distances, and supplemented with direct emissions calculated to account for the Project's upstream and downstream emissions. The use of a combination of localized peer-reviewed published studies and direct emissions calculations for the Project represents the "GHG Analysis" approach in this evaluation.

For the purposes of estimating lifecycle GHG emissions, the overall Project lifetime varies by subprogram. Replacement of equipment with an estimated lifetime of less than the respective subprogram's lifetime is accounted for by multiplying the number of equipment units installed by the ratio of the subprogram lifetime to the equipment lifetime (rounded up to the nearest integer) to determine the total number of pieces of equipment required throughout the subprogram lifetime.

As part of the analysis, Ramboll reviewed an extensive body of peer-reviewed literature to develop GHG emissions estimates based on the best reasonably-available public data. Commission Order 36407 acknowledges that the use of emissions values based on peer-reviewed literature can serve as a reasonable proxy in the absence of detailed installation location- and/or Project-specific data, while encouraging use of Project-specific data when available.[1] When available and practicable, Ramboll adjusted these emissions estimates to reasonably account for Project-, technology-, and site-specific factors representative of a project on O'ahu, Hawai'i Island, or Maui, depending on the installation location.

Section 3 provides the methodology and **Section 4** provides the resulting estimate of Project GHG emissions, including operations emissions of the Project ("Project Operations Emissions") and lifecycle emissions of the Project ("Project Lifecycle Emissions"). All responses involving calculated data are provided in the Excel-compatible spreadsheet files "Resilience Projects_Hawaii_GHGAnalysis.xlsx", "Resilience Projects_Maui_GHGAnalysis.xlsx", and "Resilience Projects_Oahu_GHGAnalysis.xlsx" which

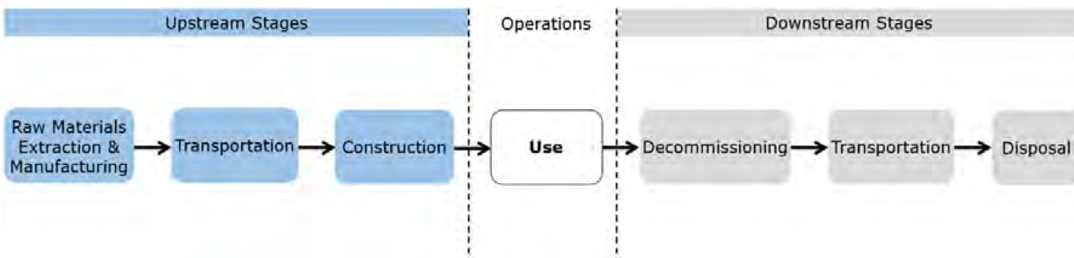
[1] See Commission Order 36407 (Docket 2018-0433).

provide live cell logic, references, and unhidden and unprotected calculations and formulas. The calculations, including the summary tables, are also provided as a PDF in **Attachment A**.

3. METHODOLOGY

This GHG Analysis evaluates the potential GHG emissions of the proposed Project. Ramboll's approach addresses the Project's direct emissions and reasonably foreseeable indirect emissions across the Project's Upstream, Construction, and Downstream Stages, as shown in **Figure 1**. There is no net increase in operations and maintenance expected from the Project; therefore, GHG emissions from Project Operations were not quantified.

Figure 1. Stages for Consideration in Project GHG Emissions Calculation



Potentially significant and reasonably foreseeable equipment, materials, and activities are accounted for throughout the Project lifecycle. The following sections provide an overview of the methodology, including key data sources and assumptions, for each Project Stage. The attached "Resilience Projects_Hawaii_GHGAnalysis.xlsx", "Resilience Projects_Maui_GHGAnalysis.xlsx", and "Resilience Projects_Oahu_GHGAnalysis.xlsx" Excel files each include a "Project Emissions" tab that provides the GHG Emissions for each Project Stage; "Equipment I + A" and "Construction I + A" tabs that detail the Project-, technology-, and location-specific inputs and assumptions used in the analysis; and detailed calculation tabs for each Project Stage. Each Project Stage calculation tab provides live cell logic, unhidden and unprotected calculations and formulas, and references.

3.1 Equipment Manufacturing, Including Material Extraction

The GHG emissions associated with raw material extraction and manufacturing ("RMEM") are for equipment and materials installed during the Project. The Project's GHG emissions are estimated based on the total number of pieces of equipment required to meet each subprogram's lifetime, as the lifetimes of each subprogram vary. The GHG emissions factors for the resilience infrastructure manufacturing, including material extraction, were obtained from peer-reviewed lifecycle studies and databases that provided GHG emissions lifecycle inventory data for the system components and scope relevant to this Project, as detailed in **Appendix Table A1: Raw Materials Extraction & Manufacturing Equipment GHG Emissions Calculations**. This table provides detailed calculations, including assumptions and inputs related to grid infrastructure system manufacturing.

3.2 Additional Transportation to and from Installation Locations

To adjust the lifecycle results to the Project and island-specific location, additional transportation emissions were calculated using an "inventory approach" where direct GHG emissions from transportation and construction are calculated based on Project- and installation location-specific data.

This includes upstream and downstream transportation for all Project components from manufacturer locations to the Project site. The net weight is determined based on the weight of each system component and the quantity of each component, if available, or publicly available information for similar components. For instance, the weight of the transmission line system is based on the material requirements for a 150 kV aerial transmission line as set forth in Jorge et al (see Footnote **Error! Bookmark not defined.**). The transportation emissions are calculated by determining the distance, mode of travel (including truck, marine shipping, or aircraft) with corresponding emission factor, and weight of material transported for each transportation leg. For a given transportation segment, if the mode of travel is not known and if multiple travel modes are available, the most emissions-intensive mode is selected.[2] Transportation emissions are estimated based on one-way travel from an origin to a destination with the exception of estimated emissions to or from the site. Emissions to and from the site are estimated based on the roundtrip distance.

Emission factors for road transportation were obtained from the United States Environmental Protection Agency ("US EPA", or "EPA") Scope 3 Inventory Guidance,[3] and the emission factor for shipping was obtained from Global Maritime Trade Lane Emissions Factors.[4] Shipping distances were estimated using the Sea Distance tool,[5] based on shipping distances from the nearest port to the manufacturer location to Los Angeles, California, from Los Angeles to Honolulu for O'ahu, and, for installation locations on Hawai'i Island or Maui, the additional distance from Honolulu, O'ahu to Hawai'i Island or Maui. Truck distances from the manufacturer location to the port were estimated using Google Maps to determine driving distances. The distance from Kahului, Maui to the site was provided by Hawaiian Electric.

Appendix Table A2: Material Transportation GHG Emissions Calculations provides detailed calculations, including assumptions and inputs related to material transport.

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[2] The GHG emissions per ton-mile of transportation from maritime shipping are lower than for rail and trucks. As indicated in the above section, this analysis conservatively assumes the most emissions-intensive transportation mode if the travel mode is not known.

[3] EPA Scope 3 Inventory Guidance is available at: https://www.epa.gov/climateleadership/scope-3-inventory-guidance, and recommends emission factors from Table 8 of Emission Factors for Greenhouse Gas Inventories, available at: https://www.epa.gov/system/files/documents/2022-04/ghg_emission_factors_hub.pdf. Accessed May 2022.

[4] The emission factor for shipping is based on the Global Maritime Emission Factor for dry (i.e., non-refrigerated) cargo shipping overall trade lanes for 2020 with a 70% utilization factor, assuming an average load weight of 10 tons in each container. Global Maritime Emission Factors are available at: https://www.bsr.org/files/clean-cargo/BSR-Clean-Cargo-Emissions-Report-2021.pdf. Accessed May 2022.

[5] Available at: https://sea-distances.org. Accessed August 2019.

3.3 Project Construction

To adjust the lifecycle results to the Project and island-specific location, construction emissions were calculated using an "inventory approach" where direct GHG emissions from transportation and construction are calculated based on Project- and installation location-specific data.

Construction emissions were based on construction activity information, such as schedule, equipment mix, and on-road trip information, provided by Hawaiian Electric Companies for specific construction activities. Emission factors for off-road equipment were obtained from OFFROAD,[6] which is a model that estimates emissions from heavy duty equipment created by the California Air Resources Board ("CARB"). Emission factors for helicopters are consistent with the Valley Ivyglen and Alberhill System Project, which quantified GHG emissions from helicopter use during construction.[7] Emission factors for on-road trips for workers and vendors were obtained from CARB's EMFAC website, which provides emissions inventories and associated documentation for on-road mobile sources in California.[8]

Appendix Table A3: Construction GHG Emissions Calculations provides detailed calculations, including assumptions and inputs related to construction.

3.4 Decommissioning & Disposal

To adjust lifecycle results to the Project-specific scopes of work, the additional decommissioning and disposal emissions were calculated to account for the resilience infrastructure. The decommissioning and disposal of existing equipment was not included within the scope of this analysis, as the removal of existing equipment would happen with or without the Project. The GHG emissions resulting from the decommissioning and disposal of proposed resilience infrastructure was included within the scope of the analysis. Based on information provided by the Companies, decommissioning intensity of proposed equipment relative to construction is expected to be 3% for the overall Project. The disposal emission factors are multiplied by the mass of system components or material to estimate GHG emissions from decommissioning and disposal. The disposal estimates account for potential end of life treatment including landfill, incineration, and recycling, and conservatively do not take credit for recycling. Unless noted in the "Equipment I + A" tab, the Downstream transportation emissions include transportation of material from the Project site to a disposal site in Los Angeles, California. The scrap yard at Los Angeles was selected as the disposal site as a reasonable, conservative assumption.[9] The equipment and materials that are disposed of locally are noted in the "Equipment I + A" tab. The GHG emissions factors for

[6] California Air Resources Board (CARB) 2022. OFFROAD 2021. Available at: https://arb.ca.gov/emfac/emissions-inventory. Accessed May 2022.

[7] Valley-Ivyglen and Alberhill System Project. Available at: https://www.cpuc.ca.gov/environment/info/ene/alberhill/Alberhill.html

[8] California Air Resources Board (CARB) 2022. EMFAC2021. Available at: https://arb.ca.gov/emfac/emissions-inventory. Accessed May 2022.

[9] At this stage in the Project lifecycle, the end-of-life fate of the Project equipment is not known. There are several potential options for equipment end-of-life, including reuse of equipment in Hawai'i, disposal in Hawai'i, or transportation back to Los Angeles for disposal. Of the potential end-of-life activities, the latter of sending all equipment to a Los Angeles scrap yard is the most conservative assumption.

the disposal of the system components are obtained from peer-reviewed lifecycle studies and databases that provided GHG emissions lifecycle inventory data for the system components and scope relevant to this Project, as detailed in **Appendix Table A4: Decommissioning & Disposal GHG Emissions Calculations**. This table provides detailed calculations, including assumptions and inputs.

4. CONCLUSION / GHG ANALYSIS RESULTS

The GHG Analysis of the Project results in an estimated **Project Lifecycle Emissions** of **27,506 metric tons carbon dioxide equivalent (“MT CO_2e”)**. The GHG Analysis for the Project includes projected GHG emissions directly attributable to the Project, as well as indirect GHG emissions from upstream and downstream activities, modified to the Project and its installation sites, all as described above in this report. There is no net increase in operations and maintenance expected from the Project; therefore, GHG emissions from Project operations were not quantified. Project GHG emissions results are summarized in Table 1, Table 2, and Table 3 and in **Appendix A Table 1: Hawaiian Electric Project GHG Emissions by Stage**, **Appendix B Table 1: Hawai‘i Electric Light Project GHG Emissions by Stage**, and **Appendix C Table 1: Maui Electric Project GHG Emissions by Stage**.

Table 1. Project GHG Emissions by Stage (Hawaiian Electric)

Project Stage		GHG Emissions (MT CO_2e)							
		Transmission Hardening	Critical Pole Hardening	Critical Circuit Hardening	Wildfire Mitigation	Substation Flood Monitors	Lateral Undergrounding	Hazard Tree Removal	**Total**
Upstream	Raw Materials Extraction & Manufacturing	3,388	1,137	1,739	1,541	0.089	1,731	0	**9,535**
	Transportation	890	111	170	99	0.014	88	0	**1,360**
	Construction	781	932	220	185	3.6	568	1,072	**3,761**
Project Operations	Operations & Maintenance	0	0	0	0	0	0	0	**0**
Downstream	Transportation	18	12	18	8.3	8.8E-04	2.5	0	**58**
	Decommissioning & Disposal	42	52	43	9.0	0.11	33	0	**179**
Total Project Lifecycle		**5,119**	**2,244**	**2,190**	**1,843**	**3.8**	**2,423**	**1,072**	**14,893**

Table 2. Project GHG Emissions by Stage (Hawaiʻi Electric Light)

Project Stage		GHG Emissions (MT CO_2e)						
		Transmission Hardening	Critical Pole Hardening	Critical Circuit Hardening	Wildfire Mitigation	Substation Flood Monitors	Hazard Tree Removal	**Total**
Upstream	Raw Materials Extraction & Manufacturing	1,052	869	535	1,528	0.089	0	**3,985**
	Transportation	229	89	55	102	0.01	0	**475**
	Construction	366	725	71	195	3.8	1,111	**2,472**
Project Operations	Operations & Maintenance	0	0	0	0	0	0	**0**
Downstream	Transportation	21	13	8.1	11	0.0011	0	**53**
	Decommissioning & Disposal	61	40	13	9.2	0.12	0	**123**
Total Project Lifecycle		**1,730**	**1,736**	**683**	**1,845**	**4.0**	**1,111**	**7,108**

Table 3. Project GHG Emissions by Stage (Maui Electric)

Project Stage		GHG Emissions (MT CO_2e)							
		Transmission Hardening	Critical Pole Hardening	Critical Circuit Hardening	Wildfire Mitigation	Substation Flood Monitors	Distribution Feeder Ties	Hazard Tree Removal	**Total**
Upstream	Raw Materials Extraction & Manufacturing	260	535	535	1,528	0.089	68	0	**2,927**
	Transportation	142	52	52	99	0.014	2.2	0	**346**
	Construction	133	440	67	182	3.6	9.4	1,062	**1,897**
Project Operations	Operations & Maintenance	0	0	0	0	0	0	0	**0**
Downstream	Transportation	7.0	5.4	5.4	7.6	8.0E-04	1.0	0	**26**
	Decommissioning & Disposal	43	24	13	8.8	0.11	3.6	0	**93**
Total Project Lifecycle		**586**	**1,056**	**672**	**1,826**	**3.8**	**84**	**1,062**	**5,290**

ATTACHMENT A
HAWAIIAN ELECTRIC TABLES AND CALCULATIONS

Resilience Projects GHG Analysis (O‘ahu)
O‘ahu, HI
Table of Contents

Table 1
Project GHG Emissions by Stage
Resilience Projects GHG Analysis (O‘ahu)
O‘ahu, HI

Project Stage		GHG Emissions (MT CO2e)[1,2]
Upstream[3]	Raw Materials Extraction & Manufacturing	9,535
	Transportation	1,360
	Construction	3,761
Project Operations	Operations & Maintenance	0
Downstream[4]	Transportation	58
	Decommissioning & Disposal	179
	Total Project Operations[5]	**0**
	Total Project Lifecycle	**14,893**

Notes:

1. This table summarizes results from the GHG Analysis undertaken to determine Project GHG Emissions. The supporting calculations are provided in the Calculation tabs for each Project Stage; each tab provides live cell logic, references, calculations and formulas unhidden and unprotected. Note that numbers may not add to totals due to rounding.
2. The Project GHG Emissions estimates are based on the most current information including emissions factors available to Ramboll at the time the analysis was completed.
3. Upstream Transportation and Construction Stages include all construction and transportation activity related to the installation of the proposed project activities, as described in more detail in the Transportation and Construction calculation tables.
4. Downstream decommissioning and disposal emissions include emissions associated with the removal and disposal of Project equipment.
5. Total Project Operations assumed to be zero as there is no net increase in Operations & Maintenance (Use) due to the Project.

Abbreviations:

CO_2e - carbon dioxide equivalent

GHG - greenhouse gas

MT - metric ton

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Table 2
Project Specific Inputs and Assumptions
Resilience Projects GHG Analysis (O'ahu)
O'ahu, HI

	Description	Input	Unit	Reference
General Project				
General Project	**Project Name**	Resilience Projects - O'ahu	--	Provided by Hawaiian Electric.
	Project Location (Island)	O'ahu	--	Provided by Hawaiian Electric.
	Island Location of Site (Final Port Location)	Honolulu Harbor	--	Determined based on Project Location (Island).
	Distance from Final Hawai'i Port to Site Location	15	mi	Provided by Hawaiian Electric. Distance to center of island.
Transmission Hardening				
General	**General Subprogram Project**			
	Subprogram Project Name	O'ahu Transmission Hardening	--	Provided by Hawaiian Electric.
	Subprogram Project Lifetime	58	yr	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Tangent Steel Pole with Concrete Foundation**	Yes		Provided by Hawaiian Electric.
	Number of Steel Poles (w/ concrete foundation)	73	item	Provided by Hawaiian Electric. 90% of the steel utility poles installed for the Transmission Hardening project are assumed to be tangent poles.
	Weight of Each Steel Pole	17,865	lb	Provided by Hawaiian Electric.
	Height of Steel Poles (w/ concrete foundation)	75	ft	Confirmed by Hawaiian Electric.
	Volume of concrete foundation (length x width x height)	270	ft^3	Provided by Hawaiian Electric.
	Weight of Each Concrete Foundation	40,500	lb	Calculated based on information provided and concrete density of 150 lb/ft^3.
	Location of Utility Pole Manufacturer - Steel Poles (w/ Concrete Foundation)	Valley, Nebraska	--	Confirmed by Hawaiian Electric.
	Equipment Lifetime (Expected Useful Life of the Equipment)	58	yr	Confirmed by Hawaiian Electric.
	Number of Equipment over Project Lifetime	73	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	Final Steel Pole and Concrete Disposal Location	Local (Island Location of Site)	--	Concrete disposal location provided by Hawaiian Electric.
	End of Life Treatment	Decommissioning and disposal	--	Confirmed by Hawaiian Electric.
	Dead End Steel Pole with Concrete Foundation	Yes		Provided by Hawaiian Electric.
	Number of Steel Poles (w/ concrete foundation)	8	item	Provided by Hawaiian Electric. 10% of the steel utility poles installed for the Transmission Hardening project are assumed to be dead end poles.
	Weight of Each Steel Pole	40,000	lb	Provided by Hawaiian Electric.
	Height of Steel Poles (w/ concrete foundation)	75	ft	Confirmed by Hawaiian Electric.
	Volume of concrete foundation (length x width x height)	270	ft^3	Provided by Hawaiian Electric.
	Weight of Each Concrete Foundation	40,500	lb	Calculated based on information provided and concrete density of 150 lb/ft^3.
	Location of Utility Pole Manufacturer - Steel Poles (w/ Concrete Foundation)	Valley, Nebraska	--	Confirmed by Hawaiian Electric.
	Equipment Lifetime (Expected Useful Life of the Equipment)	58	yr	Confirmed by Hawaiian Electric.
	Number of Equipment over Project Lifetime	8	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	Final Concrete Disposal Location	Local (Island Location of Site)	--	Concrete disposal location provided by Hawaiian Electric.
	End of Life Treatment	Decommissioning and disposal	--	Confirmed by Hawaiian Electric.
Critical Pole Hardening				
General	**General Subprogram Project**			
	Subprogram Project Name	O'ahu Critical Pole Hardening	--	Provided by Hawaiian Electric.
	Subprogram Project Lifetime	58	yr	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Steel Pole (Self Supporting, Direct-Buried)**	Yes		Provided by Hawaiian Electric.
	Number of Steel Poles	85	item	Provided by Hawaiian Electric.
	Weight of Each Steel Pole	6,600	lb	Provided by Hawaiian Electric.
	Height of Steel Poles	75	ft	Provided by Hawaiian Electric.
	Location of Utility Pole Manufacturer - Steel Poles	Valley, Nebraska	--	Confirmed by Hawaiian Electric.
	Equipment Lifetime (Expected Useful Life of the Equipment)	58	yr	Confirmed by Hawaiian Electric.
	Number of Equipment over Project Lifetime	85	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	End of Life Treatment	Decommissioning and disposal	--	Confirmed by Hawaiian Electric.
	Wood Pole	Yes		Provided by Hawaiian Electric.
	Number of Wood Poles	85	item	Provided by Hawaiian Electric.
	Height of Each Wood Pole	65	ft	Provided by Hawaiian Electric.
	Weight of Each Wood Pole	5,000	lb	Provided by Hawaiian Electric.
	Location of Wood Pole Manufacturer	Tacoma, Washington	--	Confirmed by Hawaiian Electric.
	Equipment Lifetime (Expected Useful Life of the Equipment)	58	yr	Confirmed by Hawaiian Electric.
	Number of Equipment over Project Lifetime	85	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	Final Wood Pole Disposal Location	Local (Island Location of Site)	--	Wood pole disposal location provided by Hawaiian Electric.
	End of Life Treatment	Decommissioning and disposal	--	Confirmed by Hawaiian Electric.

Table 2
Project Specific Inputs and Assumptions
Resilience Projects GHG Analysis (O'ahu)
O'ahu, HI

	Description	Input	Unit	Reference
Critical Circuit Hardening				
General	**General Subprogram Project**			
	Subprogram Project Name	O'ahu Critical Circuit Hardening	--	Provided by Hawaiian Electric.
	Subprogram Project Lifetime	58	yr	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Steel Pole (Self Supporting, Direct-Buried)**	Yes		Provided by Hawaiian Electric.
	Number of Steel Poles	130	item	Provided by Hawaiian Electric.
	Weight of Each Steel Pole	6,600	lb	Provided by Hawaiian Electric.
	Height of Steel Poles	75	ft	Provided by Hawaiian Electric.
	Location of Utility Pole Manufacturer - Steel Poles	Valley, Nebraska	--	Confirmed by Hawaiian Electric.
	Equipment Lifetime (Expected Useful Life of the Equipment)	58	yr	Confirmed by Hawaiian Electric.
	Number of Equipment over Project Lifetime	130	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	End of Life Treatment	Decommissioning and disposal	--	Confirmed by Hawaiian Electric.
	Wood Pole	Yes		Provided by Hawaiian Electric.
	Number of Wood Poles	130	item	Provided by Hawaiian Electric.
	Height of Each Wood Pole	65	ft	Provided by Hawaiian Electric.
	Weight of Each Wood Pole	5,000	lb	Provided by Hawaiian Electric.
	Location of Wood Pole Manufacturer	Tacoma, Washington	--	Confirmed by Hawaiian Electric.
	Equipment Lifetime (Expected Useful Life of the Equipment)	58	yr	Confirmed by Hawaiian Electric.
	Number of Equipment over Project Lifetime	130	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	Final Wood Pole Disposal Location	Local (Island Location of Site)	--	Wood pole disposal location provided by Hawaiian Electric.
	End of Life Treatment	Decommissioning and disposal	--	Confirmed by Hawaiian Electric.
Wildfire Mitigation				
General	**General Subprogram Project**			
	Subprogram Project Name	O'ahu Wildfire Mitigation	--	Provided by Hawaiian Electric.
	Subprogram Project Lifetime	55	yr	Provided by Hawaiian Electric.
Overhead Sub-Transmission Line	**Overhead Sub-Transmission Line**	Yes		Provided by Hawaiian Electric.
	Sub-Transmission Line Voltage	46	kV	Provided by Hawaiian Electric.
	Sub-Transmission Line Material	Aluminum Conductor	--	Confirmed by Hawaiian Electric.
	Location of Sub-Transmission Line Manufacturer	Florence, Alabama	--	Confirmed by Hawaiian Electric.
	Length of Sub-Transmission Line (linear feet)	42,240	ft	Provided by Hawaiian Electric.
	Conductor + Bulk of System	158,308	kg	Conservatively estimated based on material requirements per km of 150 kV aerial transmission line from Table S5 of Jorge et al. (2011a), and assumed to account for bulk of transmission line system (e.g. circuit breakers, insulators, conductors).[1]
	Equipment Lifetime (Expected Useful Life of the Equipment)	58	yr	Confirmed by Hawaiian Electric.
	Number of Equipment over Project Lifetime	1	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	End of Life Treatment	Decommissioning and disposal	--	Confirmed by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Steel Pole (Self Supporting, Direct-Buried)**	Yes		Provided by Hawaiian Electric.
	Number of Steel Poles	16	item	Provided by Hawaiian Electric.
	Weight of Each Steel Pole	6,600	lb	Provided by Hawaiian Electric.
	Height of Steel Poles	75	ft	Provided by Hawaiian Electric.
	Location of Utility Pole Manufacturer - Steel Poles	Valley, Nebraska	--	Confirmed by Hawaiian Electric.
	Equipment Lifetime (Expected Useful Life of the Equipment)	58	yr	Confirmed by Hawaiian Electric.
	Number of Equipment over Project Lifetime	16	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	End of Life Treatment	Decommissioning and disposal	--	Confirmed by Hawaiian Electric.
Misc. Project Equipment	**Thermal Cameras**	Yes		Provided by Hawaiian Electric.
	Number of Cameras	16	item	Provided by Hawaiian Electric.
	Weight of Each Camera	40	lb	Provided by Hawaiian Electric.
	Manufacturer/Model of Cameras	FLIR/ Model: $A_3$10PT	--	Provided by Hawaiian Electric.
	Location of Camera Manufacturer	Goleta, California	--	Provided by Hawaiian Electric.
	Equipment Lifetime (Expected Useful Life of the Equipment)	55	yr	Provided by Hawaiian Electric.
	Number of Equipment over Project Lifetime	16	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	End of Life Treatment	Decommissioning and disposal	--	Provided by Hawaiian Electric.
	Weather Stations	Yes		Provided by Hawaiian Electric.
	Number of Weather Stations	8	item	Provided by Hawaiian Electric.
	Weight of Each Weather Station	80	kg	Provided by Hawaiian Electric.
	Manufacturer/Model of Weather Stations	Orion Weather Station, Columbia Weather Systems	--	Provided by Hawaiian Electric.
	Additional Components Included for Weather Stations	Includes sensor module, surge protector, interface, Weather MicroServer, LCD display console	--	Provided by Hawaiian Electric.

Table 2
Project Specific Inputs and Assumptions
Resilience Projects GHG Analysis (O'ahu)
O'ahu, HI

	Description	Input	Unit	Reference
Misc. Project Equipment	Location of Weather Station Manufacturer	Hillsboro, Oregon	--	Provided by Hawaiian Electric.
	Equipment Lifetime (Expected Useful Life of the Equipment)	55	--	Provided by Hawaiian Electric.
	Number of Equipment over Project Lifetime	8	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	End of Life Treatment	Decommissioning and disposal	--	Provided by Hawaiian Electric.
Substation Flood Monitors				
General	**General Subprogram Project**			
	Subprogram Project Name	O'ahu Substation Flood Monitors	--	Provided by Hawaiian Electric.
	Subprogram Project Lifetime	55	yr	Provided by Hawaiian Electric.
Misc. Project Equipment	**Flood Monitors**	Yes		Provided by Hawaiian Electric.
	Number of Flood Monitors	4	item	Provided by Hawaiian Electric.
	Flood Monitors Voltage	10	V	Based on information provided by Hawaiian Electric.
	Weight of Each Flood Monitor Sensor (Stainless Steel Alloy)	10	lb	Provided by Hawaiian Electric.
	Weight of Each Flood Monitor Casing (PVC)	1.0	lb	Provided by Hawaiian Electric.
	Weight of Each Flood Monitor Cable (PVC)	1.0	lb	Provided by Hawaiian Electric.
	Manufacturer / Model of Flood Monitors	Flygt, a Xylem Brand	--	Based on information provided by Hawaiian Electric.
	Location of Flood Monitors Manufacturer	Batavia, New York	--	Confirmed by Hawaiian Electric. Estimated based on Flygt office locations in New York.
	Equipment Lifetime (Expected Useful Life of the Equipment)	55	yr	Provided by Hawaiian Electric.
	Number of Equipment over Project Lifetime	4	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	End of Life Treatment	Decommissioning and disposal	--	Provided by Hawaiian Electric.
Lateral Undergrounding				
General	**General Subprogram Project**			
	Subprogram Project Name	O'ahu Lateral Undergrounding	--	Provided by Hawaiian Electric.
	Subprogram Project Lifetime	51	yr	Provided by Hawaiian Electric.
Underground Distribution Line	**Underground Distribution Line Conductor**	Yes		Provided by Hawaiian Electric.
	Distribution Line Voltage	12	kV	Confirmed by Hawaiian Electric.
	Distribution Line Material	Aluminum Conductor	--	Confirmed by Hawaiian Electric.
	Distribution Line Insulation	Polyethylene	--	Provided by Hawaiian Electric.
	Location of Distribution Line Manufacturer	Abbeville, South Carolina	--	Confirmed by Hawaiian Electric.
	Length of Distribution Line (linear feet)	21,120	ft	Provided by Hawaiian Electric.
	Conductor + Bulk of System	22,176	lb	Provided by Hawaiian Electric. Based on #2 PEICN conductor density of 1.05 lb/ft.
	Equipment Lifetime (Expected Useful Life of the Equipment)	51	yr	Provided by Hawaiian Electric.
	Number of Equipment over Project Lifetime	1	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	End of Life Treatment	Decommissioning and disposal	--	Provided by Hawaiian Electric.
	Conduit Duct for Underground Distribution Line	Yes		Provided by Hawaiian Electric.
	Conduit Duct Material	PVC	--	Confirmed by Hawaiian Electric.
	Conduit Duct (Inner) Diameter	4.0	in	Confirmed by Hawaiian Electric.
	# of Conduits per Duct Bank	8	--	Provided by Hawaiian Electric.
	Total Length of Conduit Duct	21,120	ft	Provided by Hawaiian Electric.
	Weight of Conduit Duct	2.3	lb/ft	Weight based on 2.312 lb/ft from 4" PVC Rigid Conduit from Allied Tube & Conduit. Confirmed by Hawaiian Electric.
	Total Weight of Conduit Duct	390,636	lb	Estimated based on conduit duct weight per foot and total length of conduit duct.
	Location of Conduit Duct Manufacturer	Milford, Utah	--	Confirmed by Hawaiian Electric.
	Equipment Lifetime (Expected Useful Life of the Equipment)	51	yr	Provided by Hawaiian Electric.
	Number of Equipment over Project Lifetime	1	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	End of Life Treatment	Abandoned in place	--	Confirmed by Hawaiian Electric.
	Duct Bank Casing	Yes		Provided by Hawaiian Electric.
	Duct Bank Casing (Containing Distribution Line + Conduit Duct) Material	Concrete Encased	--	Provided by Hawaiian Electric.
	Duct Bank Casing Dimensions (Width)	16	in	Provided by Hawaiian Electric.
	Duct Bank Casing Dimensions (Depth)	16	in	Provided by Hawaiian Electric.
	Length Of Duct Bank Casing	21,120	ft	Provided by Hawaiian Electric.
	Volume of Duct Bank	37,547	ft^3	Calculated based on duct bank casing dimensions and length.
	Weight of Duct Bank	5,632,000	lb	Calculated based on concrete density of 150 lb/ft^3
	Material to Surround Duct Bank	Soil Backfill	--	Provided by Hawaiian Electric.
	Volume of Material to Surround Duct Bank	147,253	ft^3	Calculated based on excavation dimensions provided by Hawaiian Electric.
	Weight of Material to Surround Duct Bank	--	lb	Confirmed by Hawaiian Electric. Soil used will be sourced from the project site.
	Location of Duct Bank Casing Manufacturer - Local Manufacturer	Kapolei, Hawai'i	--	Confirmed by Hawaiian Electric.

Table 2
Project Specific Inputs and Assumptions
Resilience Projects GHG Analysis (Oʻahu)
Oʻahu, HI

	Description	Input	Unit	Reference
Underground Distribution Line	Distance from Location of Duct Bank Casing Local Manufacturer to Site Location	20	mi	Provided by Hawaiian Electric.
	Equipment Lifetime (Expected Useful Life of the Equipment)	51	yr	Provided by Hawaiian Electric.
	Number of Equipment over Project Lifetime	1	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	End of Life Treatment	Abandoned in place	--	Confirmed by Hawaiian Electric.
	Concrete Handhole 2' x 4'	Yes		Provided by Hawaiian Electric.
	Total Number of Handholes	211	item	Provided by Hawaiian Electric.
	Dimensions of Handholes	2 x 4	ft x ft	Provided by Hawaiian Electric.
	Handhole Material	Steel Frame with Concrete	--	Confirmed by Hawaiian Electric.
	Volume of Each Handhole	200	ft^3	Confirmed by Hawaiian Electric.
	Weight of Each Handhole	7,400	lb	Provided by Hawaiian Electric.
	Location of Handhole Manufacturer	Kapolei, Hawaiʻi	--	Confirmed by Hawaiian Electric.
	Distance from Handhole Manufacturer to Site	20	mi	Confirmed by Hawaiian Electric.
	Equipment Lifetime (Expected Useful Life of the Equipment)	51	yr	Confirmed by Hawaiian Electric.
	Number of Equipment over Project Lifetime	211	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	End of Life Treatment	Abandoned in place	--	Provided by Hawaiian Electric.
	Handhole Cover	Yes		Provided by Hawaiian Electric.
	Total Number of Handhole Covers	654	item	Provided by Hawaiian Electric.
	Handhole Cover Material	Steel Frame with Concrete	--	Confirmed by Hawaiian Electric.
	Weight of Handhole Cover	210	lb	Confirmed by Hawaiian Electric.
	Location of Handhole Cover Manufacturer	Kapolei, Hawaiʻi	--	Confirmed by Hawaiian Electric.
	Distance from Handhole Cover Manufacturer to Site	20	mi	Confirmed by Hawaiian Electric.
	Equipment Lifetime (Expected Useful Life of the Equipment)	51	yr	Confirmed by Hawaiian Electric.
	Number of Equipment over Project Lifetime	654	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	End of Life Treatment	Abandoned in place	--	Confirmed by Hawaiian Electric.
	Concrete Handhole 6' x 11'	Yes		Provided by Hawaiian Electric.
	Total Number of Manholes	3	item	Provided by Hawaiian Electric.
	Dimensions of Manholes	6 x 11	ft x ft	Confirmed by Hawaiian Electric.
	Manhole Material	Concrete	--	Confirmed by Hawaiian Electric.
	Manhole Volume	601	ft^3	Confirmed by Hawaiian Electric.
	Manhole Weight	50,900	lb	Confirmed by Hawaiian Electric.
	Location of Manhole Manufacturer	Kapolei, Hawaiʻi	--	Confirmed by Hawaiian Electric.
	Distance from Manhole Manufacturer to Site	20	mi	Confirmed by Hawaiian Electric.
	Equipment Lifetime (Expected Useful Life of the Equipment)	51	yr	Confirmed by Hawaiian Electric.
	Number of Equipment over Project Lifetime	3	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	End of Life Treatment	Abandoned in place	--	Confirmed by Hawaiian Electric.
Transformers, Switches, Switchgears, Circuit Breakers	Transformer (Rating 0 - 1.87 MVA)	Yes		Provided by Hawaiian Electric.
	Number of Transformers	43	item	Provided by Hawaiian Electric.
	Transformer Rating	50	kVA	Provided by Hawaiian Electric.
	Weight of Each Transformer	1,100	lb	Provided by Hawaiian Electric.
	Location of Transformer Manufacturer	Jefferson City, Missouri	--	Provided by Hawaiian Electric.
	Equipment Lifetime (Expected Useful Life of the Equipment)	27	yr	Confirmed by Hawaiian Electric.
	Number of Equipment over Project Lifetime	86	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	End of Life Treatment	Decommissioning and disposal	--	Confirmed by Hawaiian Electric.
	Switchgear	Yes		Provided by Hawaiian Electric.
	Total number of Switchgears	3	item	Provided by Hawaiian Electric.
	Voltage of Switchgears	15	kV	Confirmed by Hawaiian Electric.
	Weight of Switchgears	2,650	lb	Provided by Hawaiian Electric.
	Specification of Switchgears	S&C	--	Provided by Hawaiian Electric.
	Switchgear Insulation Material	Cycloaliphatic Epoxy	--	Provided by Hawaiian Electric.
	Location of Switches Manufacturer	Chicago, Illinois	--	Provided by Hawaiian Electric.
	Equipment Lifetime (Expected Useful Life of the Equipment)	30	yr	Provided by Hawaiian Electric.
	Number of Equipment over Project Lifetime	6	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	End of Life Treatment	Decommissioning and disposal	--	Provided by Hawaiian Electric.
	Transformer - Concrete Pad	Yes		Provided by Hawaiian Electric.
	Number of Concrete Pads	46	item	Provided by Hawaiian Electric.
	Transformer Concrete Pad Thickness	0.33	ft/per pad	Provided by Hawaiian Electric.
	Transformer Concrete Pad Dimensions - Length	4.2	ft	Provided by Hawaiian Electric.
	Transformer Concrete Pad Dimensions - Width	3.3	ft	Provided by Hawaiian Electric.
	Cubic Feet of Concrete	4.6	ft^3	Calculated based on information provided by Hawaiian Electric.
	Weight of Concrete	640	lb	Provided by Hawaiian Electric.

Table 2
Project Specific Inputs and Assumptions
Resilience Projects GHG Analysis (Oʻahu)
Oʻahu, HI

	Description	Input	Unit	Reference
Transformers, Switches, Switchgears, Circuit Breakers	**Location of Concrete Manufacturer**	Maui, Hawaiʻi	--	Confirmed by Hawaiian Electric.
	Equipment Lifetime (Expected Useful Life of the Equipment)	51	yr	Provided by Hawaiian Electric.
	Number of Equipment over Project Lifetime	46	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	Final Concrete Disposal Location	Local (Island Location of Site)	--	Concrete disposal location provided by Hawaiian Electric.
	End of Life Treatment	Decommissioning and disposal	--	Confirmed by Hawaiian Electric.
Hazard Tree Removal				
General	**General Subprogram Project**			
	Subprogram Project Name	Oʻahu Hazard Tree Removal	--	Provided by Hawaiian Electric.
Tree Removal	**Tree Removal**	Yes		Provided by Hawaiian Electric.
	Total Number of Trees to be Removed	800	item	Provided by Hawaiian Electric.
	Final Disposal Location	Abandoned in place	--	Provided by Hawaiian Electric. The trees will be lopped and scattered on-site.
Use	**Use (General)**			
	Changes to O&M	No net increase in O&M expected from project		Provided by Hawaiian Electric.
Decom. & Disposal	**Decommissioning and Disposal of Proposed Project**			
	Decommissioning Intensity Relative to Construction	3%	%	Provided by Hawaiian Electric.
GWP's	**Global Warming Potentials**			
	Carbon Dioxide	1	g CO_2e/g CO_2	Intergovernmental Panel on Climate Change (IPCC), Fifth Assessment Report (AR5), 2014. [2]
	Methane	28	g CO_2e/g CH_4	
	Nitrous Oxide	265	g CO_2e/g N_2O	

Abbreviations:
CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
ft - feet
ft^3 - cubic feet
GHG - greenhouse gas
GWP - global warming potentials
g - gram
IPCC - Intergovernmental Panel on Climate Change
kg - kilogram
kV - kilovolt
kVA - kilovolt-ampere
lb - pounds
mi - miles
MVA - megavolt-ampere
N_2O - nitrous oxide
O&M - operations and maintenance
yr - year

References:
1. Jorge, R. S.; Hawkins, T. R.; Hertwich, E. G. (2011a). Life cycle assessment of electricity transmission and distribution - part 1: power lines and cables. International Journal of Life Cycle Assessment, 17, 1. Available at: https://doi.org/10.1007/s11367-011-0335-1.
2. Intergovernmental Panel on Climate Change (IPCC), Fifth Assessment Report (AR5), 2014.

RAMBOLL

Table 3
Project Specific Construction Inputs and Assumptions
Resilience Projects GHG Analysis (Oʻahu)
Oʻahu, HI

	Description	Input	Unit	Reference
Transmission Hardening				
General	**General Subprogram Project Construction**			
	Construction Start Date (mm/dd/yyyy)	2/21/2024	--	Provided by Hawaiian Electric.
	Construction End Date (mm/dd/yyyy)	1/20/2026	--	Provided by Hawaiian Electric.
	Construction Site Area	N/A	acres	Provided by Hawaiian Electric.
Transmission Hardening	**Steel Pole Installation**	Yes		
	Strato-Tower	1	#	Confirmed by Hawaiian Electric.
	Pick-Up Truck	2	#	
	Hyliner	1	#	
	Crane	1	#	
	Number of Days	40	days	Provided by Hawaiian Electric. Assuming 50% of poles are accessible and 1 pole installation per day.
	Number of Workers	12	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	10	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
	Steel Pole Installation - Helicopter	Yes		
	Helicopter	1	#	Provided by Hawaiian Electric.
	Number of Days	41	days	Provided by Hawaiian Electric. Assuming 50% of poles are inaccessible and 1 pole installation per day.
	Number of Workers	16	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	10	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
	Helicopter Horsepower	9,000	horsepower	Confirmed by developer. Default helicopter horsepower was selected based on the helicopter model with specifications in line with the scope of this construction activity (i.e., heavy lifting). Emission factors are consistent with the Valley-Ivyglen and Alberhill System Project, which quantified GHG emissions from helicopter use during construction.[1]
	Helicopter Total Operating Hours	197	hours/helicopter	Helicopter total operating hours based on the number of days in the construction activity, the average usage hours provided by Hawaiian Electric (6 hours/day), and the utilization rate of the helicopter.
Critical Pole Hardening				
General	**General Subprogram Project Construction**			
	Construction Start Date (mm/dd/yyyy)	9/1/2023	--	Provided by Hawaiian Electric.
	Construction End Date (mm/dd/yyyy)	4/30/2026	--	Provided by Hawaiian Electric.
	Construction Site Area	N/A	acres	Confirmed by Hawaiian Electric.
Critical Pole Hardening	**Wood Pole Installation**	Yes		
	Strato-Tower	1	#	Confirmed by Hawaiian Electric.
	Pick-Up Truck	2	#	
	Hyliner	1	#	
	Number of Days	64	days	Provided by Hawaiian Electric. Assuming 75% of poles are accessible and 1 pole installation per day.
	Number of Workers	8	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	10	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
	Wood Pole Installation - Helicopter	Yes		
	Helicopter	1	#	Provided by Hawaiian Electric.
	Number of Days	21	days	Provided by Hawaiian Electric. Assuming 25% of poles are inaccessible and 1 pole installation per day.
	Number of Workers	12	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	10	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
	Helicopter Horsepower	9,000	horsepower	Confirmed by developer. Default helicopter horsepower was selected based on the helicopter model with specifications in line with the scope of this construction activity (i.e., heavy lifting). Emission factors are consistent with the Valley-Ivyglen and Alberhill System Project, which quantified GHG emissions from helicopter use during construction.[1]
	Helicopter Total Operating Hours	101	hours/helicopter	Helicopter total operating hours based on the number of days in the construction activity, the average usage hours provided by Hawaiian Electric (6 hours/day), and the utilization rate of the helicopter.
	Steel Pole Installation	Yes		
	Strato-Tower	1	#	Confirmed by Hawaiian Electric.
	Pick-Up Truck	2	#	
	Hyliner	1	#	
	Number of Days	64	days	Provided by Hawaiian Electric. Assuming 75% of poles are accessible and 1 pole installation per day.
	Number of Workers	8	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	10	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.

Table 3
Project Specific Construction Inputs and Assumptions
Resilience Projects GHG Analysis (Oʻahu)
Oʻahu, HI

	Description	Input	Unit	Reference
Critical Pole Hardening	**Steel Pole Installation - Helicopter**	Yes		
	Helicopter	1	#	Provided by Hawaiian Electric.
	Number of Days	21	days	Provided by Hawaiian Electric. Assuming 25% of poles are inaccessible and 1 pole installation per day.
	Number of Workers	12	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	10	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
	Helicopter Horsepower	9,000	horsepower	Confirmed by developer. Default helicopter horsepower was selected based on the helicopter model with specifications in line with the scope of this construction activity (i.e., heavy lifting). Emission factors are consistent with the Valley-Ivyglen and Alberhill System Project, which quantified GHG emissions from helicopter use during construction.[1]
	Helicopter Total Operating Hours	101	hours/helicopter	Helicopter total operating hours based on the number of days in the construction activity, the average usage hours provided by Hawaiian Electric (6 hours/day), and the utilization rate of the helicopter.
Critical Circuit Hardening				
General	**General Subprogram Project Construction**			
	Construction Start Date (mm/dd/yyyy)	9/1/2023	--	Provided by Hawaiian Electric.
	Construction End Date (mm/dd/yyyy)	6/30/2026	--	Provided by Hawaiian Electric.
	Construction Site Area	N/A	acres	Provided by Hawaiian Electric.
Critical Circuit Hardening	**Wood Pole Installation**	Yes		
	Strato-Tower	1	#	Confirmed by Hawaiian Electric.
	Pick-Up Truck	2	#	
	Hyliner	1	#	
	Number of Days	65	days	Provided by Hawaiian Electric. Assuming all poles are accessible and 2 pole installations per day.
	Number of Workers	8	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	10	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
	Steel Pole Installation	Yes		
	Strato-Tower	1	#	Confirmed by Hawaiian Electric.
	Pick-Up Truck	2	#	
	Hyliner	1	#	
	Number of Days	65	days	Provided by Hawaiian Electric. Assuming all poles are accessible and 2 pole installations per day.
	Number of Workers	8	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	10	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
Wildfire Mitigation				
General	**General Subprogram Project Construction**			
	Construction Start Date (mm/dd/yyyy)	2/21/2024	--	Provided by Hawaiian Electric.
	Construction End Date (mm/dd/yyyy)	9/1/2026	--	Provided by Hawaiian Electric.
	Construction Site Area	N/A	acres	Provided by Hawaiian Electric.
Wildfire Mitigation	**Steel Pole Installation**	Yes		
	Strato-Tower	1	#	Confirmed by Hawaiian Electric.
	Pick-Up Truck	2	#	
	Hyliner	1	#	
	Number of Days	16	days	Provided by Hawaiian Electric. Assuming 1 pole installation per day.
	Number of Workers	8	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	10	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
	Overhead Cable Installation	Yes		
	Strato-Tower	1	#	Confirmed by Hawaiian Electric.
	Pick-Up Truck	2	#	
	Hyliner	1	#	
	Number of Days	85	days	Provided by Hawaiian Electric. Assuming 500 ft/day of installation.
	Number of Workers	8	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	10	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
	Install Thermal Cameras	Yes		
	Bucket Truck	1	#	Provided by Hawaiian Electric.
	Pick-Up Truck	1	#	
	Number of Days	8	days	Provided by Hawaiian Electric. Assuming 2 cameras installed per day.
	Number of Workers	4	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	10	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
	Install Weather Stations	Yes		
	Bucket Truck	1	#	Provided by Hawaiian Electric.
	Pick-Up Truck	1	#	
	Number of Days	8	days	Provided by Hawaiian Electric. Assuming one station installed per day.
	Number of Workers	4	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	10	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.

Table 3
Project Specific Construction Inputs and Assumptions
Resilience Projects GHG Analysis (Oʻahu)
Oʻahu, HI

	Description	Input	Unit	Reference
Substation Flood Monitors				
General	**General Subprogram Project Construction**			
	Construction Start Date (mm/dd/yyyy)	2/21/2023	--	Provided by Hawaiian Electric.
	Construction End Date (mm/dd/yyyy)	12/23/2025	--	Provided by Hawaiian Electric.
	Construction Site Area	N/A	acres	Provided by Hawaiian Electric.
Substation Flood Monitors	**Install Flood Monitors**	Yes		
	Bucket Truck	1	#	Provided by Hawaiian Electric.
	Pick-Up Truck	1	#	
	Number of Days	4	days	Provided by Hawaiian Electric. Assuming one flood monitor installed per day.
	Number of Workers	4	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	10	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
Lateral Undergrounding				
General	**General Subprogram Project Construction**			
	Construction Start Date (mm/dd/yyyy)	9/1/2023	--	Provided by Hawaiian Electric.
	Construction End Date (mm/dd/yyyy)	4/30/2026	--	Provided by Hawaiian Electric.
	Construction Site Area	N/A	acres	Provided by Hawaiian Electric.
Lateral Undergrounding	**Trenching**	Yes		
	Dozer with Rippers	1	#	Confirmed by Hawaiian Electric.
	Excavator	1	#	
	Backhoe	2	#	
	Trencher	2	#	
	Number of Days	317	days	Provided by Hawaiian Electric. Assuming 75 days per 5,000 linear feet.
	Number of Workers	8	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	10	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
Lateral Undergrounding	**Underground Cable Installation**	Yes		
	Trailer	1	#	Provided by Hawaiian Electric.
	Vans	2	#	
	Pick-Up Truck	1	#	
	Hog	1	#	
	Number of Days	127	days	Provided by Hawaiian Electric. Assuming 30 days per 5,000 linear feet.
	Number of Workers	8	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	10	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
	Switchgear Installation	Yes		
	Pick-Up Truck	3	#	Provided by Hawaiian Electric.
	Hyliner	1	#	
	Number of Days	3	days	Provided by Hawaiian Electric.
	Number of Workers	6	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	10	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
	Transformer Installation	Yes		
	Pick-Up Truck	2	#	Confirmed by Hawaiian Electric.
	Hyliner	1	#	
	Number of Days	43	days	Provided by Hawaiian Electric. Assuming one transformer installed per day.
	Number of Workers	4	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	10	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
Hazard Tree Removal				
General	**General Subprogram Project Construction**			
	Construction Start Date (mm/dd/yyyy)	6/1/2023	--	Provided by Hawaiian Electric.
	Construction End Date (mm/dd/yyyy)	9/30/2026	--	Provided by Hawaiian Electric.
	Construction Site Area	N/A	acres	Provided by Hawaiian Electric.
Hazard Tree Removal	**Tree Removal**	Yes		
	Pick-Up Truck	2	#	Provided by Hawaiian Electric.
	Bucket Truck	1	#	
	Number of Days	800	days	Provided by Hawaiian Electric. Assuming one tree removed per day.
	Number of Workers	4	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	10	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.

Abbreviations:
- number
ft^3 - cubic feet

References:
1. Valley-Ivyglen and Alberhill System Project. Available at: https://www.cpuc.ca.gov/environment/info/ene/alberhill/Alberhill.html

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Appendix Table A1
Raw Materials Extraction & Manufacturing GHG Emissions Calculations
Resilience Projects GHG Analysis (Oʻahu)
Oʻahu, HI

System	Description	Total Items[1]	Weight per Item (kg)[1]	Rating (MVA)[1]	Lifecycle GHG Emission Factor	Units	Note	GHG Emissions (MT CO_2e)
Transmission Hardening	Tangent Steel Pole with Concrete Foundation - Steel Pole	73	8,103	--	4.4	kg CO_2e/kg	2	2,595
	Tangent Steel Pole with Concrete Foundation - Concrete Foundation	73	18,370	--	0.10	kg CO_2e/kg	3	141
	Dead End Steel Pole with Concrete Foundation - Steel Pole	8	18,144	--	4.4	kg CO_2e/kg	2	637
	Dead End Steel Pole with Concrete Foundation - Concrete Foundation	8	18,370	--	0.10	kg CO_2e/kg	3	15
Critical Pole Hardening	Steel Pole (Self Supporting, Direct-Buried)	85	2,994	--	4.4	kg CO_2e/kg	2	1,116
	Wood Pole	85	2,268	--	0.11	kg CO_2e/kg	4	20
Critical Circuit Hardening	Steel Pole (Self Supporting, Direct-Buried)	130	2,994	--	4.4	kg CO_2e/kg	2	1,707
	Wood Pole	130	2,268	--	0.11	kg CO_2e/kg	4	31
Wildfire Mitigation	Conductor + Bulk of System - Overhead Sub-Transmission	1	158,308	--	8.2	kg CO_2e/kg	5	1,302
	Steel Pole (Self Supporting, Direct-Buried)	16	2,994	--	4.4	kg CO_2e/kg	2	210
	Thermal Cameras	16	18	--	18	kg CO_2e/kg	6	5.2
	Weather Stations	8	80	--	36	kg CO_2e/kg	7	23
Substation Flood Monitors	Flood Monitors - Sensor	4	4.5	--	4.4	kg CO_2e/kg	8	0.080
	Flood Monitors - Casing & Cable	4	0.91	--	2.6	kg CO_2e/kg	9	0.0094
Lateral Undergrounding	Conductor + Bulk of System	1	10,059	--	8.2	kg CO_2e/kg	5	83
	PVC Conduit Duct for Underground Distribution Line	1	177,189	--	2.6	kg CO_2e/kg	10	457
	Duct Bank Casing (Concrete Encased)	1	2,554,632	--	0.10	kg CO_2e/kg	11	268
	Concrete Handhole 2' x 4'	211	3,357	--	0.10	kg CO_2e/kg	12	74
	Handhole Cover	654	95	--	4.4	kg CO_2e/kg	13	273
	Concrete Handhole 6' x 11'	3	23,088	--	0.10	kg CO_2e/kg	14	7.3
	Transformer (Rating 0 - 1.87 MVA)	86	--	0.050	6,237	kg CO_2e/item	15	536
	Switchgear	6	1,202	--	4.2	kg CO_2e/kg	16	30
	Transformer - Concrete Pad	46	290	--	0.10	kg CO_2e/kg	17	1.4
							Total	**9,535**

Appendix Table A1
Raw Materials Extraction & Manufacturing GHG Emissions Calculations
Resilience Projects GHG Analysis (O'ahu)
O'ahu, HI

Notes:

1. Project specifications, assumptions and references are provided in Table 2.
2. The GHG emission factor for the Tangent Steel Pole with Concrete Foundation - Steel Pole, Dead End Steel Pole with Concrete Foundation - Steel Pole and Steel Pole (Self Supportin, Direct-Buried) is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Classen, M., market for steel, chromium steel 18/8, hot rolled, global geography ("GLO", e.g. value represents activities which are considered to be an average valid for all countries in the world, and are calculated as the average of the regional datasets that contain information for the activity), System Model Allocation, cut-off by classification ("Allocation, cut-off by classification", e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
3. The GHG emission factor for the Concrete Foundations of Tangent Steel Pole with Concrete Foundation, Dead End Steel Pole with Concrete Foundation is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Martineau, G., market for concrete, 20MPa, North America geography ("RNA", e.g. value represents activities which are considered to be an average valid for all countries in North America, and are calculated as the average of the regional datasets that contain information for the activity), System Model Allocation, cut-off by classification ("Allocation, cut-off by classification", e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1. The emission factor is normalized based on the density of concrete, approximately 2,335 kg/m^3, provided in documentation of the dataset.
4. The GHG emission factor for the Wood Pole is estimated from Bolin and Smith, 2011 (Table 2). This factor represents total CO_2e emissions per utility pole for the pole production and treating life cycle stages. As defined by Bolin and Smith, 2011, pole production for the wood pole includes: "replanting a harvested area of forest, growing and maintaining the forest plantation until harvest, harvesting of the trees, drying, and milling and associated transportation" and treating includes: "pole peeling, pole drying, preservative manufacture and transport, treatment, storage of untreated and treated poles, releases, and transportation of poles to the utility yard". The estimated emissions from Bolin and Smith were conservatively scaled based on the weight of each pole.
5. The GHG emission factor for the Conductor + Bulk of System is an estimate from Jorge, et al. (2011a) estimated emissions for a 150 kV overhead transmission line (Figure 1a), scaled based on the weight of the transmission line. The estimated emissions for an overhead transmission line are used because the transmission line material for this Project is of similar material to that of the overhead transmission line from Jorge, et al. (2011a). This factor represents total CO_2e emissions per kg of transmission line for components such as conductors, insulators, installation, and usage. Installation and usage together account for less than approximately 4% of total emissions, so these are conservatively included in addition to the Construction emissions estimated in Tables A3.
6. The GHG emission factor for Thermal Cameras is derived from Hillerström, H. and Troborg, U (2010) materials and manufacturing CO_2 emissions for a security camera as provided in Table 7. The emission factor was normalized based on the weight of the security camera used in the study, AXIS Q6032-E.
7. The GHG emission factor for the Weather Stations is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Hischier, R., market for electronics, for control units, global geography ("GLO", e.g. value represents activities which are considered to be an average valid for all countries in the world, and are calculated as the average of the regional datasets that contain information for the activity), System Model Allocation, cut-off by classification ("Allocation, cut-off by classification", e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
8. The GHG emission factor for the Flood Monitors - Sensor is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Classen, M., market for steel, chromium steel 18/8, hot rolled, global geography ("GLO", e.g. value represents activities which are considered to be an average valid for all countries in the world, and are calculated as the average of the regional datasets that contain information for the activity), System Model Allocation, cut-off by classification ("Allocation, cut-off by classification", e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
9. The GHG emission factor for the Flood Monitors - Casing & Cable is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Hischier, R., market for polyvinylchloride, bulk polymerised, global geography ("GLO", e.g. value represents activities which are considered to be an average valid for all countries in the world, and are calculated as the average of the regional datasets that contain information for the activity), System Model Allocation, cut-off by classification ("Allocation, cut-off by classification", e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
10. The GHG emission factor for the PVC Conduit Duct is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Hischier, R., market for polyvinylchloride, bulk polymerised, global geography ("GLO", e.g. value represents activities which are considered to be an average valid for all countries in the world, and are calculated as the average of the regional datasets that contain information for the activity), System Model Allocation, cut-off by classification ("Allocation, cut-off by classification", e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
11. The GHG emissions factor for the Duct Bank Casing (Thermal Concrete) is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Martineau, G., market for concrete, 20MPa, North America geography ("RNA", e.g. value represents activities which are considered to be an average valid for all countries in North America, and are calculated as the average of the regional datasets that contain information for the activity), System Model Allocation, cut-off by classification ("Allocation, cut-off by classification", e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1. The emission factor is normalized based on the density of concrete, approximately 2,335 kg/m3, provided in documentation of the dataset.
12. The GHG emission factor for the Concrete Handholes 2' x 4' is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Martineau, G., market for concrete, 20MPa, North America geography ("RNA", e.g. value represents activities which are considered to be an average valid for all countries in North America, and are calculated as the average of the regional datasets that contain information for the activity), System Model Allocation, cut-off by classification ("Allocation, cut-off by classification", e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1. The emission factor is normalized based on the density of concrete, approximately 2,335 kg/m3, provided in documentation of the dataset.

Appendix Table A1
Raw Materials Extraction & Manufacturing GHG Emissions Calculations
Resilience Projects GHG Analysis (O‘ahu)
O‘ahu, HI

13. The GHG emission factor for the Handhole Covers is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Classen, M., market for steel, chromium steel 18/8, hot rolled, global geography ("GLO", e.g. value represents activities which are considered to be an average valid for all countries in the world, and are calculated as the average of the regional datasets that contain information for the activity), System Model Allocation, cut-off by classification (“Allocation, cut-off by classification”, e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.

14. The GHG emission factor for the Concrete Handhole 6' x 11' is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Martineau, G., market for concrete, 20MPa, North America geography ("RNA", e.g. value represents activities which are considered to be an average valid for all countries in North America, and are calculated as the average of the regional datasets that contain information for the activity), System Model Allocation, cut-off by classification (“Allocation, cut-off by classification”, e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1. The emission factor is normalized based on the density of concrete, approximately 2,335 kg/m3, provided in documentation of the dataset.

15. The GHG emission factor for the Transformer is estimated from Jorge, et al. (2011b, Figure 1). These factors represent the CO_2e emissions per item associated with raw material extraction and production for the transformer. Jorge et al., 2011b estimated emissions from transformers of ratings between 0.35 to 500 MVA; the emission factor for the Project's transformer was calculated based on the emissions per transformer rating for the Jorge transformer with the closest rating (using geometric mean) to the Project's transformer, scaled to the Project's rating.

16. The GHG emission factor for the Switchgear is estimated from Jorge, et al., 2011b (Figure 2). This factor represent the CO_2e emissions per item associated with raw material extraction and production for the Switchgear. The emission factor for the Switchgears is based on the emission factor for the Medium Voltage Switchgear from Jorge et al., 2011b, normalized based on weight, provided in Table S18 of Jorge, et al., 2011b.

17. The GHG emissions factor for the Transformer - Concrete Pad is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Martineau, G., market for concrete, 20MPa, North America geography ("RNA", e.g. value represents activities which are considered to be an average valid for all countries in North America, and are calculated as the average of the regional datasets that contain information for the activity), System Model Allocation, cut-off by classification (“Allocation, cut-off by classification”, e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1. The emission factor is normalized based on the density of concrete, approximately 2,335 kg/m3, provided in documentation of the dataset.

Abbreviations:

CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
GHG - greenhouse gas
GWP - global warming potential
IPCC - Intergovernmental Panel on Climate Change
kg - kilogram
kV - kilovolts
m^3 - cubic meter
MPa - megapascal
MT - metric ton
MVA - megavolt-ampere

References

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Appendix Table A2
Material Transportation GHG Emissions Calculations
Resilience Projects GHG Analysis (O'ahu)
O'ahu, HI

Mode of Travel	Emission Factors[1,2]							
	CO_2	units	CH_4	units	N_2O	units	CO_2e	units
Truck	0.21	kg/ton-mi	2.0E-06	kg/ton-mi	4.9E-06	kg/ton-mi	0.15	kg/MT-km
Ship	--	kg/ton-mi	--	kg/ton-mi	--	kg/ton-mi	0.0066	kg/MT-km

Transportation Emissions:

Shipment Item		Weight per Item (kg)	Total Items	Net Weight (MT)[3]	Phase	Origin	Destination	Mode[4]	Trip length (mi or nmi)[5]	Trip Type[6]	GHG Emissions (MT CO_2e) Per Segment	GHG Emissions (MT CO_2e) Per Shipment Item Type
Transmission Hardening	Tangent Steel Pole with Concrete Foundation	26,474	73	1,933	Upstream	Valley, Nebraska (Manufacturer/Warehouse)	Los Angeles (Port)	Truck	1,562	One-Way	707	773
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	53	
						Honolulu Harbor (Port)	Site	Truck	15	Roundtrip	14	
					Downstream	Site	Grace Pacific Landfill, O'ahu	Truck	17	Roundtrip	15	15
	Dead End Steel Pole with Concrete Foundation	36,514	8	292	Upstream	Valley, Nebraska (Manufacturer/Warehouse)	Los Angeles (Port)	Truck	1,562	One-Way	107	117
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	8.0	
						Honolulu Harbor (Port)	Site	Truck	15	Roundtrip	2.1	
					Downstream	Site	Grace Pacific Landfill, O'ahu	Truck	17	Roundtrip	2.3	2.3
Critical Pole Hardening	Steel Pole (Self Supporting, Direct-Buried)	2,994	85	254	Upstream	Valley, Nebraska (Manufacturer/Warehouse)	Los Angeles (Port)	Truck	1,562	One-Way	93	102
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	7.0	
						Honolulu Harbor (Port)	Site	Truck	15	Roundtrip	1.8	
					Downstream	Site	Honolulu Harbor (Port)	Truck	15	Roundtrip	1.8	10
						Honolulu Harbor (Port)	Los Angeles (Port)	Ship	2,231	One-Way	7.0	
						Los Angeles (Port)	Los Angeles (Scrap Yard)	Truck	25	One-Way	1.5	
	Wood Pole	2,268	85	193	Upstream	Tacoma, Washington (Manufacturer/Warehouse)	Tacoma (Port)	Truck	5.0	One-Way	0.23	10
						Tacoma (Port)	Los Angeles (Port)	Ship	1,165	One-Way	2.8	
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	5.3	
						Honolulu Harbor (Port)	Site	Truck	15	Roundtrip	1.4	
					Downstream	Site	Grace Pacific Landfill, O'ahu	Truck	17	Roundtrip	1.5	1.5
Critical Circuit Hardening	Steel Pole (Self Supporting, Direct-Buried)	2,994	130	389	Upstream	Valley, Nebraska (Manufacturer/Warehouse)	Los Angeles (Port)	Truck	1,562	One-Way	142	156
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	11	
						Honolulu Harbor (Port)	Site	Truck	15	Roundtrip	2.7	
					Downstream	Site	Honolulu Harbor (Port)	Truck	15	Roundtrip	2.7	16
						Honolulu Harbor (Port)	Los Angeles (Port)	Ship	2,231	One-Way	11	
						Los Angeles (Port)	Los Angeles (Scrap Yard)	Truck	25	One-Way	2.3	
	Wood Pole	2,268	130	295	Upstream	Tacoma, Washington (Manufacturer/Warehouse)	Tacoma (Port)	Truck	5.0	One-Way	0.35	15
						Tacoma (Port)	Los Angeles (Port)	Ship	1,165	One-Way	4.2	
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	8.1	
						Honolulu Harbor (Port)	Site	Truck	15	Roundtrip	2.1	
					Downstream	Site	Grace Pacific Landfill, O'ahu	Truck	17	Roundtrip	2.3	2.3
Wildfire Mitigation	Conductor + Bulk of System	158,308	1	158	Upstream	Florence, Alabama (Manufacturer/Warehouse)	Los Angeles (Port)	Truck	2,013	One-Way	75	80
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	4.3	
						Honolulu Harbor (Port)	Site	Truck	15	Roundtrip	1.1	
					Downstream	Site	Honolulu Harbor (Port)	Truck	15	Roundtrip	1.1	6.4
						Honolulu Harbor (Port)	Los Angeles (Port)	Ship	2,231	One-Way	4.3	
						Los Angeles (Port)	Los Angeles (Scrap Yard)	Truck	25	One-Way	0.93	
	Steel Pole (Self Supporting, Direct-Buried)	2,994	16	48	Upstream	Valley, Nebraska (Manufacturer/Warehouse)	Los Angeles (Port)	Truck	1,562	One-Way	18	19
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	1.3	
						Honolulu Harbor (Port)	Site	Truck	15	Roundtrip	0.34	
					Downstream	Site	Honolulu Harbor (Port)	Truck	15	Roundtrip	0.34	1.9
						Honolulu Harbor (Port)	Los Angeles (Port)	Ship	2,231	One-Way	1.3	
						Los Angeles (Port)	Los Angeles (Scrap Yard)	Truck	25	One-Way	0.28	
	Thermal Cameras	18	16	0.29	Upstream	Goleta, California (Manufacturer/Warehouse)	Los Angeles (Port)	Truck	125	One-Way	0.0085	0.018
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	0.0080	
						Honolulu Harbor (Port)	Site	Truck	15	Roundtrip	0.0020	
					Downstream	Site	Honolulu Harbor (Port)	Truck	15	Roundtrip	0.0020	0.012
						Honolulu Harbor (Port)	Los Angeles (Port)	Ship	2,231	One-Way	0.0080	
						Los Angeles (Port)	Los Angeles (Scrap Yard)	Truck	25	One-Way	0.0017	
	Weather Stations	80	8	0.64	Upstream	Hillsboro, Oregon (Manufacturer/Warehouse)	Portland (Port)	Truck	32	One-Way	0.0048	0.035
						Portland (Port)	Los Angeles (Port)	Ship	979	One-Way	0.0077	
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	0.018	
						Honolulu Harbor (Port)	Site	Truck	15	Roundtrip	0.0045	
					Downstream	Site	Honolulu Harbor (Port)	Truck	15	Roundtrip	0.0045	0.026
						Honolulu Harbor (Port)	Los Angeles (Port)	Ship	2,231	One-Way	0.018	
						Los Angeles (Port)	Los Angeles (Scrap Yard)	Truck	25	One-Way	0.0037	
Substation Flood Monitors	Flood Monitors	5.4	4	0.022	Upstream	Batavia, New York (Manufacturer/Warehouse)	Los Angeles (Port)	Truck	2,586	One-Way	0.013	0.014
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	6.0E-04	
						Honolulu Harbor (Port)	Site	Truck	15	Roundtrip	1.5E-04	
					Downstream	Site	Honolulu Harbor (Port)	Truck	15	Roundtrip	1.5E-04	8.8E-04
						Honolulu Harbor (Port)	Los Angeles (Port)	Ship	2,231	One-Way	6.0E-04	
						Los Angeles (Port)	Los Angeles (Scrap Yard)	Truck	25	One-Way	1.3E-04	
Lateral Undergrounding	Conductor + Bulk of System	10,059	1	10	Upstream	Abbeville, South Carolina (Manufacturer/Warehouse)	Los Angeles (Port)	Truck	2,351	One-Way	5.5	5.9
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	0.28	
						Honolulu Harbor (Port)	Site	Truck	15	Roundtrip	0.071	
					Downstream	Site	Honolulu Harbor (Port)	Truck	15	Roundtrip	0.071	0.41
						Honolulu Harbor (Port)	Los Angeles (Port)	Ship	2,231	One-Way	0.28	
						Los Angeles (Port)	Los Angeles (Scrap Yard)	Truck	25	One-Way	0.059	

Appendix Table A2
Material Transportation GHG Emissions Calculations
Resilience Projects GHG Analysis (O'ahu)
O'ahu, HI

Mode of Travel	Emission Factors[1,2]							
	CO_2	units	CH_4	units	N_2O	units	CO_2e	units
Truck	0.21	kg/ton-mi	2.0E-06	kg/ton-mi	4.9E-06	kg/ton-mi	0.15	kg/MT-km
Ship	--	kg/ton-mi	--	kg/ton-mi	--	kg/ton-mi	0.0066	kg/MT-km

Transportation Emissions:

Shipment Item		Weight per Item (kg)	Total Items	Net Weight (MT)[3]	Phase	Origin	Destination	Mode[4]	Trip length (mi or nmi)[5]	Trip Type[6]	GHG Emissions (MT CO_2e) Per Segment	GHG Emissions (MT CO_2e) Per Shipment Item Type
Lateral Undergrounding	PVC Conduit Duct for Underground Distribution Line	177,189	1	177	Upstream	Milford, Utah (Manufacturer/Warehouse)	Los Angeles (Port)	Truck	510	One-Way	21	27
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	4.9	
						Honolulu Harbor (Port)	Site	Truck	15	Roundtrip	1.2	
	Duct Bank Casing (Concrete Encased) - Kapolei, Hawai'i	2,554,632	1	2,555	Upstream	Kapolei, Hawai'i (Manufacturer/Warehouse)	Site	Truck	20	Roundtrip	24	24
	Concrete Handhole 2' x 4'	3,357	211	708	Upstream	Kapolei, Hawai'i (Manufacturer/Warehouse)	Site	Truck	20	Roundtrip	6.6	6.6
	Handhole Cover	95	654	62	Upstream	Kapolei, Hawai'i (Manufacturer/Warehouse)	Site	Truck	20	Roundtrip	0.58	0.58
	Concrete Handhole 6' x 11'	23,088	3	69	Upstream	Kapolei, Hawai'i (Manufacturer/Warehouse)	Site	Truck	20	Roundtrip	0.65	0.65
	Transformer (Rating 0 - 1.87 MVA)	499	86	43	Upstream	Jefferson City, Missouri (Manufacturer/Warehouse)	Los Angeles (Port)	Truck	1,791	One-Way	18	19
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	1.2	
						Honolulu Harbor (Port)	Site	Truck	15	Roundtrip	0.30	
					Downstream	Site	Honolulu Harbor (Port)	Truck	15	Roundtrip	0.30	1.7
						Honolulu Harbor (Port)	Los Angeles (Port)	Ship	2,231	One-Way	1.2	
						Los Angeles (Port)	Los Angeles (Scrap Yard)	Truck	25	One-Way	0.25	
	Switchgear	1,202	6	7.2	Upstream	Chicago, Illinois (Manufacturer/Warehouse)	Los Angeles (Port)	Truck	2,038	One-Way	3.4	3.7
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	0.20	
						Honolulu Harbor (Port)	Site	Truck	15	Roundtrip	0.051	
					Downstream	Site	Honolulu Harbor (Port)	Truck	15	Roundtrip	0.051	0.29
						Honolulu Harbor (Port)	Los Angeles (Port)	Ship	2,231	One-Way	0.20	
						Los Angeles (Port)	Los Angeles (Scrap Yard)	Truck	25	One-Way	0.042	
	Transformer - Concrete Pad	290	46	13	Upstream	Maui, Hawai'i (Manufacturer/Warehouse)	Kahului Harbor (Port)	Truck	60	One-Way	0.19	0.30
						Kahului Harbor (Port)	Honolulu Harbor (Port)	Ship	100	One-Way	0.016	
						Honolulu Harbor (Port)	Site	Truck	15	Roundtrip	0.094	
					Downstream	Site	Grace Pacific Landfill, O'ahu	Truck	17	Roundtrip	0.11	0.11
Total Upstream GHG Emissions (MT CO_2e)[7]												**1,360**
Total Downstream GHG Emissions (MT CO_2e)[8]												**58**
Total GHG Emissions (MT CO_2e)												**1,418**

Notes:

1. The emission factors for road transportation are taken from US Environmental Protection Agency (EPA) Scope 3 Inventory Guidance, which recommends emission factors from Table 8 of Emission Factors for Greenhouse Gas Inventories.
2. The emission factor for shipping is based on the Global Maritime Emission Factor for dry (i.e., non-refrigerated) cargo shipping over all trade lanes for 2020 with a 70% utilization factor, assuming an average load weight of 10 tons in each container.
3. The net weight is determined based on the weight of each item and the quantity of each item.
4. For a given transportation segment, if the mode of travel is not known and if multiple travel modes are available, the most emissions-intensive mode is selected.
5. The trip lengths for each leg of travel were estimated based on the following assumptions:
   (a) Shipping distances were estimated using the Sea Distance tool, available at https://sea-distances.org.
   (b) Truck distances were estimated by using Google Maps to determine driving distances between the locations.
6. GHG emissions are per segment (i.e. one-way travel) with the exception of estimated emissions to or from the site. These segments consider roundtrip travel and multiply the per segment GHG emissions by two to account for roundtrip travel. This approach conservatively treats the empty return trip as loaded.
7. Upstream transportation emissions include emissions from transporting the project materials from manufacturing to the project site.
8. Downstream transportation emissions include emissions from transporting the project materials from the project site to disposal at the scrap yard.

Abbreviations:

CH_4 - methane
CN - Canadian National
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
GHG - greenhouse gas
GWP - global warming potential
kg - kilogram
km - kilometer
mi - mile
MT - metric ton
nmi - nautical mile
N_2O - nitrous oxide

References:

EPA. Scope 3 Inventory Guidance. Available at: https://www.epa.gov/climateleadership/scope-3-inventory-guidance
EPA (2022). Emission Factors for Greenhouse Gas Inventories. April 1. Available at: https://www.epa.gov/system/files/documents/2022-04/ghg_emission_factors_hub.pdf
Global Maritime Emission Factors. Available at: https://www.bsr.org/files/clean-cargo/BSR-Clean-Cargo-Emissions-Report-2021.pdf

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Appendix Table A3
Construction GHG Emissions Calculations
Resilience Projects GHG Analysis (O'ahu)
O'ahu, HI

Construction Schedule[1]:

System	Construction Activity	Number of Workers	Days
Transmission Hardening	Steel Pole Installation	12	40
	Steel Pole Installation - Helicopter	16	41
Critical Pole Hardening	Wood Pole Installation	8	64
	Wood Pole Installation - Helicopter	12	21
	Steel Pole Installation	8	64
	Steel Pole Installation - Helicopter	12	21
Critical Circuit Hardening	Wood Pole Installation	8	65
	Steel Pole Installation	8	65
Wildfire Mitigation	Steel Pole Installation	8	16
	Overhead Cable Installation	8	85
	Install Thermal Cameras	4	8
	Install Weather Stations	4	8
Substation Flood Monitors	Install Flood Monitors	4	4
Lateral Undergrounding	Trenching	8	317
	Underground Cable Installation	8	127
	Switchgear Installation	6	3
	Transformer Installation	4	43
Hazard Tree Removal	Tree Removal	4	800

Installation Offroad Emissions:

Phase	Construction Subphase	Equipment Type[1]	Total Items[1]	Avg. Usage Hours per Day	Utilization Rate	Hours of Operation (hr / project)	Horsepower[2]	Load[2]	EF (g / bhp-hr)[3]			GHG Emissions[4] (MT CO_2e)
									CO_2	CH_4	CO_2e	
Transmission Hardening	Steel Pole Installation	Strato-Tower	1	8	0.8	256	376	0.38	475	0.15	480	18
		Pick-Up Truck	2	8	0.8	512	376	0.38	475	0.15	480	35
		Hyliner	1	8	0.8	256	367	0.29	472	0.15	476	13.0
		Crane	1	8	0.8	256	367	0.29	472	0.15	476	13.0
	Steel Pole Installation - Helicopter	Helicopter	1	6	0.8	197	9,000	--	393	0.011	393	696
Critical Pole Hardening	Wood Pole Installation	Strato-Tower	1	8	0.8	410	376	0.38	475	0.15	480	28
		Pick-Up Truck	2	8	0.8	819	376	0.38	475	0.15	479	56
		Hyliner	1	8	0.8	410	367	0.29	472	0.15	477	21
	Wood Pole Installation - Helicopter	Helicopter	1	6	0.8	101	9,000	--	393	0.011	393	356
	Steel Pole Installation	Strato-Tower	1	8	0.8	410	376	0.38	475	0.15	479	28
		Pick-Up Truck	2	8	0.8	819	376	0.38	475	0.15	479	56
		Hyliner	1	8	0.8	410	367	0.29	472	0.15	477	21
	Steel Pole Installation - Helicopter	Helicopter	1	6	0.8	101	9,000	--	393	0.011	393	356
Critical Circuit Hardening	Wood Pole Installation	Strato-Tower	1	8	0.8	416	376	0.38	475	0.15	479	28
		Pick-Up Truck	2	8	0.8	832	376	0.38	475	0.15	479	57
		Hyliner	1	8	0.8	416	367	0.29	472	0.15	477	21
	Steel Pole Installation	Strato-Tower	1	8	0.8	416	376	0.38	475	0.15	479	28
		Pick-Up Truck	2	8	0.8	832	376	0.38	475	0.15	479	57
		Hyliner	1	8	0.8	416	367	0.29	472	0.15	477	21

Appendix Table A3
Construction GHG Emissions Calculations
Resilience Projects GHG Analysis (O'ahu)
O'ahu, HI

Phase	Construction Subphase	Equipment Type[1]	Total Items[1]	Avg. Usage Hours per Day	Utilization Rate	Hours of Operation (hr / project)	Horsepower[2]	Load[2]	EF (g / bhp-hr)[3]			GHG Emissions[4] ($MT\ CO_2e$)
									CO_2	CH_4	CO_2e	
Wildfire Mitigation	Steel Pole Installation	Strato-Tower	1	8	0.8	102	376	0.38	475	0.15	480	7.0
		Pick-Up Truck	2	8	0.8	205	376	0.38	475	0.15	480	14
		Hyliner	1	8	0.8	102	367	0.29	472	0.15	476	5.2
	Overhead Cable Installation	Strato-Tower	1	8	0.8	544	376	0.38	475	0.15	480	37
		Pick-Up Truck	2	8	0.8	1,088	376	0.38	475	0.15	480	75
		Hyliner	1	8	0.8	544	367	0.29	472	0.15	476	28
	Install Thermal Cameras	Bucket Truck	1	8	0.8	51	376	0.38	475	0.15	480	3.5
		Pick-Up Truck	1	8	0.8	51	376	0.38	475	0.15	480	3.5
	Install Weather Stations	Bucket Truck	1	8	0.8	51	376	0.38	475	0.15	480	3.5
		Pick-Up Truck	1	8	0.8	51	376	0.38	475	0.15	480	3.5
Substation Flood Monitors	Install Flood Monitors	Bucket Truck	1	8	0.8	26	376	0.38	475	0.15	479	1.8
		Pick-Up Truck	1	8	0.8	26	376	0.38	475	0.15	479	1.8
Lateral Undergrounding	Trenching	Dozer with Rippers	1	8	0.8	2,029	367	0.40	479	0.16	484	144
		Excavator	1	8	0.8	2,029	36	0.38	525	0.17	530	15
		Backhoe	2	8	0.8	4,058	84	0.37	476	0.15	481	61
		Trencher	2	8	0.8	4,058	40	0.50	527	0.17	532	43
	Underground Cable Installation	Trailer	1	8	0.8	813	376	0.38	475	0.15	479	56
		Vans	2	8	0.8	1,626	376	0.38	475	0.15	479	111
		Pick-Up Truck	1	8	0.8	813	376	0.38	475	0.15	479	56
		Hog	1	8	0.8	813	10.0	0.56	568	0.062	570	2.6
	Switchgear Installation	Pick-Up Truck	3	8	0.8	58	376	0.38	475	0.15	479	3.9
		Hyliner	1	8	0.8	19	367	0.29	472	0.15	477	0.97
	Transformer Installation	Pick-Up Truck	2	8	0.8	550	376	0.38	475	0.15	479	38
		Hyliner	1	8	0.8	275	367	0.29	472	0.15	477	14.0
Hazard Tree Removal	Tree Removal	Pick-Up Truck	2	8	0.8	10,240	376	0.38	475	0.15	479	701
		Bucket Truck	1	8	0.8	5,120	376	0.38	475	0.15	479	351
Total Offroad Emissions from Construction Activity												**3,690**

Appendix Table A3
Construction GHG Emissions Calculations
Resilience Projects GHG Analysis (O'ahu)
O'ahu, HI

Installation Onroad Emissions:

Phase	Construction Subphase	Average Trip Rates (trips/day)		Trip Length (mi/trip)		CO_2e Hauling EF[6]		CO_2e Worker EF[6]		GHG Emissions[7] (MT CO_2e)
		Worker[5]	Hauling	Worker	Hauling	(g/trip)	(g/mi)	(g/trip)	(g/mi)	
Transmission Hardening	Steel Pole Installation	24	0	10	0	247	723	84	294	2.9
	Steel Pole Installation - Helicopter	32	0	10	0	247	723	84	294	4.0
Critical Pole Hardening	Wood Pole Installation	16	0	10	0	251	736	86	302	3.2
	Wood Pole Installation - Helicopter	24	0	10	0	251	736	86	302	1.6
	Steel Pole Installation	16	0	10	0	251	736	86	302	3.2
	Steel Pole Installation - Helicopter	24	0	10	0	251	736	86	302	1.6
Critical Circuit Hardening	Wood Pole Installation	16	0	10	0	251	736	86	302	3.2
	Steel Pole Installation	16	0	10	0	251	736	86	302	3.2
Wildfire Mitigation	Steel Pole Installation	16	0	10	0	247	723	84	294	0.77
	Overhead Cable Installation	16	0	10	0	247	723	84	294	4.1
	Install Thermal Cameras	8	0	10	0	247	723	84	294	0.19
	Install Weather Stations	8	0	10	0	247	723	84	294	0.19
Substation Flood Monitors	Install Flood Monitors	8	0	10	0	251	736	86	302	0.10
Lateral Undergrounding	Trenching	16	0	10	0	251	736	86	302	16
	Underground Cable Installation	16	0	10	0	251	736	86	302	6.3
	Switchgear Installation	12	0	10	0	251	736	86	302	0.11
	Transformer Installation	8	0	10	0	251	736	86	302	1.1
Hazard Tree Removal	Tree Removal	8	0	10	0	251	736	86	302	20
Total Onroad Emissions from Construction Activity										**71**
Total Construction Emissions										**3,761**

Notes:

1. Project specifications, assumptions and references are provided in Table 3. Each piece of construction equipment was modeled using a comparable piece of equipment from CalEEMod's off-road equipment list.

2. Unless specifically provided by the developer, horsepower and load factor were assumed to be consistent with CalEEMod® v2022.1., default assumptions.

3. Emission factors associated with offroad equipment are from CARB OFFROAD2021 for calendar year 2024, based on the construction start year of each subprogram project. This CARB database provides GHG emission factors for various equipment types and sizes. While more stringent criteria air pollutant requirements may result in lower criteria pollutant emission factors in California than Hawai'i, the fuel economy and therefore the GHG emission factors from offroad equipment are not expected to vary regionally. The OFFROAD database does not contain emission factors for N_2O emissions, which are expected to be minimal compared to overall offroad GHG emissions.

4. Offroad GHG emissions are calculated using a g/bhp-hr emission factor. This emission factor is multiplied by the hours of operation, horsepower, and load for each piece of equipment, then converted from grams to metric tons.

5. The number of home-to-work trips per day associated with each construction subphase activity was determined by multiplying the number of workers by two.

6. Emission factors associated with worker and hauling trips were estimated from California statewide emission factors generated using EMFAC2021 for calendar year 2023 and 2024, based on the construction start year of each subprogram project. The worker fleet assumes only light duty vehicles (EMFAC classes LDA, LDT1, and LDT2) and the hauling fleet assumes heavy duty trucks (EMFAC classes HHDT, LHDT1, LHDT2, MDV, and MHDT). Mobile emission factors from California's EMFAC database represent a reasonable estimate of mobile emission factors for the Project. Hawai'i does not maintain a publicly-accessible database like EMFAC that could be used to assess location-specific vehicle fleet data in future years. However, 2015 data on average fuel economy for the existing light-duty fleets show relatively minor differences between Hawai'i, California, and US-average vehicles. Given that onroad vehicles represent a small portion of lifecycle emissions for the Project, any adjustments to these emission factors would not result in significant changes to the resulting emissions.

7. Onroad GHG emissions are calculated using g/trip and g/mi emission factors. The g/trip emission factors are multiplied by the trips per day, and the g/mi emission factors are multiplied by the miles per trip and trips per day. These emission rates are then multiplied by the number of days in each subphase, and converted from grams to metric tons.

Appendix Table A3
Construction GHG Emissions Calculations
Resilience Projects GHG Analysis (Oʻahu)
Oʻahu, HI

Abbreviations:

bhp - brake horsepower
CalEEMod - California Emissions Estimator MODel
CARB - California Air Resources Board
CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
EF - emissions factor
EMFAC - EMission FACtor model
g - gram
GHG - greenhouse gas
HHDT - heavy-heavy-duty truck
hr - hour
kg - kilogram
LDA - light-duty automobile
LDT - light-duty truck
LHDT - light-heavy-duty truck
MDV - medium-duty vehicle
MHDT - medium-heavy-duty truck
mi - mile
MT - metric ton
N_2O - nitrous oxide

References:

California Emissions Estimator Model (CalEEMod®) v2022.1 Appendix G. Available at: https://www.caleemod.com/documents/user-guide/08_Appendix%20G.xlsx
California Air Resources Board (CARB) 2022. OFFROAD 2021. Available at: https://ww2.arb.ca.gov/our-work/programs/mobile-source-emissions-inventory/msei-modeling-tools.
California Air Resources Board (CARB) 2022. EMFAC2021 v1.0.2. Available at: https://arb.ca.gov/emfac/emissions-inventory.

Appendix Table A4
Decommissioning & Disposal GHG Emissions Calculations
Resilience Projects GHG Analysis (O'ahu)
O'ahu, HI

Decommissioning and Disposal:

System	Stages	Components	Total Items[1]	Weight per Item (kg)[1]	Lifecycle GHG Emission Factor	Units	Note	GHG Emissions (MT CO_2e)
Transmission Hardening	Disposal	Tangent Steel Pole with Concrete Foundation - Steel Pole	73	8,103	0.0083	kg CO_2e/kg disposed	2	4.9
		Tangent Steel Pole with Concrete Foundation - Concrete Foundation	73	18,370	0.0083	kg CO_2e/kg disposed	3	11
		Dead End Steel Pole with Concrete Foundation - Steel Pole	8	18,144	0.0083	kg CO_2e/kg disposed	2	1.2
		Dead End Steel Pole with Concrete Foundation - Concrete Foundation	8	18,370	0.0083	kg CO_2e/kg disposed	3	1.2
Critical Pole Hardening	Disposal	Steel Pole (Self Supporting, Direct-Buried)	85	2,994	0.0083	kg CO_2e/kg disposed	2	2.1
		Wood Pole	85	2,268	0.11	kg CO_2e/kg disposed	4	22
Critical Circuit Hardening	Disposal	Steel Pole (Self Supporting, Direct-Buried)	130	2,994	0.0083	kg CO_2e/kg disposed	2	3.2
		Wood Pole	130	2,268	0.11	kg CO_2e/kg disposed	4	33
Wildfire Mitigation	Disposal	Conductor + Bulk of System - Overhead Sub-Transmission	1	158,308	0.017	kg CO_2e/kg disposed	5	2.7
		Steel Pole (Self Supporting, Direct-Buried)	16	2,994	0.0083	kg CO_2e/kg disposed	2	0.40
		Thermal Cameras	16	18	0.32	kg CO_2e/kg disposed	6	0.092
		Weather Stations	8	80	0.32	kg CO_2e/kg disposed	7	0.20
Substation Flood Monitors	Disposal	Flood Monitors - Sensor	4	4.5	0.0083	kg CO_2e/kg disposed	8	1.5E-04
		Flood Monitors - Casing & Cable	4	0.91	0.48	kg CO_2e/kg disposed	9	0.0017
Lateral Undergrounding	Disposal	Conductor + Bulk of System	1	10,059	0.017	kg CO_2e/kg disposed	5	0.17
		Transformer (Rating 0 - 1.87 MVA)	86	499	0.32	kg CO_2e/kg disposed	10	14
		Switchgear	6	1,202	0.32	kg CO_2e/kg disposed	11	2.3
		Transformer - Concrete Pad	46	290	0.0083	kg CO_2e/kg disposed	12	0.11
Proposed Project	Decommissioning	Infrastructure System Decommissioning					13	81
						Total Decommissioning and Disposal Emissions		**179**

Notes:

1. Project specifications, assumptions and references are provided in Table 2.
2. The GHG emission factor for the Tangent Steel Pole with Concrete Foundation - Steel Pole, Dead End Steel Pole with Concrete Foundation - Steel Pole and Steel Pole (Self Supporting, Direct-Buried) is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Hischier, R., market for scrap steel, Rest of world geography ("RoW", e.g. datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database for specific regions), System Model Allocation, cut-off by classification (“Allocation, cut-off by classification”, e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
3. The GHG emission factor for the Concrete Foundations of Tangent Steel Pole with Concrete Foundation, Dead End Steel Pole with Concrete Foundation is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Doka, G., market for waste concrete, Rest of world geography ("RoW", e.g. datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database for specific regions), System Model Allocation, cut-off by classification (“Allocation, cut-off by classification”, e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
4. The GHG emission factor for the Wood Pole is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Doka, G., market for waste wood, untreated, Rest of world geography ("RoW", e.g. datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database for specific regions), System Model Allocation, cut-off by classification (“Allocation, cut-off by classification”, e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
5. The GHG emission factor for the Conductor + Bulk of System is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Doka, G., market for scrap aluminium, Rest of world geography ("RoW", e.g. datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database for specific regions), System Model Allocation, cut-off by classification (“Allocation, cut-off by classification”, e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
6. The GHG emission factor for the Thermal Cameras is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Hischier, R., market for used industrial electronic device, WEEE collection, Rest of world geography ("RoW", e.g. datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database for specific regions), System Model Allocation, cut-off by classification (“Allocation, cut-off by classification”, e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
7. The GHG emission factor for the Weather Stations is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Hischier, R., market for used industrial electronic device, WEEE collection, Rest of world geography ("RoW", e.g. datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database for specific regions), System Model Allocation, cut-off by classification (“Allocation, cut-off by classification”, e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
8. The GHG emission factor for the Flood Monitors - Sensor is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Hischier, R., market for scrap steel, Rest of world geography ("RoW", e.g. datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database for specific regions), System Model Allocation, cut-off by classification (“Allocation, cut-off by classification”, e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
9. The GHG emission factor for the Flood Monitors - Casing & Cable is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP for Doka, G., market for waste polyvinylchloride, Rest of world geography ("RoW", e.g. datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database for specific regions), System Model Allocation, cut-off by classification (“Allocation, cut-off by classification”, e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database 3.6.
10. The GHG emission factor for the Transformers is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Hischier, R., market for used industrial electronic device, WEEE collection, Rest of world geography ("RoW", e.g. datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database for specific regions), System Model Allocation, cut-off by classification (“Allocation, cut-off by classification”, e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
11. The GHG emission factor for the Switchgears is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Hischier, R., market for used industrial electronic device, WEEE collection, Rest of world geography ("RoW", e.g. datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database for specific regions), System Model Allocation, cut-off by classification (“Allocation, cut-off by classification”, e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
12. The GHG emission factor for the Transformer - Concrete Pad is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Doka, G., market for waste concrete, Rest of world geography ("RoW", e.g. datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database for specific regions), System Model Allocation, cut-off by classification (“Allocation, cut-off by classification”, e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
13. Infrastructure system decommissioning emissions are assumed to be a percentage of construction emissions, as detailed in the Decommissioning and Disposal of Proposed Project, Decommissioning Intensity Relative to Construction inputs in Table 2, which includes all subprograms except Hazard Tree Removal.

Abbreviations:

CO_2e - carbon dioxide equivalent
GHG - greenhouse gas
GLO - global
GWP - global warming potential
IPCC - Intergovernmental Panel on Climate Change
kg - kilogram
MT - metric ton
MVA - megavolt-ampere
RoW - rest of world
WEEE - Waste Electrical and Electronic Equipment

References

Doka, G., market for scrap aluminum, RoW, Allocation, cut-off by classification, ecoinvent database version 3.7.1.
Doka, G., market for waste concrete, RoW, Allocation, cut-off by classification, ecoinvent database version 3.7.1.
Doka, G., market for waste polyvinylchloride, RoW, Allocation, cut-off by classification, ecoinvent database version 3.7.1.
Doka, G., market for waste wood, untreated, RoW, Allocation, cut-off by classification, ecoinvent database version 3.7.1.
Hischier, R., market for scrap steel, RoW, Allocation, cut-off by classification, ecoinvent database version 3.7.1.
Hischier, R., market for used industrial electronic device, WEEE collection, RoW, Allocation, cut-off by classification, ecoinvent database version 3.7.1.
Intergovernmental Panel on Climate Change (IPCC), Fifth Assessment Report (AR5), 2014.

ATTACHMENT B
HAWAI‘I ELECTRIC LIGHT TABLES AND CALCULATIONS

Resilience Projects - Hawai'i Island
Hawai'i, HI
Table of Contents

Table 1
Project GHG Emissions by Stage
Resilience Projects - Hawai‘i Island
Hawai‘i, HI

Project Stage		GHG Emissions (MT CO2e)[1,2]
Upstream[3]	Raw Materials Extraction & Manufacturing	3,985
	Transportation	475
	Construction	2,472
Project Operations	Operations & Maintenance	0
Downstream[4]	Transportation	53
	Decommissioning & Disposal	123
	Total Project Operations[5]	**0**
	Total Project Lifecycle	**7,108**

Notes:

1. This table summarizes results from the GHG Analysis undertaken to determine Project GHG Emissions. The supporting calculations are provided in the Calculation tabs for each Project Stage; each tab provides live cell logic, references, calculations and formulas unhidden and unprotected. Note that numbers may not add to totals due to rounding.
2. The Project GHG Emissions estimates are based on the most current information including emissions factors available to Ramboll at the time the analysis was completed.
3. Upstream Transportation and Construction Stages include all construction and transportation activity related to the installation of the proposed project activities, as described in more detail in the Transportation and Construction calculation tables.
4. Downstream decommissioning and disposal emissions include emissions associated with the removal and disposal of Project equipment.
5. Total Project Operations assumed to be zero as there is no net increase in Operations & Maintenance (Use) due to the Project.

Abbreviations:

CO_2e - carbon dioxide equivalent

GHG - greenhouse gas

MT - metric ton

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Table 2
Project Specific Inputs and Assumptions
Resilience Projects GHG Analysis (Hawaiʻi)
Hawaiʻi, HI

	Description	Input	Unit	Reference
General Project				
General Project	**Project Name**	Resilience Projects - Hawaiʻi Island	--	Provided by Hawaiian Electric.
General Project	**Project Location (Island)**	Hawaiʻi	--	Provided by Hawaiian Electric.
General Project	**Island Location of Site (Final Port Location)**	Hilo Harbor	--	Determined based on Project Location (Island).
General Project	**Distance from Final Hawaiʻi Port to Site Location**	33	mi	Provided by Hawaiian Electric.
Transmission Hardening				
General	**General Subprogram Project**			
General	**Subprogram Project Name**	Hawaiʻi Island Transmission Hardening	--	Provided by Hawaiian Electric.
General	**Subprogram Project Lifetime**	58	yr	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Wood Pole**	Yes		Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Number of Wood Poles**	161	item	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Weight of Each Wood Pole**	5,515	lb	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Height of Each Wood Pole**	70	ft	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Location of Wood Pole Manufacturer**	Tacoma, Washington	--	Confirmed by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Equipment Lifetime (Expected Useful Life of the Equipment)**	58	yr	Confirmed by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Number of Equipment over Project Lifetime**	161	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
Utility Poles (Wood or Steel)	**Final Wood Pole Disposal Location**	Local (Island Location of Site)	--	Wood pole disposal location provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**End of Life Treatment**	Decommissioning and disposal	--	Confirmed by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Overhead Transmission Line**	Yes		Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Transmission Line Voltage**	69	kV	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Transmission Line Material**	Aluminum Conductor	--	Confirmed by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Location of Transmission Line Manufacturer**	Florence, Alabama	--	Confirmed by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Length of Transmission Line (linear feet)**	52,800	ft	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Conductor + Bulk of System**	197,885	lb	Conservatively estimated based on material requirements per km of 150 kV aerial transmission line from Table S5 of Jorge et al. (2011a), and assumed to account for bulk of transmission line system (e.g. circuit breakers, insulators, conductors).[1]
Utility Poles (Wood or Steel)	**Equipment Lifetime (Expected Useful Life of the Equipment)**	58	yr	Confirmed by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Number of Equipment over Project Lifetime**	1	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
Utility Poles (Wood or Steel)	**End of Life Treatment**	Decommissioning and disposal	--	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Steel Pole with Concrete Foundation**	Yes		Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Number of Steel Poles (w/ concrete foundation)**	18	item	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Weight of Each Steel Pole**	6,600	lb	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Height of Steel Poles (w/ concrete foundation)**	75	ft	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Volume of concrete foundation (length x width x height)**	270	ft^3	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Weight of Each Concrete Foundation**	40,500	lb	Calculated based on information provided and concrete density of 150 lb/ft^3.
Utility Poles (Wood or Steel)	**Location of Utility Pole Manufacturer - Steel Poles (w/ Concrete Foundation)**	Valley, Nebraska	--	Confirmed by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Equipment Lifetime (Expected Useful Life of the Equipment)**	58	yr	Confirmed by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Number of Equipment over Project Lifetime**	18	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
Utility Poles (Wood or Steel)	**Final Concrete Disposal Location**	Local (Island Location of Site)	--	Confirmed by Hawaiian Electric.
Utility Poles (Wood or Steel)	**End of Life Treatment**	Decommissioning and disposal	--	Confirmed by Hawaiian Electric.

Table 2
Project Specific Inputs and Assumptions
Resilience Projects GHG Analysis (Hawai'i)
Hawai'i, HI

	Description	Input	Unit	Reference
Critical Pole Hardening				
General	**General Subprogram Project**			
	Subprogram Project Name	Hawai'i Island Critical Pole Hardening	--	Provided by Hawaiian Electric.
	Subprogram Project Lifetime	58	yr	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Steel Pole (Self Supporting, Direct-Buried)**	Yes		Provided by Hawaiian Electric.
	Number of Steel Poles	65	item	Provided by Hawaiian Electric.
	Weight of Each Steel Pole	6,600	lb	Provided by Hawaiian Electric.
	Height of Steel Poles	75	ft	Provided by Hawaiian Electric.
	Location of Utility Pole Manufacturer - Steel Poles	Valley, Nebraska	--	Confirmed by Hawaiian Electric.
	Equipment Lifetime (Expected Useful Life of the Equipment)	58	yr	Confirmed by Hawaiian Electric.
	Number of Equipment over Project Lifetime	65	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	End of Life Treatment	Decommissioning and disposal	--	Confirmed by Hawaiian Electric.
	Wood Pole	Yes		Provided by Hawaiian Electric.
	Number of Wood Poles	65	item	Provided by Hawaiian Electric.
	Height of Each Wood Pole	65	ft	Provided by Hawaiian Electric.
	Weight of Each Wood Pole	5,000	lb	Provided by Hawaiian Electric.
	Location of Wood Pole Manufacturer	Tacoma, Washington	--	Confirmed by Hawaiian Electric.
	Equipment Lifetime (Expected Useful Life of the Equipment)	58	yr	Confirmed by Hawaiian Electric.
	Number of Equipment over Project Lifetime	65	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	Final Wood Pole Disposal Location	Local (Island Location of Site)	--	Wood pole disposal location provided by Hawaiian Electric.
	End of Life Treatment	Decommissioning and disposal	--	Confirmed by Hawaiian Electric.
Critical Circuit Hardening				
General	**General Subprogram Project**			
	Subprogram Project Name	Hawai'i Island Critical Circuit Hardening	--	Provided by Hawaiian Electric.
	Subprogram Project Lifetime	58	yr	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Steel Pole (Self Supporting, Direct-Buried)**	Yes		Provided by Hawaiian Electric.
	Number of Steel Poles	40	item	Provided by Hawaiian Electric.
	Weight of Each Steel Pole	6,600	lb	Provided by Hawaiian Electric.
	Height of Steel Poles	75	ft	Provided by Hawaiian Electric.
	Location of Utility Pole Manufacturer - Steel Poles	Valley, Nebraska	--	Confirmed by Hawaiian Electric.
	Equipment Lifetime (Expected Useful Life of the Equipment)	58	yr	Confirmed by Hawaiian Electric.
	Number of Equipment over Project Lifetime	40	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	End of Life Treatment	Decommissioning and disposal	--	Confirmed by Hawaiian Electric.
	Wood Pole	Yes		Provided by Hawaiian Electric.
	Number of Wood Poles	40	item	Provided by Hawaiian Electric.
	Height of Each Wood Pole	65	ft	Provided by Hawaiian Electric.
	Weight of Each Wood Pole	5,000	lb	Provided by Hawaiian Electric.
	Location of Wood Pole Manufacturer	Tacoma, Washington	--	Confirmed by Hawaiian Electric.
	Equipment Lifetime (Expected Useful Life of the Equipment)	58	yr	Confirmed by Hawaiian Electric.
	Number of Equipment over Project Lifetime	40	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	Final Wood Pole Disposal Location	Local (Island Location of Site)	--	Wood pole disposal location provided by Hawaiian Electric.
	End of Life Treatment	Decommissioning and disposal	--	Confirmed by Hawaiian Electric.

Table 2
Project Specific Inputs and Assumptions
Resilience Projects GHG Analysis (Hawai'i)
Hawai'i, HI

	Description	Input	Unit	Reference
Wildfire Mitigation				
General	**General Subprogram Project**			
General	**Subprogram Project Name**	Hawai'i Island Wildfire Mitigation	--	Provided by Hawaiian Electric.
General	**Subprogram Project Lifetime**	55	yr	Provided by Hawaiian Electric.
Overhead Sub-Transmission Line	**Overhead Sub-Transmission Line**	Yes		Provided by Hawaiian Electric.
Overhead Sub-Transmission Line	**Sub-Transmission Line Voltage**	34	kV	Provided by Hawaiian Electric.
Overhead Sub-Transmission Line	**Sub-Transmission Line Material**	Aluminum Conductor	--	Confirmed by Hawaiian Electric.
Overhead Sub-Transmission Line	**Location of Sub-Transmission Line Manufacturer**	Florence, Alabama	--	Confirmed by Hawaiian Electric.
Overhead Sub-Transmission Line	**Length of Sub-Transmission Line (linear feet)**	42,240	ft	Provided by Hawaiian Electric.
Overhead Sub-Transmission Line	**Conductor + Bulk of System**	158,308	kg	Conservatively estimated based on material requirements per km of 150 kV aerial transmission line from Table S5 of Jorge et al. (2011a), and assumed to account for bulk of transmission line system (e.g. circuit breakers, insulators, conductors).[1]
Overhead Sub-Transmission Line	**Equipment Lifetime (Expected Useful Life of the Equipment)**	58	yr	Provided by Hawaiian Electric.
Overhead Sub-Transmission Line	**Number of Equipment over Project Lifetime**	1	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
Overhead Sub-Transmission Line	**End of Life Treatment**	Decommissioning and disposal	--	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Steel Pole (Self Supporting, Direct-Buried)**	Yes		Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Number of Steel Poles**	16	item	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Weight of Each Steel Pole**	6,600	lb	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Height of Steel Poles**	75	ft	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Location of Utility Pole Manufacturer - Steel Poles**	Valley, Nebraska	--	Confirmed by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Equipment Lifetime (Expected Useful Life of the Equipment)**	58	yr	Confirmed by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Number of Equipment over Project Lifetime**	16	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
Utility Poles (Wood or Steel)	**End of Life Treatment**	Decommissioning and disposal	--	Confirmed by Hawaiian Electric.
Misc. Project Equipment	**Thermal Cameras**	Yes		Provided by Hawaiian Electric.
Misc. Project Equipment	**Number of Cameras**	16	item	Provided by Hawaiian Electric.
Misc. Project Equipment	**Weight of Each Camera**	40	lb	Provided by Hawaiian Electric.
Misc. Project Equipment	**Manufacturer / Model of Cameras**	FLIR / Model: A30PT	--	Provided by Hawaiian Electric.
Misc. Project Equipment	**Location of Camera Manufacturer**	Goleta, California	--	Provided by Hawaiian Electric.
Misc. Project Equipment	**Equipment Lifetime (Expected Useful Life of the Equipment)**	55	yr	Provided by Hawaiian Electric.
Misc. Project Equipment	**Number of Equipment over Project Lifetime**	16	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
Misc. Project Equipment	**End of Life Treatment**	Decommissioning and disposal	--	Provided by Hawaiian Electric.
Misc. Project Equipment	**Weather Stations**	Yes		Provided by Hawaiian Electric.
Misc. Project Equipment	**Number of Weather Stations**	8	item	Provided by Hawaiian Electric.
Misc. Project Equipment	**Weight of Each Weather Station**	80	lb	Provided by Hawaiian Electric.
Misc. Project Equipment	**Manufacturer / Model of Weather Stations**	Orion Weather Station, Columbia Weather Systems	--	Provided by Hawaiian Electric.
Misc. Project Equipment	**Additional Components Included for Weather Stations**	Includes sensor module, surge protector, interface, Weather MicroServer, LCD display console	--	Provided by Hawaiian Electric.
Misc. Project Equipment	**Location of Weather Station Manufacturer**	Hillsboro, Oregon	--	Provided by Hawaiian Electric.
Misc. Project Equipment	**Equipment Lifetime (Expected Useful Life of the Equipment)**	55	--	Provided by Hawaiian Electric.
Misc. Project Equipment	**Number of Equipment over Project Lifetime**	8	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
Misc. Project Equipment	**End of Life Treatment**	Decommissioning and disposal	--	Provided by Hawaiian Electric.

Table 2
Project Specific Inputs and Assumptions
Resilience Projects GHG Analysis (Hawaiʻi)
Hawaiʻi, HI

	Description	Input	Unit	Reference
Substation Flood Monitors				
General	**General Subprogram Project**			
	Subprogram Project Name	Hawaiʻi Island Substation Flood Monitors	--	Provided by Hawaiian Electric.
	Subprogram Project Lifetime	55	yr	Provided by Hawaiian Electric.
Misc. Project Equipment	**Flood Monitors**	Yes		Provided by Hawaiian Electric.
	Number of Flood Monitors	4	item	Provided by Hawaiian Electric.
	Flood Monitors Voltage	10	V	Based on information provided by Hawaiian Electric.
	Weight of Each Flood Monitor Sensor (Stainless Steel Alloy)	10	lb	Provided by Hawaiian Electric.
	Weight of Each Flood Monitor Casing (PVC)	1.0	lb	Provided by Hawaiian Electric.
	Weight of Each Flood Monitor Cable (PVC)	1.0	lb	Provided by Hawaiian Electric.
	Manufacturer / Model of Flood Monitors	Flygt, a Xylem Brand	--	Based on information provided by Hawaiian Electric.
	Location of Flood Monitors Manufacturer	Batavia, New York	--	Confirmed by Hawaiian Electric. Based on Flygt, Xylem office location.
Misc. Project Equipment	**Equipment Lifetime (Expected Useful Life of the Equipment)**	55	yr	Provided by Hawaiian Electric.
	Number of Equipment over Project Lifetime	4	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	End of Life Treatment	Decommissioning and disposal	--	Provided by Hawaiian Electric.
Hazard Tree Removal				
General	**General Subprogram Project**			
	Subprogram Project Name	Hawaiʻi Island Hazard Tree Removal	--	Provided by Hawaiian Electric.
Tree Removal	**Tree Removal**	Yes		Provided by Hawaiian Electric.
	Total number of Trees to be Removed	800	item	Provided by Hawaiian Electric.
	Final Disposal Location	Abandoned in Place	--	Provided by Hawaiian Electric. The trees will be lopped and scattered on site.
Use	**Use (General)**			
	Changes to O&M	No net increase in O&M expected from project		Provided by Hawaiian Electric.
Decom. & Disposal	**Decommissioning and Disposal of Proposed Project**			
	Decommissioning Intensity Relative to Construction	3%	%	Provided by Hawaiian Electric.
GWP's	**Global Warming Potentials**			
	Carbon Dioxide	1	g CO_2e/g CO_2	Intergovernmental Panel on Climate Change (IPCC), Fifth Assessment Report (AR5), 2014.
	Methane	28	g CO_2e/g CH_4	
	Nitrous Oxide	265	g CO_2e/g N_2O	

Abbreviations:

CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
ft - feet
ft^3 - cubic feet
GHG - greenhouse gas
GWP - global warming potentials
g - gram
IPCC - Intergovernmental Panel on Climate Change
kg - kilogram
kV - kilovolt
kVA - kilovolt-ampere
lb - pounds
mi - miles
MVA - megavolt-ampere
N_2O - nitrous oxide
O&M - operations and maintenance
yr - year

References:

1. Jorge, R. S.; Hawkins, T. R.; Hertwich, E. G. (2011a). Life cycle assessment of electricity transmission and distribution - part 1: power lines and cables. International Journal of Life Cycle Assessment, 17, 1. Available at: https://doi.org/10.1007/s11367-011-0335-1.
2. Intergovernmental Panel on Climate Change (IPCC), Fifth Assessment Report (AR5), 2014.

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Table 3
Project Specific Construction Inputs and Assumptions
Resilience Projects - Hawaiʻi Island
Hawaiʻi, HI

	Description	Input	Unit	Reference
Transmission Hardening				
General	**General Subprogram Project Construction**			
	Construction Start Date (mm/dd/yyyy)	6/1/2023	--	Provided by Hawaiian Electric.
	Construction End Date (mm/dd/yyyy)	1/30/2026	--	Provided by Hawaiian Electric.
	Construction Site Area	N/A	acres	Provided by Hawaiian Electric.
Transmission Hardening	**Steel Pole Installation**	Yes		
	Strato-Tower	1	#	Confirmed by Hawaiian Electric.
	Pick-Up Truck	2	#	
	Hyliner	1	#	
	Number of Days	18	days	Provided by Hawaiian Electric. Assumes one pole installed per day.
	Number of Workers	8	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	30	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
	Wood Pole Installation	Yes		
	Strato-Tower	1	#	Confirmed by Hawaiian Electric.
	Pick-Up Truck	2	#	
	Hyliner	1	#	
	Number of Days	81	days	Provided by Hawaiian Electric. Assumes two poles installed per day.
	Number of Workers	8	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	30	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
	Overhead Cable Installation	Yes		
	Strato-Tower	1	#	Confirmed by Hawaiian Electric.
	Pick-Up Truck	2	#	
	Hyliner	1	#	
	Number of Days	106	days	Provided by Hawaiian Electric. Assumes 500 ft installed per day.
	Number of Workers	8	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	30	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
Critical Pole Hardening				
General	**General Subprogram Project Construction**			
	Construction Start Date (mm/dd/yyyy)	9/1/2023	--	Provided by Hawaiian Electric.
	Construction End Date (mm/dd/yyyy)	4/30/2026	--	Provided by Hawaiian Electric.
	Construction Site Area	N/A	acres	Provided by Hawaiian Electric.
Critical Pole Hardening	**Wood Pole Installation**	Yes		
	Strato-Tower	1	#	Confirmed by Hawaiian Electric.
	Pick-Up Truck	2	#	
	Hyliner	1	#	
	Number of Days	49	days	Provided by Hawaiian Electric. Assumes 75% of poles are accessible and one pole installed per day.
	Number of Workers	8	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	30	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
	Wood Pole Installation - Helicopter	Yes		
	Helicopter	1	#	
	Number of Days	16	days	Provided by Hawaiian Electric. Assumes 25% of poles are inaccessible and one pole installed per day.
	Number of Workers	12	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	30	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
	Helicopter Horsepower	9,000	horsepower	Confirmed by developer. Default helicopter horsepower was selected based on the helicopter model with specifications in line with the scope of this construction activity (i.e., heavy lifting). Emission factors are consistent with the Valley-Ivyglen and Alberhill System Project, which quantified GHG emissions from helicopter use during construction.[1]
	Helicopter Total Operating Hours	77	hours/helicopter	Helicopter total operating hours based on the number of days in the construction activity, the average usage hours provided by Hawaiian Electric (6 hours/day), and the utilization rate of the helicopter.
	Steel Pole Installation	Yes		
	Strato-Tower	1	#	Confirmed by Hawaiian Electric.
	Pick-Up Truck	2	#	
	Hyliner	1	#	
	Number of Days	49	days	Provided by Hawaiian Electric. Assumes 75% of poles are accessible and one pole installed per day.
	Number of Workers	8	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	30	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
	Steel Pole Installation - Helicopter	Yes		
	Helicopter	1	#	Provided by Hawaiian Electric.
	Number of Days	16	days	Provided by Hawaiian Electric. Assumes 25% of poles are inaccessible and one pole installed per day.
	Number of Workers	12	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	30	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
	Helicopter Horsepower	9,000	horsepower	Confirmed by developer. Default helicopter horsepower was selected based on the helicopter model with specifications in line with the scope of this construction activity (i.e., heavy lifting). Emission factors are consistent with the Valley-Ivyglen and Alberhill System Project, which quantified GHG emissions from helicopter use during construction.[1]
	Helicopter Total Operating Hours	77	hours/helicopter	Helicopter total operating hours based on the number of days in the construction activity, the average usage hours provided by Hawaiian Electric (6 hours/day), and the utilization rate of the helicopter.

Table 3
Project Specific Construction Inputs and Assumptions
Resilience Projects - Hawai'i Island
Hawai'i, HI

	Description	Input	Unit	Reference
Critical Circuit Hardening				
General	**General Subprogram Project Construction**			
General	Construction Start Date (mm/dd/yyyy)	9/1/2023	--	Provided by Hawaiian Electric.
General	Construction End Date (mm/dd/yyyy)	6/30/2026	--	Provided by Hawaiian Electric.
General	Construction Site Area	N/A	acres	Provided by Hawaiian Electric.
Critical Circuit Hardening	**Wood Pole Installation**	Yes		
Critical Circuit Hardening	Strato-Tower	1	#	Confirmed by Hawaiian Electric.
Critical Circuit Hardening	Pick-Up Truck	2	#	
Critical Circuit Hardening	Hyliner	1	#	
Critical Circuit Hardening	Number of Days	20	days	Provided by Hawaiian Electric. Assumes two poles installed per day.
Critical Circuit Hardening	Number of Workers	8	workers	Provided by Hawaiian Electric.
Critical Circuit Hardening	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
Critical Circuit Hardening	Worker Trip Length to/from the Site	30	miles/one-way trip	Provided by Hawaiian Electric.
Critical Circuit Hardening	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
Critical Circuit Hardening	**Steel Pole Installation**	Yes	--	
Critical Circuit Hardening	Strato-Tower	1	#	Confirmed by Hawaiian Electric.
Critical Circuit Hardening	Pick-Up Truck	2	#	
Critical Circuit Hardening	Hyliner	1	#	
Critical Circuit Hardening	Number of Days	20	days	Provided by Hawaiian Electric. Assumes two poles installed per day.
Critical Circuit Hardening	Number of Workers	8	workers	Provided by Hawaiian Electric.
Critical Circuit Hardening	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
Critical Circuit Hardening	Worker Trip Length to/from the Site	30	miles/one-way trip	Provided by Hawaiian Electric.
Critical Circuit Hardening	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
Wildfire Mitigation				
General	**General Subprogram Project Construction**			
General	Construction Start Date (mm/dd/yyyy)	2/21/2024	--	Provided by Hawaiian Electric.
General	Construction End Date (mm/dd/yyyy)	9/1/2026	--	Provided by Hawaiian Electric.
General	Construction Site Area	N/A	acres	Provided by Hawaiian Electric.
Wildfire Mitigation	**Steel Pole Installation**	Yes		
Wildfire Mitigation	Strato-Tower	1	#	Confirmed by Hawaiian Electric.
Wildfire Mitigation	Pick-Up Truck	2	#	
Wildfire Mitigation	Hyliner	1	#	
Wildfire Mitigation	Number of Days	16	days	Provided by Hawaiian Electric. Assumes one pole installed per day.
Wildfire Mitigation	Number of Workers	8	workers	Provided by Hawaiian Electric.
Wildfire Mitigation	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
Wildfire Mitigation	Worker Trip Length to/from the Site	30	miles/one-way trip	Provided by Hawaiian Electric.
Wildfire Mitigation	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
Wildfire Mitigation	**Overhead Cable Installation**	Yes		
Wildfire Mitigation	Strato-Tower	1	#	Confirmed by Hawaiian Electric.
Wildfire Mitigation	Pick-Up Truck	2	#	
Wildfire Mitigation	Hyliner	1	#	
Wildfire Mitigation	Number of Days	85	days	Provided by Hawaiian Electric. Assumes 500 ft installed per day.
Wildfire Mitigation	Number of Workers	8	workers	Provided by Hawaiian Electric.
Wildfire Mitigation	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
Wildfire Mitigation	Worker Trip Length to/from the Site	30	miles/one-way trip	Provided by Hawaiian Electric.
Wildfire Mitigation	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
Wildfire Mitigation	**Install Thermal Cameras**	Yes		
Wildfire Mitigation	Bucket Truck	1	#	Provided by Hawaiian Electric.
Wildfire Mitigation	Pick-up Truck	1	#	
Wildfire Mitigation	Number of Days	8	days	Provided by Hawaiian Electric.
Wildfire Mitigation	Number of Workers	4	workers	Provided by Hawaiian Electric.
Wildfire Mitigation	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
Wildfire Mitigation	Worker Trip Length to/from the Site	30	miles/one-way trip	Provided by Hawaiian Electric.
Wildfire Mitigation	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
Wildfire Mitigation	**Install Weather Stations**	Yes		
Wildfire Mitigation	Bucket Truck	1	#	Provided by Hawaiian Electric.
Wildfire Mitigation	Pick-up Truck	1	#	
Wildfire Mitigation	Number of Days	8	days	Provided by Hawaiian Electric.
Wildfire Mitigation	Number of Workers	4	workers	Provided by Hawaiian Electric.
Wildfire Mitigation	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
Wildfire Mitigation	Worker Trip Length to/from the Site	30	miles/one-way trip	Provided by Hawaiian Electric.
Wildfire Mitigation	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
Substation Flood Monitors				
General	**General Subprogram Project Construction**			
General	Construction Start Date (mm/dd/yyyy)	2/21/2023	--	Provided by Hawaiian Electric.
General	Construction End Date (mm/dd/yyyy)	12/23/2025	--	Provided by Hawaiian Electric.
General	Construction Site Area	N/A	acres	Provided by Hawaiian Electric.
Substation Flood Monitors	**Install Flood Monitors**	Yes		
Substation Flood Monitors	Bucket Truck	1	#	Provided by Hawaiian Electric.
Substation Flood Monitors	Pick-up Truck	1	#	
Substation Flood Monitors	Number of Days	4	days	Provided by Hawaiian Electric.
Substation Flood Monitors	Number of Workers	4	workers	Provided by Hawaiian Electric.
Substation Flood Monitors	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
Substation Flood Monitors	Worker Trip Length to/from the Site	30	miles/one-way trip	Provided by Hawaiian Electric.
Substation Flood Monitors	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.

Table 3
Project Specific Construction Inputs and Assumptions
Resilience Projects - Hawai'i Island
Hawai'i, HI

	Description	Input	Unit	Reference
Hazard Tree Removal				
General	**General Subprogram Project Construction**			
	Construction Start Date (mm/dd/yyyy)	6/1/2023	--	Provided by Hawaiian Electric.
	Construction End Date (mm/dd/yyyy)	9/30/2026	--	Provided by Hawaiian Electric.
	Construction Site Area	N/A	acres	Provided by Hawaiian Electric.
Hazard Tree Removal	**Tree Removal**	Yes		
	Pick-Up Truck	2	#	Provided by Hawaiian Electric.
	Bucket Truck	1	#	
	Number of Days	800	days	Provided by Hawaiian Electric.
	Number of Workers	4	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	30	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.

Abbreviations:
- number
ft^3 - cubic feet

References:
1. Valley-Ivyglen and Alberhill System Project. Available at: https://www.cpuc.ca.gov/environment/info/ene/alberhill/Alberhill.html

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Appendix Table A1
Raw Materials Extraction & Manufacturing GHG Emissions Calculations
Resilience Projects - Hawaiʻi Island
Hawaiʻi, HI

System	Description	Total Items[1]	Weight per Item (kg)[1]	Lifecycle GHG Emission Factor	Units	Note	GHG Emissions (MT CO_2e)
Transmission Hardening	Wood Pole	161	2,502	0.11	kg CO_2e/kg	2	43
	Conductor + Bulk of System	1	89,759	8.2	kg CO_2e/kg	3	738
	Steel Pole with Concrete Foundation - Steel Pole	18	2,994	4.4	kg CO_2e/kg	4	236
	Steel Pole with Concrete Foundation - Concrete Foundation	18	18,370	0.10	kg CO_2e/kg	5	35
Critical Pole Hardening	Steel Pole (Self Supporting, Direct-Buried)	65	2,994	4.4	kg CO_2e/kg	4	854
	Wood Pole	65	2,268	0.11	kg CO_2e/kg	2	16
Critical Circuit Hardening	Steel Pole (Self Supporting, Direct-Buried)	40	2,994	4.4	kg CO_2e/kg	4	525
	Wood Pole	40	2,268	0.11	kg CO_2e/kg	2	10
Wildfire Mitigation	Conductor + Bulk of System	1	158,308	8.2	kg CO_2e/kg	3	1,302
	Steel Pole (Self Supporting, Direct-Buried)	16	2,994	4.4	kg CO_2e/kg	4	210
	Thermal Cameras	16	18	18	kg CO_2e/kg	6	5.2
	Weather Stations	8	36	36	kg CO_2e/kg	7	11
Substation Flood Monitors	Flood Monitors - Sensor	4	4.5	4.4	kg CO_2e/kg	8	0.080
	Flood Monitors - Casing & Cable	4	0.91	2.6	kg CO_2e/kg	9	0.0094
						Total	**3,985**

Notes:

1. Project specifications, assumptions and references are provided in Table 2.
2. The GHG emission factor for the Wood Pole is estimated from Bolin and Smith, 2011 (Table 2). This factor represents total CO_2e emissions per utility pole for the pole production and treating life cycle stages. As defined by Bolin and Smith, 2011, pole production for the wood pole includes: "replanting a harvested area of forest, growing and maintaining the forest plantation until harvest, harvesting of the trees, drying, and milling and associated transportation" and treating includes: "pole peeling, pole drying, preservative manufacture and transport, treatment, storage of untreated and treated poles, releases, and transportation of poles to the utility yard". The estimated emissions from Bolin and Smith were conservatively scaled based on the weight of each pole.
3. The GHG emission factor for the Conductor + Bulk of System is an estimate from Jorge, et al. (2011a) estimated emissions for a 150 kV overhead transmission line (Figure 1a), scaled based on the weight of the transmission line. The estimated emissions for an overhead transmission line are used because the transmission line material for this Project is of similar material to that of the overhead transmission line from Jorge, et al. (2011a). This factor represents total CO_2e emissions per kg of transmission line for components such as conductors, insulators, installation, and usage. Installation and usage together account for less than approximately 4% of total emissions, so these are conservatively included in addition to the Construction emissions estimated in Tables A3.

4. The GHG emission factor for the Steel Pole with Concrete Foundation - Steel Pole and Steel Pole (Self Supporting, Direct-Buried) is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Classen, M., market for steel, chromium steel 18/8, hot rolled, global geography ("GLO", e.g. value represents activities which are considered to be an average valid for all countries in the world, and are calculated as the average of the regional datasets that contain information for the activity), System Model Allocation, cut-off by classification (“Allocation, cut-off by classification”, e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.

5. The GHG emission factor for the Concrete Foundations of Steel Pole with Concrete Foundation is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Martineau, G., market for concrete, 20MPa, North America geography ("RNA", e.g. value represents activities which are considered to be an average valid for all countries in North America, and are calculated as the average of the regional datasets that contain information for the activity), System Model Allocation, cut-off by classification (“Allocation, cut-off by classification”, e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1. The emission factor is normalized based on the density of concrete, approximately 2,335 kg/m3, provided in documentation of the dataset.

6. The GHG emission factor for Thermal Cameras is derived from Hillerström, H. and Troborg, U (2010) materials and manufacturing CO_2 emissions for a security camera as provided in Table 7. The emission factor was normalized based on the weight of the security camera used in the study, AXIS Q6032-E.

7. The GHG emission factor for the Weather Stations is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Hischier, R., market for electronics, for control units, global geography ("GLO", e.g. value represents activities which are considered to be an average valid for all countries in the world, and are calculated as the average of the regional datasets that contain information for the activity), System Model Allocation, cut-off by classification (“Allocation, cut-off by classification”, e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.

8. The GHG emission factor for the Flood Monitors - Sensor is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Classen, M., market for steel, chromium steel 18/8, hot rolled, global geography ("GLO", e.g. value represents activities which are considered to be an average valid for all countries in the world, and are calculated as the average of the regional datasets that contain information for the activity), System Model Allocation, cut-off by classification (“Allocation, cut-off by classification”, e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.

9. The GHG emission factor for the Flood Monitors - Casing & Cable is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Hischier, R., market for polyvinylchloride, bulk polymerised, global geography ("GLO", e.g. value represents activities which are considered to be an average valid for all countries in the world, and are calculated as the average of the regional datasets that contain information for the activity), System Model Allocation, cut-off by classification (“Allocation, cut-off by classification”, e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.

Abbreviations:

CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
GHG - greenhouse gas
GWP - global warming potential
IPCC - Intergovernmental Panel on Climate Change
kg - kilogram
kV - kilovolts
m^3 - cubic meter
MPa - megapascal
MT - metric ton

References

Bolin, Christopher; Smith, Stephen. (2011). Life cycle assessment of pentachlorophenol-treated wooden utility poles with comparisons to steel and concrete utility poles. Renewable and Sustainable Energy Reviews, 15, 2. Available at: https://doi.org/10.1016/j.rser.2011.01.019.

Classen, M., market for steel, chromium steel 18/8, hot rolled, GLO, Allocation, cut-off by classification, ecoinvent database version 3.7.1.

Hillerström, H. and Troborg, U. (2010). Customized LCA for Network Cameras. KTH Industrial Engineering and Management, Master of Science Thesis.

Hischier, R., market for electronics, for control units, GLO, Allocation, cut-off by classification, ecoinvent database version 3.7.1.

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Martineau, G., market for concrete, 20MPa, RNA, Allocation, cut-off by classification, ecoinvent database version 3.7.1.

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Appendix Table A2
Material Transportation GHG Emissions Calculations
Resilience Projects - Hawai'i Island
Hawai'i, HI

Mode of Travel	Emission Factors[1,2]							
	CO_2	units	CH_4	units	N_2O	units	CO_2e	units
Truck	0.21	kg/ton-mi	2.0E-06	kg/ton-mi	4.9E-06	kg/ton-mi	0.15	kg/MT-km
Ship	--	kg/ton-mi	--	kg/ton-mi	--	kg/ton-mi	0.0066	kg/MT-km

Transportation Emissions:

Shipment Item		Weight per Item (kg)	Total Items	Net Weight (MT)[3]	Phase	Origin	Destination	Mode[4]	Trip length (mi or nmi)[5]	Trip Type[6]	GHG Emissions (MT CO_2e) Per Segment	GHG Emissions (MT CO_2e) Per Shipment Item Type
Transmission Hardening	Wood Pole	2,502	161	403	Upstream	Tacoma, Washington (Manufacturer/Warehouse)	Tacoma (Port)	Truck	5.0	One-Way	0.47	25
						Tacoma (Port)	Los Angeles (Port)	Ship	1,165	One-Way	6	
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	11	
						Honolulu Harbor (Port)	Hilo Harbor (Port)	Ship	230	One-Way	1.1	
						Hilo Harbor (Port)	Site	Truck	33	Roundtrip	6	
					Downstream	Site	County Landfill, Hawai'i	Truck	45	Roundtrip	8	8
	Conductor + Bulk of System	89,759	1	90	Upstream	Florence, Alabama (Manufacturer/Warehouse)	Los Angeles (Port)	Truck	2,013	One-Way	42	46
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	2.5	
						Honolulu Harbor (Port)	Hilo Harbor (Port)	Ship	230	One-Way	0.25	
						Hilo Harbor (Port)	Site	Truck	33	Roundtrip	1.4	
					Downstream	Site	Hilo Harbor (Port)	Truck	33	Roundtrip	1.4	4.6
						Hilo Harbor (Port)	Honolulu Harbor (Port)	Ship	230	One-Way	0.25	
						Honolulu Harbor (Port)	Los Angeles (Port)	Ship	2,231	One-Way	2.5	
						Los Angeles (Port)	Los Angeles (Scrap Yard)	Truck	25	One-Way	0.53	
	Steel Pole with Concrete Foundation	21,364	18	385	Upstream	Valley, Nebraska (Manufacturer/Warehouse)	Los Angeles (Port)	Truck	1,562	One-Way	141	158
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	11	
						Honolulu Harbor (Port)	Hilo Harbor (Port)	Ship	230	One-Way	1.1	
						Hilo Harbor (Port)	Site	Truck	33	Roundtrip	6	
					Downstream	Site	County Landfill, Hawai'i	Truck	45	Roundtrip	8	8
Critical Pole Hardening	Steel Pole (Self Supporting, Direct-Buried)	2,994	65	195	Upstream	Valley, Nebraska (Manufacturer/Warehouse)	Los Angeles (Port)	Truck	1,562	One-Way	71	80
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	5	
						Honolulu Harbor (Port)	Hilo Harbor (Port)	Ship	230	One-Way	0.6	
						Hilo Harbor (Port)	Site	Truck	33	Roundtrip	3.0	
					Downstream	Site	Hilo Harbor (Port)	Truck	33	Roundtrip	3.0	10
						Hilo Harbor (Port)	Honolulu Harbor (Port)	Ship	230	One-Way	0.6	
						Honolulu Harbor (Port)	Los Angeles (Port)	Ship	2,231	One-Way	5	
						Los Angeles (Port)	Los Angeles (Scrap Yard)	Truck	25	One-Way	1.1	
	Wood Pole	2,268	65	147	Upstream	Tacoma, Washington (Manufacturer/Warehouse)	Tacoma (Port)	Truck	5.0	One-Way	0.17	9
						Tacoma (Port)	Los Angeles (Port)	Ship	1,165	One-Way	2.1	
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	4.0	
						Honolulu Harbor (Port)	Hilo Harbor (Port)	Ship	230	One-Way	0.42	
						Hilo Harbor (Port)	Site	Truck	33	Roundtrip	2.3	
					Downstream	Site	County Landfill, Hawai'i	Truck	45	Roundtrip	3.1	3.1
Critical Circuit Hardening	Steel Pole (Self Supporting, Direct-Buried)	2,994	40	120	Upstream	Valley, Nebraska (Manufacturer/Warehouse)	Los Angeles (Port)	Truck	1,562	One-Way	44	49
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	3.3	
						Honolulu Harbor (Port)	Hilo Harbor (Port)	Ship	230	One-Way	0.34	
						Hilo Harbor (Port)	Site	Truck	33	Roundtrip	1.9	
					Downstream	Site	Hilo Harbor (Port)	Truck	33	Roundtrip	1.9	6.2
						Hilo Harbor (Port)	Honolulu Harbor (Port)	Ship	230	One-Way	0.34	
						Honolulu Harbor (Port)	Los Angeles (Port)	Ship	2,231	One-Way	3.3	
						Los Angeles (Port)	Los Angeles (Scrap Yard)	Truck	25	One-Way	0.70	
	Wood Pole	2,268	40	91	Upstream	Tacoma, Washington (Manufacturer/Warehouse)	Tacoma (Port)	Truck	5.0	One-Way	0.11	5.6
						Tacoma (Port)	Los Angeles (Port)	Ship	1,165	One-Way	1.3	
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	2.5	
						Honolulu Harbor (Port)	Hilo Harbor (Port)	Ship	230	One-Way	0.26	
						Hilo Harbor (Port)	Site	Truck	33	Roundtrip	1.4	
					Downstream	Site	County Landfill, Hawai'i	Truck	45	Roundtrip	1.9	1.9
Wildfire Mitigation	Conductor + Bulk of System	158,308	1	158	Upstream	Florence, Alabama (Manufacturer/Warehouse)	Los Angeles (Port)	Truck	2,013	One-Way	75	82
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	4.3	
						Honolulu Harbor (Port)	Hilo Harbor (Port)	Ship	230	One-Way	0.45	
						Hilo Harbor (Port)	Site	Truck	33	Roundtrip	2.4	
					Downstream	Site	Hilo Harbor (Port)	Truck	33	Roundtrip	2.4	8.2
						Hilo Harbor (Port)	Honolulu Harbor (Port)	Ship	230	One-Way	0.45	
						Honolulu Harbor (Port)	Los Angeles (Port)	Ship	2,231	One-Way	4.3	
						Los Angeles (Port)	Los Angeles (Scrap Yard)	Truck	25	One-Way	0.93	
	Steel Pole (Self Supporting, Direct-Buried)	2,994	16	48	Upstream	Valley, Nebraska (Manufacturer/Warehouse)	Los Angeles (Port)	Truck	1,562	One-Way	18	20
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	1.3	
						Honolulu Harbor (Port)	Hilo Harbor (Port)	Ship	230	One-Way	0.14	
						Hilo Harbor (Port)	Site	Truck	33	Roundtrip	0.74	
					Downstream	Site	Hilo Harbor (Port)	Truck	33	Roundtrip	0.74	2.5
						Hilo Harbor (Port)	Honolulu Harbor (Port)	Ship	230	One-Way	0.14	
						Honolulu Harbor (Port)	Los Angeles (Port)	Ship	2,231	One-Way	1.3	
						Los Angeles (Port)	Los Angeles (Scrap Yard)	Truck	25	One-Way	0.28	
	Thermal Cameras	18	16	0.29	Upstream	Goleta, California (Manufacturer/Warehouse)	Los Angeles (Port)	Truck	125	One-Way	0.0085	0.022
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	0.0080	
						Honolulu Harbor (Port)	Hilo Harbor (Port)	Ship	230	One-Way	8.2E-04	
						Hilo Harbor (Port)	Site	Truck	33	Roundtrip	0.0045	
					Downstream	Site	Hilo Harbor (Port)	Truck	33	Roundtrip	0.0045	0.015
						Hilo Harbor (Port)	Honolulu Harbor (Port)	Ship	230	One-Way	8.2E-04	
						Honolulu Harbor (Port)	Los Angeles (Port)	Ship	2,231	One-Way	0.0080	
						Los Angeles (Port)	Los Angeles (Scrap Yard)	Truck	25	One-Way	0.0017	

Appendix Table A2
Material Transportation GHG Emissions Calculations
Resilience Projects - Hawai'i Island
Hawai'i, HI

Mode of Travel	Emission Factors[1,2]							
	CO_2	units	CH_4	units	N_2O	units	CO_2e	units
Truck	0.21	kg/ton-mi	2.0E-06	kg/ton-mi	4.9E-06	kg/ton-mi	0.15	kg/MT-km
Ship	--	kg/ton-mi	--	kg/ton-mi	--	kg/ton-mi	0.0066	kg/MT-km

Transportation Emissions:

Shipment Item		Weight per Item (kg)	Total Items	Net Weight (MT)[3]	Phase	Origin	Destination	Mode[4]	Trip length (mi or nmi)[5]	Trip Type[6]	GHG Emissions (MT CO_2e) Per Segment	GHG Emissions (MT CO_2e) Per Shipment Item Type
Wildfire Mitigation	Weather Stations	36	8	0.29	Upstream	Hillsboro, Oregon (Manufacturer/Warehouse)	Portland (Port)	Truck	32	One-Way	0.0022	0.019
						Portland (Port)	Los Angeles (Port)	Ship	979	One-Way	0.0035	
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	0.0080	
						Honolulu Harbor (Port)	Hilo Harbor (Port)	Ship	230	One-Way	8.2E-04	
						Hilo Harbor (Port)	Site	Truck	33	Roundtrip	0.0045	
					Downstream	Site	Hilo Harbor (Port)	Truck	33	Roundtrip	0.0045	0.015
						Hilo Harbor (Port)	Honolulu Harbor (Port)	Ship	230	One-Way	8.2E-04	
						Honolulu Harbor (Port)	Los Angeles (Port)	Ship	2,231	One-Way	0.0080	
						Los Angeles (Port)	Los Angeles (Scrap Yard)	Truck	25	One-Way	0.0017	
Substation Flood Monitors	Flood Monitors	5.4	4	0.022	Upstream	Batavia, New York (Manufacturer/Warehouse)	Los Angeles (Port)	Truck	2,586	One-Way	0.013	0.014
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	6.0E-04	
						Honolulu Harbor (Port)	Hilo Harbor (Port)	Ship	230	One-Way	6.2E-05	
						Hilo Harbor (Port)	Site	Truck	33	Roundtrip	3.4E-04	
					Downstream	Site	Hilo Harbor (Port)	Truck	33	Roundtrip	3.4E-04	0.0011
						Hilo Harbor (Port)	Honolulu Harbor (Port)	Ship	230	One-Way	6.2E-05	
						Honolulu Harbor (Port)	Los Angeles (Port)	Ship	2,231	One-Way	6.0E-04	
						Los Angeles (Port)	Los Angeles (Scrap Yard)	Truck	25	One-Way	1.3E-04	
Total Upstream GHG Emissions (MT CO_2e)[7]												**475**
Total Downstream GHG Emissions (MT CO_2e)[8]												**53**
Total GHG Emissions (MT CO_2e)												**528**

Notes:

1. The emission factors for road transportation are taken from US Environmental Protection Agency (EPA) Scope 3 Inventory Guidance, which recommends emission factors from Table 8 of Emission Factors for Greenhouse Gas Inventories.
2. The emission factor for shipping is based on the Global Maritime Emission Factor for dry (i.e., non-refrigerated) cargo shipping over all trade lanes for 2020 with a 70% utilization factor, assuming an average load weight of 10 tons in each container.
3. The net weight is determined based on the weight of each item and the quantity of each item.
4. For a given transportation segment, if the mode of travel is not known and if multiple travel modes are available, the most emissions-intensive mode is selected.
5. The trip lengths for each leg of travel were estimated based on the following assumptions:
   (a) Shipping distances were estimated using the Sea Distance tool, available at https://sea-distances.org.
   (b) Truck distances were estimated by using Google Maps to determine driving distances between the locations.
6. GHG emissions are per segment (i.e. one-way travel) with the exception of estimated emissions to or from the site. These segments consider roundtrip travel and multiply the per segment GHG emissions by two to account for roundtrip travel. This approach conservatively treats the empty return trip as loaded.
7. Upstream transportation emissions include emissions from transporting the project materials from manufacturing to the project site.
8. Downstream transportation emissions include emissions from transporting the project materials from the project site to disposal at the scrap yard.

Abbreviations:

CH_4 - methane
CN - Canadian National
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
GHG - greenhouse gas
GWP - global warming potential
kg - kilogram
km - kilometer
mi - mile
MT - metric ton
nmi - nautical mile
N_2O - nitrous oxide

References:

EPA. Scope 3 Inventory Guidance. Available at: https://www.epa.gov/climateleadership/scope-3-inventory-guidance
EPA (2022). Emission Factors for Greenhouse Gas Inventories. April 1. Available at: https://www.epa.gov/system/files/documents/2022-04/ghg_emission_factors_hub.pdf
Global Maritime Emission Factors. Available at: https://www.bsr.org/files/clean-cargo/BSR-Clean-Cargo-Emissions-Report-2021.pdf

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Appendix Table A3
Construction GHG Emissions Calculations
Resilience Projects - Hawaiʻi Island
Hawaiʻi, HI

Construction Schedule[1]:

System	Construction Activity	Number of Workers	Days
Transmission Hardening	Steel Pole Installation	8	18
	Wood Pole Installation	8	81
	Overhead Cable Installation	8	106
Critical Pole Hardening	Wood Pole Installation	8	49
	Wood Pole Installation - Helicopter	12	16
	Steel Pole Installation	8	49
	Steel Pole Installation - Helicopter	12	16
Critical Circuit Hardening	Wood Pole Installation	8	20
	Steel Pole Installation	8	20
Wildfire Mitigation	Steel Pole Installation	8	16
	Overhead Cable Installation	8	85
	Install Thermal Cameras	4	8
	Install Weather Stations	4	8
Substation Flood Monitors	Install Flood Monitors	4	4
Hazard Tree Removal	Tree Removal	4	800

Installation Offroad Emissions:

Phase	Construction Subphase	Equipment Type[1]	Total Items[1]	Avg. Usage Hours per Day	Utilization Rate	Hours of Operation (hr / project)	Horsepower[2]	Load[2]	EF (g / bhp-hr)[3]			GHG Emissions[4] (MT CO_2e)
									CO_2	CH_4	CO_2e	
Transmission Hardening	Steel Pole Installation	Strato-Tower	1	8	0.80	115	376	0.38	475	0.15	479	7.9
		Pick-Up Truck	2	8	0.80	230	376	0.38	475	0.15	479	16
		Hyliner	1	8	0.80	115	367	0.29	472	0.15	477	5.8
	Wood Pole Installation	Strato-Tower	1	8	0.80	518	376	0.38	475	0.15	479	36
		Pick-Up Truck	2	8	0.80	1,037	376	0.38	475	0.15	479	71
		Hyliner	1	8	0.80	518	367	0.29	472	0.15	477	26
	Overhead Cable Installation	Strato-Tower	1	8	0.80	678	376	0.38	475	0.15	479	46
		Pick-Up Truck	2	8	0.80	1,357	376	0.38	475	0.15	479	93
		Hyliner	1	8	0.80	678	367	0.29	472	0.15	477	34
Critical Pole Hardening	Wood Pole Installation	Strato-Tower	1	8	0.80	314	376	0.38	475	0.15	479	21
		Pick-Up Truck	2	8	0.80	0,627	376	0.38	475	0.15	479	43
		Hyliner	1	8	0.80	314	367	0.29	472	0.15	477	16
	Wood Pole Installation - Helicopter	Helicopter	1	6	0.80	77	9,000	--	393	0.011	393	272
	Steel Pole Installation	Strato-Tower	1	8	0.80	314	376	0.38	475	0.15	479	21
		Pick-Up Truck	2	8	0.80	0,627	376	0.38	475	0.15	479	43
		Hyliner	1	8	0.80	314	367	0.29	472	0.15	477	16
	Steel Pole Installation - Helicopter	Helicopter	1	6	0.80	77	9,000	--	393	0.011	393	272

Appendix Table A3
Construction GHG Emissions Calculations
Resilience Projects - Hawaiʻi Island
Hawaiʻi, HI

Phase	Construction Subphase	Equipment Type[1]	Total Items[1]	Avg. Usage Hours per Day	Utilization Rate	Hours of Operation (hr / project)	Horsepower[2]	Load[2]	EF (g/bhp-hr)[3]			GHG Emissions[4] ($MT\ CO_2e$)
									CO_2	CH_4	CO_2e	
Critical Circuit Hardening	Wood Pole Installation	Strato-Tower	1	8	0.80	128	376	0.38	475	0.15	479	8.8
		Pick-Up Truck	2	8	0.80	256	376	0.38	475	0.15	479	18
		Hyliner	1	8	0.80	128	367	0.29	472	0.15	477	6.5
	Steel Pole Installation	Strato-Tower	1	8	0.80	128	376	0.38	475	0.15	479	8.8
		Pick-Up Truck	2	8	0.80	256	376	0.38	475	0.15	479	18
		Hyliner	1	8	0.80	128	367	0.29	472	0.15	477	6.5
Wildfire Mitigation	Steel Pole Installation	Strato-Tower	1	8	0.80	102	376	0.38	475	0.15	480	7.0
		Pick-Up Truck	2	8	0.80	205	376	0.38	475	0.15	480	14
		Hyliner	1	8	0.80	102	367	0.29	472	0.15	476	5.2
	Overhead Cable Installation	Strato-Tower	1	8	0.80	544	376	0.38	475	0.15	480	37
		Pick-Up Truck	2	8	0.80	1088	376	0.38	475	0.15	480	75
		Hyliner	1	8	0.80	544	367	0.29	472	0.15	476	28
	Install Thermal Cameras	Bucket Truck	1	8	0.80	51	376	0.38	475	0.15	480	3.5
		Pick-up Truck	1	8	0.80	51	376	0.38	475	0.15	480	3.5
	Install Weather Stations	Bucket Truck	1	8	0.80	51	376	0.38	475	0.15	480	3.5
		Pick-up Truck	1	8	0.80	51	376	0.38	475	0.15	480	3.5
Substation Flood Monitors	Install Flood Monitors	Bucket Truck	1	8	0.80	26	376	0.38	475	0.15	479	1.8
		Pick-up Truck	1	8	0.80	26	376	0.38	475	0.15	479	1.8
Hazard Tree Removal	Tree Removal	Pick-Up Truck	2	8	0.80	10,240	376	0.38	475	0.15	479	701
		Bucket Truck	1	8	0.80	5,120	376	0.38	475	0.15	479	351
Total Offroad Emissions from Construction Activity												**2,341**

Installation Onroad Emissions:

Phase	Construction Subphase	Average Trip Rates (trips/day)		Trip Length (mi/trip)		CO_2e Hauling EF[6]		CO_2e Worker EF[6]		GHG Emissions[7] ($MT\ CO_2e$)
		Worker[5]	Hauling	Worker	Hauling	(g/trip)	(g/mi)	(g/trip)	(g/mi)	
Transmission Hardening	Steel Pole Installation	16	0	30	0	251	736	86	302	2.6
	Wood Pole Installation	16	0	30	0	251	736	86	302	12
	Overhead Cable Installation	16	0	30	0	251	736	86	302	16
Critical Pole Hardening	Wood Pole Installation	16	0	30	0	251	736	86	302	7.2
	Wood Pole Installation - Helicopter	24	0	30	0	251	736	86	302	3.5
	Steel Pole Installation	16	0	30	0	251	736	86	302	7.2
	Steel Pole Installation - Helicopter	24	0	30	0	251	736	86	302	3.5
Critical Circuit Hardening	Wood Pole Installation	16	0	30	0	251	736	86	302	2.9
	Steel Pole Installation	16	0	30	0	251	736	86	302	2.9
Wildfire Mitigation	Steel Pole Installation	16	0	30	0	247	723	84	294	2.3
	Overhead Cable Installation	16	0	30	0	247	723	84	294	12
	Install Thermal Cameras	8	0	30	0	247	723	84	294	0.57
	Install Weather Stations	8	0	30	0	247	723	84	294	0.57
Substation Flood Monitors	Install Flood Monitors	8	0	30	0	251	736	86	302	0.29
Hazard Tree Removal	Tree Removal	8	0	30	0	251	736	86	302	59
Total Onroad Emissions from Construction Activity										**132**
Total Construction Emissions										**2,472**

Appendix Table A3
Construction GHG Emissions Calculations
Resilience Projects - Hawaiʻi Island
Hawaiʻi, HI

Notes:

1. Project specifications, assumptions and references are provided in Table 3. Each piece of construction equipment was modeled using a comparable piece of equipment from CalEEMod's off-road equipment list.
2. Unless specifically provided by the developer, horsepower and load factor were assumed to be consistent with CalEEMod® v2022.1, default assumptions.
3. Emission factors associated with offroad equipment are from CARB OFFROAD2021 for calendar year 2023, based on the construction start year of each subprogram project. This CARB database provides GHG emission factors for various equipment types and sizes. While more stringent criteria air pollutant requirements may result in lower criteria pollutant emission factors in California than Hawaiʻi, the fuel economy and therefore the GHG emission factors from offroad equipment are not expected to vary regionally. The OFFROAD database does not contain emission factors for N_2O emissions, which are expected to be minimal compared to overall offroad GHG emissions.
4. Offroad GHG emissions are calculated using a g/bhp-hr emission factor. This emission factor is multiplied by the hours of operation, horsepower, and load for each piece of equipment, then converted from grams to metric tons.
5. The number of home-to-work trips per day associated with each construction subphase activity was determined by multiplying the number of workers by two.
6. Emission factors associated with worker and hauling trips were estimated from California statewide emission factors generated using EMFAC2021 for calendar year 2023 and 2024, based on the construction start year of each subprogram project. The worker fleet assumes only light duty vehicles (EMFAC classes LDA, LDT1, and LDT2) and the hauling fleet assumes heavy duty trucks (EMFAC classes HHDT, LHDT1, LHDT2, MDV, and MHDT). Mobile emission factors from California's EMFAC database represent a reasonable estimate of mobile emission factors for the Project. Hawaiʻi does not maintain a publicly-accessible database like EMFAC that could be used to assess location-specific vehicle fleet data in future years. However, 2015 data on average fuel economy for the existing light-duty fleets show relatively minor differences between Hawaiʻi, California, and US-average vehicles. Given that onroad vehicles represent a small portion of lifecycle emissions for the Project, any adjustments to these emission factors would not result in significant changes to the resulting emissions.
7. Onroad GHG emissions are calculated using g/trip and g/mi emission factors. The g/trip emission factors are multiplied by the trips per day, and the g/mi emission factors are multiplied by the miles per trip and trips per day. These emission rates are then multiplied by the number of days in each subphase, and converted from grams to metric tons.

Abbreviations:

bhp - brake horsepower
CalEEMod - California Emissions Estimator MODel
CARB - California Air Resources Board
CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
EF - emissions factor
EMFAC - EMission FACtor model
g - gram
GHG - greenhouse gas
HHDT - heavy-heavy-duty truck
hr - hour
kg - kilogram
LDA - light-duty automobile
LDT - light-duty truck
LHDT - light-heavy-duty truck
MDV - medium-duty vehicle
MHDT - medium-heavy-duty truck
mi - mile
MT - metric ton
N_2O - nitrous oxide

References:

California Emissions Estimator Model (CalEEMod®) v2022.1 Appendix G. Available at: https://www.caleemod.com/documents/user-guide/08_Appendix%20G.xlsx
California Air Resources Board (CARB) 2022. OFFROAD 2021. Available at: https://ww2.arb.ca.gov/our-work/programs/mobile-source-emissions-inventory/msei-modeling-tools.
California Air Resources Board (CARB) 2022. EMFAC2021 v1.0.2. Available at: https://arb.ca.gov/emfac/emissions-inventory.

Appendix Table A4
Decommissioning & Disposal GHG Emissions Calculations
Resilience Projects - Hawaiʻi Island
Hawaiʻi, HI

Decommissioning and Disposal:

System	Stages	Components	Total Items[1]	Weight per Item (kg)[1]	Lifecycle GHG Emission Factor	Units	Note	GHG Emissions (MT CO_2e)
Transmission Hardening	Disposal	Wood Pole	161	2,502	0.11	kg CO_2e/kg disposed	2	45
		Conductor + Bulk of System	1	89,759	0.017	kg CO_2e/kg disposed	3	1.5
		Steel Pole with Concrete Foundation - Steel Pole	18	2,994	0.0083	kg CO_2e/kg disposed	4	0.45
		Steel Pole with Concrete Foundation - Concrete Foundation	18	18,370	0.0083	kg CO_2e/kg disposed	5	2.7
Critical Pole Hardening	Disposal	Steel Pole (Self Supporting, Direct-Buried)	65	2,994	0.0083	kg CO_2e/kg disposed	4	1.6
		Wood Pole	65	2,268	0.11	kg CO_2e/kg disposed	2	17
Critical Circuit Hardening	Disposal	Steel Pole (Self Supporting, Direct-Buried)	40	2,994	0.0083	kg CO_2e/kg disposed	4	1.0
		Wood Pole	40	2,268	0.11	kg CO_2e/kg disposed	2	10
Wildfire Mitigation	Disposal	Conductor + Bulk of System	1	158,308	0.017	kg CO_2e/kg disposed	3	2.7
		Steel Pole (Self Supporting, Direct-Buried)	16	2,994	0.0083	kg CO_2e/kg disposed	4	0.40
		Thermal Cameras	16	18	0.32	kg CO_2e/kg disposed	6	0.092
		Weather Stations	8	36	0.32	kg CO_2e/kg disposed	7	0.092
Substation Flood Monitors	Disposal	Flood Monitors - Sensor	4	4.5	0.0083	kg CO_2e/kg disposed	8	1.5E-04
		Flood Monitors - Casing & Cable	4	0.91	0.48	kg CO_2e/kg disposed	9	0.0017
Proposed Project	Decommissioning	Infrastructure System Decommissioning					10	41
Total Decommissioning and Disposal Emissions								**123**

Notes:

1. Project specifications, assumptions and references are provided in Table 2.
2. The GHG emission factor for the Wood Pole, Wood Pole - Sub-Transmission, and is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Doka, G., market for waste wood, untreated, Rest of world geography ("RoW", e.g. datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database for specific regions), System Model Allocation, cut-off by classification ("Allocation, cut-off by classification", e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
3. The GHG emission factor for the Conductor + Bulk of System is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Doka, G., market for scrap aluminium, Rest of world geography ("RoW", e.g. datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database for specific regions), System Model Allocation, cut-off by classification ("Allocation, cut-off by classification", e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
4. The GHG emission factor for the Steel Pole with Concrete Foundation - Steel Pole, Steel (Direct-Buried) Pole, and Steel (Self-Supporting) Pole is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Hischier, R., market for scrap steel, Rest of world geography ("RoW", e.g. datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database for specific regions), System Model Allocation, cut-off by classification ("Allocation, cut-off by classification", e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
5. The GHG emission factor for the Concrete Foundation for the Steel Pole with Concrete Foundation is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Doka, G., market for waste concrete, Rest of world geography ("RoW", e.g. datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database for specific regions), System Model Allocation, cut-off by classification ("Allocation, cut-off by classification", e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
6. The GHG emission factor for the Thermal Cameras is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Hischier, R., market for used industrial electronic device, WEEE collection, Rest of world geography ("RoW", e.g. datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database for specific regions), System Model Allocation, cut-off by classification ("Allocation, cut-off by classification", e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
7. The GHG emission factor for the Weather Stations is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Hischier, R., market for used industrial electronic device, WEEE collection, Rest of world geography ("RoW", e.g. datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database for specific regions), System Model Allocation, cut-off by classification ("Allocation, cut-off by classification", e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
8. The GHG emission factor for the Flood Monitors - Sensor is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Hischier, R., market for scrap steel, Rest of world geography ("RoW", e.g. datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database for specific regions), System Model Allocation, cut-off by classification ("Allocation, cut-off by classification", e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
9. The GHG emission factor for the Flood Monitors - Casing & Cable is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP for Doka, G., market for waste polyvinylchloride, Rest of world geography ("RoW", e.g. datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database for specific regions), System Model Allocation, cut-off by classification ("Allocation, cut-off by classification", e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database 3.6.
10. Infrastructure System Decommissioning emissions are assumed to be a percentage of construction emissions, as detailed in the Decommissioning and Disposal of Proposed Project, Decommissioning Intensity Relative to Construction inputs in Table 2, which includes all subprograms except Hazard Tree Removal.

Abbreviations:

CO_2e - carbon dioxide equivalent
GHG - greenhouse gas
GLO - global
GWP - global warming potential
IPCC - Intergovernmental Panel on Climate Change
kg - kilogram
MT - metric ton
RoW - rest of world
WEEE - Waste Electrical and Electronic Equipment

References

Doka, G., market for scrap aluminum, RoW, Allocation, cut-off by classification, ecoinvent database version 3.7.1.
Doka, G., market for waste concrete, RoW, Allocation, cut-off by classification, ecoinvent database version 3.7.1.
Doka, G., market for waste polyvinylchloride, RoW, Allocation, cut-off by classification, ecoinvent database version 3.7.1.
Doka, G., market for waste wood, untreated, RoW, Allocation, cut-off by classification, ecoinvent database version 3.7.1.
Hischier, R., market for scrap steel, RoW, Allocation, cut-off by classification, ecoinvent database version 3.7.1.
Hischier, R., market for used industrial electronic device, WEEE collection, RoW, Allocation, cut-off by classification, ecoinvent database version 3.7.1.
Intergovernmental Panel on Climate Change (IPCC), Fifth Assessment Report (AR5), 2014.

ATTACHMENT C
MAUI ELECTRIC TABLES AND CALCULATIONS

Resilience Projects GHG Analysis (Maui)
Maui, HI
Table of Contents

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A1	Appendix Table A1	RMEM	Raw Materials Extraction & Manufacturing GHG Emissions Calculations
A2	Appendix Table A2	Transportation	Material Transportation GHG Emissions Calculations
A3	Appendix Table A3	Construction	Construction GHG Emissions Calculations
A4	Appendix Table A4	Decom. & Disposal	Decommissioning & Disposal GHG Emissions Calculations

Table 1
Project GHG Emissions by Stage
Resilience Projects GHG Analysis (Maui)
Maui, HI

Project Stage		GHG Emissions (MT CO2e)[1,2]
Upstream[3]	Raw Materials Extraction & Manufacturing	2,927
	Transportation	346
	Construction	1,897
Project Operations	Operations & Maintenance	0
Downstream[4]	Transportation	26
	Decommissioning & Disposal	93
	Total Project Operations[5]	**0**
	Total Project Lifecycle	**5,290**

Notes:

1. This table summarizes results from the GHG Analysis undertaken to determine Project GHG Emissions. The supporting calculations are provided in the Calculation tabs for each Project Stage; each tab provides live cell logic, references, calculations and formulas unhidden and unprotected. Note that numbers may not add to totals due to rounding.
2. The Project GHG Emissions estimates are based on the most current information including emissions factors available to Ramboll at the time the analysis was completed.
3. Upstream Transportation and Construction Stages include all construction and transportation activity related to the installation of the proposed project activities, as described in more detail in the Transportation and Construction calculation tables.
4. Downstream decommissioning and disposal emissions include emissions associated with the removal and disposal of Project equipment.
5. Total Project Operations assumed to be zero as there is no net increase in Operations & Maintenance (Use) due to the Project.

Abbreviations:

CO_2e - carbon dioxide equivalent
GHG - greenhouse gas
MT - metric ton

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Table 2
Project Specific Inputs and Assumptions
Resilience Projects GHG Analysis (Maui)
Maui, HI

	Description	Input	Unit	Reference
General Project				
General Project	**Project Name**	Resilience Projects - Maui	--	Provided by Hawaiian Electric.
General Project	**Project Location (Island)**	Maui	--	Provided by Hawaiian Electric.
General Project	**Island Location of Site (Final Port Location)**	Kahului Harbor	--	Determined based on Project Location (Island).
General Project	**Distance from Final Hawai'i Port to Site Location**	5	mi	Provided by Hawaiian Electric. Distance from Kahului Harbor to Maalaea Power Plant.
Transmission Hardening				
General	**General Subprogram Project**			
General	**Subprogram Project Name**	Maui Transmission Hardening	--	Provided by Hawaiian Electric.
General	**Subprogram Project Lifetime**	58	yr	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Wood Pole**	Yes		Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Number of Wood Poles**	130	item	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Weight of Each Wood Pole**	5,515	lb	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Height of Each Wood Pole**	70	ft	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Location of Wood Pole Manufacturer**	Tacoma, Washington	--	Confirmed by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Equipment Lifetime (Expected Useful Life of the Equipment)**	58	yr	Confirmed by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Number of Equipment over Project Lifetime**	130	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
Utility Poles (Wood or Steel)	**Final Wood Pole Disposal Location**	Local (Island Location of Site)	--	Wood pole disposal location provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**End of Life Treatment**	Decommissioning and disposal	--	Confirmed by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Steel Pole with Concrete Foundation**	Yes		Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Number of Steel Poles (w/ concrete foundation)**	15	item	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Weight of Each Steel Pole**	6,600	lb	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Height of Steel Poles (w/ concrete foundation)**	75	ft	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Volume of Concrete Foundation (length x width x height)**	270	ft^3	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Weight of Each Concrete Foundation**	40,500	lb	Calculated based on information provided and concrete density of 150 lb/ft^3.
Utility Poles (Wood or Steel)	**Location of Utility Pole Manufacturer - Steel Poles (w/ Concrete Foundation)**	Valley, Nebraska	--	Confirmed by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Equipment Lifetime (Expected Useful Life of the Equipment)**	58	yr	Confirmed by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Number of Equipment over Project Lifetime**	15	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
Utility Poles (Wood or Steel)	**Final Concrete Disposal Location**	Local (Island Location of Site)	--	Concrete disposal location provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**End of Life Treatment**	Decommissioning and disposal	--	Confirmed by Hawaiian Electric.
Critical Pole Hardening				
General	**General Subprogram Project**			
General	**Subprogram Project Name**	Maui Critical Pole Hardening	--	Provided by Hawaiian Electric.
General	**Subprogram Project Lifetime**	58	yr	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Steel Pole (Self-Supporting, Direct-Buried)**	Yes		Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Number of Steel Poles**	40	item	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Weight of Each Steel Pole**	6,600	lb	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Height of Steel Poles**	75	ft	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Location of Utility Pole Manufacturer - Steel Poles**	Valley, Nebraska	--	Confirmed by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Equipment Lifetime (Expected Useful Life of the Equipment)**	58	yr	Confirmed by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Number of Equipment over Project Lifetime**	40	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
Utility Poles (Wood or Steel)	**End of Life Treatment**	Decommissioning and disposal	--	Confirmed by Hawaiian Electric.

Table 2
Project Specific Inputs and Assumptions
Resilience Projects GHG Analysis (Maui)
Maui, HI

	Description	Input	Unit	Reference
Utility Poles (Wood or Steel)	**Wood Pole**	Yes		Provided by Hawaiian Electric.
	Number of Wood Poles	40	item	Provided by Hawaiian Electric.
	Height of Each Wood Pole	65	ft	Provided by Hawaiian Electric.
	Weight of Each Wood Pole	5,000	lb	Provided by Hawaiian Electric.
	Location of Wood Pole Manufacturer	Tacoma, Washington	--	Confirmed by Hawaiian Electric.
	Equipment Lifetime (Expected Useful Life of the Equipment)	58	yr	Confirmed by Hawaiian Electric.
	Number of Equipment over Project Lifetime	40	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	Final Wood Pole Disposal Location	Local (Island Location of Site)	--	Wood pole disposal location provided by Hawaiian Electric.
	End of Life Treatment	Decommissioning and disposal	--	Confirmed by Hawaiian Electric.
Critical Circuit Hardening				
General	**General Subprogram Project**			
	Subprogram Project Name	Maui Critical Circuit Hardening	--	Provided by Hawaiian Electric.
	Subprogram Project Lifetime	58	yr	Provided by Hawaiian Electric.
Utility Poles (Wood or Steel)	**Steel Pole (Self-Supporting, Direct-Buried)**	Yes		Provided by Hawaiian Electric.
	Number of Steel Poles	40	item	Provided by Hawaiian Electric.
	Weight of Each Steel Pole	6,600	lb	Provided by Hawaiian Electric.
	Height of Steel Poles	75	ft	Provided by Hawaiian Electric.
	Location of Utility Pole Manufacturer - Steel Poles	Valley, Nebraska	--	Confirmed by Hawaiian Electric.
	Equipment Lifetime (Expected Useful Life of the Equipment)	58	yr	Confirmed by Hawaiian Electric.
	Number of Equipment over Project Lifetime	40	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	End of Life Treatment	Decommissioning and disposal	--	Confirmed by Hawaiian Electric.
	Wood Pole	Yes		Provided by Hawaiian Electric.
	Number of Wood Poles	40	item	Provided by Hawaiian Electric.
	Height of Each Wood Pole	65	ft	Provided by Hawaiian Electric.
	Weight of Each Wood Pole	5,000	lb	Provided by Hawaiian Electric.
	Location of Wood Pole Manufacturer	Tacoma, Washington	--	Confimed by Hawaiian Electric.
	Equipment Lifetime (Expected Useful Life of the Equipment)	58	yr	Confirmed by Hawaiian Electric.
	Number of Equipment over Project Lifetime	40	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	Final Wood Pole Disposal Location	Local (Island Location of Site)	--	Wood pole disposal location provided by Hawaiian Electric.
	End of Life Treatment	Decommissioning and disposal	--	Confirmed by Hawaiian Electric.
Wildfire Mitigation				
General	**General Subprogram Project**			
	Subprogram Project Name	Maui Wildfire Mitigation	--	Provided by Hawaiian Electric.
	Subprogram Project Lifetime	55	yr	Provided by Hawaiian Electric.
Overhead Transmission Line	**Overhead Transmission Line**	Yes		Provided by Hawaiian Electric.
	Transmission Line Voltage	23	kV	Provided by Hawaiian Electric.
	Transmission Line Material	Aluminum Conductor	--	Confirmed by Hawaiian Electric.
	Location of Transmission Line Manufacturer	Florence, Alabama	--	Confirmed by Hawaiian Electric.
	Length of Transmission Line (linear feet)	42,240	ft	Provided by Hawaiian Electric.
	Conductor + Bulk of System	158,308	kg	Conservatively estimated based on material requirements per km of 150 kV aerial transmission line from Table S5 of Jorge et al. (2011a), and assumed to account for bulk of transmission line system (e.g. circuit breakers, insulators, conductors).[1]
	Equipment Lifetime (Expected Useful Life of the Equipment)	58	yr	Confirmed by Hawaiian Electric.
	Number of Equipment over Project Lifetime	1	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	End of Life Treatment	Decommissioning and disposal	--	Confirmed by Hawaiian Electric.

Table 2
Project Specific Inputs and Assumptions
Resilience Projects GHG Analysis (Maui)
Maui, HI

	Description	Input	Unit	Reference
Utility Poles (Wood or Steel)	**Steel Pole (Self-Supporting, Direct-Buried)**	Yes		Provided by Hawaiian Electric.
	Number of Steel Poles	16	item	Provided by Hawaiian Electric.
	Weight of Each Steel Pole	6,600	lb	Provided by Hawaiian Electric.
	Height of Steel Poles	75	ft	Provided by Hawaiian Electric.
	Location of Utility Pole Manufacturer - Steel Poles	Valley, Nebraska	--	Confirmed by Hawaiian Electric.
	Equipment Lifetime (Expected Useful Life of the Equipment)	58	yr	Provided by Hawaiian Electric.
	Number of Equipment over Project Lifetime	16	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	End of Life Treatment	Decommissioning and disposal	--	Confirmed by Hawaiian Electric.
Misc. Project Equipment	**Thermal Cameras**	Yes		Provided by Hawaiian Electric.
	Number of Cameras	16	item	Provided by Hawaiian Electric.
	Weight of Each Camera	40	lb	Provided by Hawaiian Electric.
	Manufacturer / Model of Cameras	FLIR / Model: A310PT	--	Provided by Hawaiian Electric.
	Location of Camera Manufacturer	Goleta, California	--	Provided by Hawaiian Electric.
	Equipment Lifetime (Expected Useful Life of the Equipment)	55	yr	Provided by Hawaiian Electric.
	Number of Equipment over Project Lifetime	16	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	End of Life Treatment	Decommissioning and disposal	--	Provided by Hawaiian Electric.
	Weather Stations	Yes		Provided by Hawaiian Electric.
	Number of Weather Stations	8	item	Provided by Hawaiian Electric.
	Weight of Each Weather Station	80	lb	Provided by Hawaiian Electric.
	Manufacturer / Model of Weather Stations	Orion Weather Station, Columbia Weather Systems	--	Provided by Hawaiian Electric.
	Additional Components Included for Weather Stations	Includes sensor module, surge protector, interface, Weather MicroServer, LCD display console	--	Provided by Hawaiian Electric.
	Location of Weather Station Manufacturer	Hillsboro, Oregon	--	Provided by Hawaiian Electric.
	Equipment Lifetime (Expected Useful Life of the Equipment)	55	--	Provided by Hawaiian Electric.
	Number of Equipment over Project Lifetime	8	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	End of Life Treatment	Decommissioning and disposal	--	Provided by Hawaiian Electric.
Substation Flood Monitors				
General	**General Subprogram Project**			
	Subprogram Project Name	Maui Substation Flood Monitors	--	Provided by Hawaiian Electric.
	Subprogram Project Lifetime	55	yr	Provided by Hawaiian Electric.
Misc. Project Equipment	**Flood Monitors**	Yes		Provided by Hawaiian Electric.
	Number of Flood Monitors	4	item	Provided by Hawaiian Electric.
	Flood Monitors Voltage	10	V	Provided by Hawaiian Electric.
	Weight of Each Flood Monitor Sensor (Stainless Steel Alloy)	10	lb	Provided by Hawaiian Electric.
	Weight of Each Flood Monitor Casing (PVC)	1.0	lb	Provided by Hawaiian Electric.
	Weight of Each Flood Monitor Cable (PVC)	1.0	lb	Provided by Hawaiian Electric.
	Manufacturer / Model of Flood Monitors	Flygt, a Xylem Brand	--	Based on information provided by Hawaiian Electric.
	Location of Flood Monitors Manufacturer	Batavia, New York	--	Confirmed by Hawaiian Electric. Based on Flygt, Xylem office locations in New York.
	Equipment Lifetime (Expected Useful Life of the Equipment)	55	yr	Provided by Hawaiian Electric.
	Number of Equipment over Project Lifetime	4	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
	End of Life Treatment	Decommissioning and disposal	--	Provided by Hawaiian Electric.

Table 2
Project Specific Inputs and Assumptions
Resilience Projects GHG Analysis (Maui)
Maui, HI

	Description	Input	Unit	Reference
Distribution Feeder Ties				
General	**General Subprogram Project**			
General	**Subprogram Project Name**	Maui Distribution Feeder Ties	--	Provided by Hawaiian Electric.
General	**Subprogram Project Lifetime**	27	yr	Provided by Hawaiian Electric.
Misc. Project Equipment	**Voltage Regulator**	Yes		Provided by Hawaiian Electric.
Misc. Project Equipment	**Number of Voltage Regulators**	6	item	Provided by Hawaiian Electric.
Misc. Project Equipment	**Voltage Regulator Rating**	167	kVA	Provided by Hawaiian Electric.
Misc. Project Equipment	**Weight of Voltage Regulator**	2,125	lb	Provided by Hawaiian Electric.
Misc. Project Equipment	**Location of Voltage Regulator Manufacturer**	Tacoma, Washington	--	Provided by Hawaiian Electric.
Misc. Project Equipment	**Equipment Lifetime (Expected Useful Life of the Equipment)**	30	yr	Confirmed by Hawaiian Electric.
Misc. Project Equipment	**Number of Equipment over Project Lifetime**	6	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
Misc. Project Equipment	**End of Life Treatment**	Decommissioning and disposal	--	Provided by Hawaiian Electric.
Transformers, Switches, Switchgears, Circuit	**Transformer (Rating 3-500 kVA)**	Yes		Provided by Hawaiian Electric.
Transformers, Switches, Switchgears, Circuit	**Number of Transformers**	6	item	Provided by Hawaiian Electric.
Transformers, Switches, Switchgears, Circuit	**Transformer Rating**	500	kVA	Provided by Hawaiian Electric.
Transformers, Switches, Switchgears, Circuit	**Weight of Each Transformer**	3,294	lb	Provided by Hawaiian Electric.
Transformers, Switches, Switchgears, Circuit	**Location of Transformer Manufacturer**	San Luis Potosi, Mexico	--	Confirmed by Hawaiian Electric.
Transformers, Switches, Switchgears, Circuit	**Equipment Lifetime (Expected Useful Life of the Equipment)**	27	yr	Confirmed by Hawaiian Electric.
Transformers, Switches, Switchgears, Circuit Breakers	**Number of Equipment over Project Lifetime**	6	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
Transformers, Switches, Switchgears, Circuit Breakers	**End of Life Treatment**	Decommissioning and disposal	--	Confirmed by Hawaiian Electric.
Transformers, Switches, Switchgears, Circuit Breakers	**Switch**	Yes		Provided by Hawaiian Electric.
Transformers, Switches, Switchgears, Circuit Breakers	**Number of Switches**	2	item	Provided by Hawaiian Electric.
Transformers, Switches, Switchgears, Circuit Breakers	**Voltage of Switches**	12	kV	Provided by Hawaiian Electric.
Transformers, Switches, Switchgears, Circuit Breakers	**Weight of Switches**	350	lb	Confirmed by Hawaiian Electric.
Transformers, Switches, Switchgears, Circuit Breakers	**Specification of Switches**	Inertia Engineering	--	Confirmed by Hawaiian Electric.
Transformers, Switches, Switchgears, Circuit Breakers	**Location of Switches Manufacturer**	Stockton, California	--	Confirmed by Hawaiian Electric.
Transformers, Switches, Switchgears, Circuit Breakers	**Equipment Lifetime (Expected Useful Life of the Equipment)**	53	yr	Confirmed by Hawaiian Electric.
Transformers, Switches, Switchgears, Circuit Breakers	**Number of Equipment over Project Lifetime**	2	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
Transformers, Switches, Switchgears, Circuit Breakers	**End of Life Treatment**	Decommissioning and disposal	--	Confirmed by Hawaiian Electric.
Transformers, Switches, Switchgears, Circuit Breakers	**Transformer - Concrete Pad**	Yes		Provided by Hawaiian Electric.
Transformers, Switches, Switchgears, Circuit Breakers	**Number of Concrete Pads**	2	item	Provided by Hawaiian Electric.
Transformers, Switches, Switchgears, Circuit Breakers	**Transformer Concrete Pad Thickness**	1.5	ft/per pad	Confirmed by Hawaiian Electric.
Transformers, Switches, Switchgears, Circuit Breakers	**Transformer Concrete Pad Dimensions - Length**	9.7	ft	Confirmed by Hawaiian Electric.
Transformers, Switches, Switchgears, Circuit Breakers	**Transformer Concrete Pad Dimensions - Width**	21	ft	Confirmed by Hawaiian Electric.
Transformers, Switches, Switchgears, Circuit Breakers	**Cubic Feet of Concrete**	305	ft^3	Calculated based on information confirmed by Hawaiian Electric.
Transformers, Switches, Switchgears, Circuit Breakers	**Weight of Concrete**	45,675	lb	Calculated based on concrete density of 150 lb/ft^3 and information provided.
Transformers, Switches, Switchgears, Circuit Breakers	**Location of Concrete Manufacturer**	Maui, Hawai'i	--	Confirmed by Hawaiian Electric.
Transformers, Switches, Switchgears, Circuit Breakers	**Equipment Lifetime (Expected Useful Life of the Equipment)**	55	yr	Confirmed by Hawaiian Electric.
Transformers, Switches, Switchgears, Circuit Breakers	**Number of Equipment over Project Lifetime**	2	item	Estimated based on lifetime of equipment and Subprogram Project lifetime.
Transformers, Switches, Switchgears, Circuit Breakers	**Final Concrete Disposal Location**	Local (Island Location of Site)	--	Concrete disposal location provided by Hawaiian Electric.
Transformers, Switches, Switchgears, Circuit Breakers	**End of Life Treatment**	Decommissioning and disposal	--	Confirmed by Hawaiian Electric.
Hazard Tree Removal				
General	**General Subprogram Project**			
General	**Subprogram Project Name**	Maui Hazard Tree Removal	--	Provided by Hawaiian Electric.
Tree Removal	**Tree Removal**	Yes		Provided by Hawaiian Electric.
Tree Removal	**Total number of Trees to be Removed**	800	item	Provided by Hawaiian Electric.
Tree Removal	**Final Disposal Location**	Abandoned in Place	--	Provided by Hawaiian Electric. The trees will be lopped and scattered on site.

Table 2
Project Specific Inputs and Assumptions
Resilience Projects GHG Analysis (Maui)
Maui, HI

	Description	Input	Unit	Reference
Use	**Use (General)**			
	Changes to O&M	No net increase in O&M expected from project	--	Provided by Hawaiian Electric.
Decom. & Disposal	**Decommissioning and Disposal of Proposed Project**			
	Decommissioning Intensity Relative to Construction	3%	%	Provided by Hawaiian Electric.
GWP's	**Global Warming Potentials**			
	Carbon Dioxide	1	g CO_2e/g CO_2	Intergovernmental Panel on Climate Change (IPCC), Fifth Assessment Report (AR5), 2014.[2]
	Methane	28	g CO_2e/g CH_4	
	Nitrous Oxide	265	g CO_2e/g N_2O	

Abbreviations:

CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
ft - feet
ft^3 - cubic feet
GHG - greenhouse gas
GWP - global warming potentials
g - gram
IPCC - Intergovernmental Panel on Climate Change
kg - kilogram
kV - kilovolt
kVA - kilovolt-ampere
lb - pounds
mi - miles
MVA - megavolt-ampere
N_2O - nitrous oxide
O&M - operations and maintenance
yr - year

References:

1. Jorge, R. S.; Hawkins, T. R.; Hertwich, E. G. (2011a). Life cycle assessment of electricity transmission and distribution - part 1: power lines and cables. International Journal of Life Cycle Assessment, 17, 1. Available at: https://doi.org/10.1007/s11367-011-0335-1.

2. Intergovernmental Panel on Climate Change (IPCC), Fifth Assessment Report (AR5), 2014.

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Table 3
Project Specific Construction Inputs and Assumptions
Resilience Projects GHG Analysis (Maui)
Maui, HI

	Description	Input	Unit	Reference
Transmission Hardening				
General	**General Subprogram Project Construction**			
	Construction Start Date (mm/dd/yyyy)	6/1/2023	--	Provided by Hawaiian Electric.
	Construction End Date (mm/dd/yyyy)	1/30/2026	--	Provided by Hawaiian Electric.
	Construction Site Area	N/A	acres	Provided by Hawaiian Electric.
Transmission Hardening	**Wood Pole Installation**	Yes		
	Strato-Tower	1	#	Confirmed by Hawaiian Electric.
	Pick-Up Truck	2	#	
	Hyliner	1	#	
	Number of Days	65	days	Provided by Hawaiian Electric. Assuming two poles installed per day.
	Number of Workers	8	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	5	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
	Steel Pole Installation	Yes		
	Strato-Tower	1	#	Confirmed by Hawaiian Electric.
	Pick-Up Truck	2	#	
	Hyliner	1	#	
	Number of Days	15	days	Provided by Hawaiian Electric. Assuming one pole installed per day.
	Number of Workers	8	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	5	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
Critical Pole Hardening				
General	**General Subprogram Project Construction**			
	Construction Start Date (mm/dd/yyyy)	9/1/2023	--	Provided by Hawaiian Electric.
	Construction End Date (mm/dd/yyyy)	4/30/2026	--	Provided by Hawaiian Electric.
	Construction Site Area	N/A	acres	Provided by Hawaiian Electric.
Critical Pole Hardening	**Wood Pole Installation**	Yes		
	Strato-Tower	1	#	Confirmed by Hawaiian Electric.
	Pick-Up Truck	2	#	
	Hyliner	1	#	
	Number of Days	30	days	Provided by Hawaiian Electric. Assuming one pole installed per day and 75% are accessible.
	Number of Workers	8	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	5	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
	Wood Pole Installation - Helicopter	Yes		
	Helicopter	1	#	
	Number of Days	10	days	Provided by Hawaiian Electric. Assuming one pole installed per day and 25% are inaccessible.
	Number of Workers	12	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	5	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
	Helicopter Horsepower	9,000	horsepower	Confirmed by developer. Default helicopter horsepower was selected based on the helicopter model with specifications in line with the scope of this construction activity (i.e., heavy lifting). Emission factors are consistent with the Valley-Ivyglen and Alberhill System Project, which quantified GHG emissions from helicopter use during construction.[1]
	Helicopter Total Operating Hours	48	hours/helicopter	Helicopter total operating hours based on the number of days in the construction activity, the average usage hours provided by Hawaiian Electric (6 hours/day), and the utilization rate of the helicopter.
	Steel Pole Installation	Yes		
	Strato-Tower	1	#	Confirmed by Hawaiian Electric.
	Pick-Up Truck	2	#	
	Hyliner	1	#	
	Number of Days	30	days	Provided by Hawaiian Electric. Assuming one pole installed per day and 75% are accessible.
	Number of Workers	8	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	5	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
	Steel Pole Installation - Helicopter	Yes		
	Helicopter	1	#	Provided by Hawaiian Electric.
	Number of Days	10	days	Provided by Hawaiian Electric. Assuming one pole installed per day and 25% are inaccessible.
	Number of Workers	12	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	5	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
	Helicopter Horsepower	9,000	horsepower	Confirmed by developer. Default helicopter horsepower was selected based on the helicopter model with specifications in line with the scope of this construction activity (i.e., heavy lifting). Emission factors are consistent with the Valley-Ivyglen and Alberhill System Project, which quantified GHG emissions from helicopter use during construction.[1]
	Helicopter Total Operating Hours	48	hours/helicopter	Helicopter total operating hours based on the number of days in the construction activity, the average usage hours provided by Hawaiian Electric (6 hours/day), and the utilization rate of the helicopter.

Table 3
Project Specific Construction Inputs and Assumptions
Resilience Projects GHG Analysis (Maui)
Maui, HI

	Description	Input	Unit	Reference
Critical Circuit Hardening				
General	**General Subprogram Project Construction**			
	Construction Start Date (mm/dd/yyyy)	9/1/2023	--	Provided by Hawaiian Electric.
	Construction End Date (mm/dd/yyyy)	6/30/2026	--	Provided by Hawaiian Electric.
	Construction Site Area	N/A	acres	Provided by Hawaiian Electric.
Critical Circuit Hardening	**Wood Pole Installation**	Yes		
	Strato-Tower	1	#	Confirmed by Hawaiian Electric.
	Pick-Up Truck	2	#	
	Hyliner	1	#	
	Number of Days	20	days	Provided by Hawaiian Electric. Assuming two poles installed per day.
	Number of Workers	8	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	5	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
	Steel Pole Installation	Yes	--	
	Strato-Tower	1	#	Confirmed by Hawaiian Electric.
	Pick-Up Truck	2	#	
	Hyliner	1	#	
	Number of Days	20	days	Provided by Hawaiian Electric. Assuming two poles installed per day.
	Number of Workers	8	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	5	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
Wildfire Mitigation				
General	**General Subprogram Project Construction**			
	Construction Start Date (mm/dd/yyyy)	2/21/2024	--	Provided by Hawaiian Electric.
	Construction End Date (mm/dd/yyyy)	9/1/2026	--	Provided by Hawaiian Electric.
	Construction Site Area	N/A	acres	Provided by Hawaiian Electric.
Wildfire Mitigation	**Steel Pole Installation**	Yes		
	Strato-Tower	1	#	Confirmed by Hawaiian Electric.
	Pick-Up Truck	2	#	
	Hyliner	1	#	
	Number of Days	16	days	Provided by Hawaiian Electric. Assuming 1 pole installed per day.
	Number of Workers	8	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	5	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
	Overhead Cable Installation	Yes		
	Strato-Tower	1	#	Confirmed by Hawaiian Electric.
	Pick-Up Truck	2	#	
	Hyliner	1	#	
	Number of Days	85	days	Provided by Hawaiian Electric.
	Number of Workers	8	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	5	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
	Install Thermal Cameras	Yes		
	Bucket Truck	1	#	Provided by Hawaiian Electric.
	Pick-Up Truck	1	#	
	Number of Days	8	days	Provided by Hawaiian Electric.
	Number of Workers	4	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	5	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
	Install Weather Stations	Yes		
	Bucket Truck	1	#	Provided by Hawaiian Electric.
	Pick-Up Truck	1	#	
	Number of Days	8	days	Provided by Hawaiian Electric.
	Number of Workers	4	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	5	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
Substation Flood Monitors				
General	**General Subprogram Project Construction**			
	Construction Start Date (mm/dd/yyyy)	2/21/2023	--	Provided by Hawaiian Electric.
	Construction End Date (mm/dd/yyyy)	12/23/2025	--	Provided by Hawaiian Electric.
	Construction Site Area	N/A	acres	Provided by Hawaiian Electric.
Substation Flood Monitors	**Install Flood Monitors**	Yes		
	Bucket Truck	1	#	Provided by Hawaiian Electric.
	Pick-Up Truck	1	#	
	Number of Days	4	days	Provided by Hawaiian Electric.
	Number of Workers	4	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	5	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.

Table 3
Project Specific Construction Inputs and Assumptions
Resilience Projects GHG Analysis (Maui)
Maui, HI

	Description	Input	Unit	Reference
Distribution Feeder Ties				
General	**General Subprogram Project Construction**			
	Construction Start Date (mm/dd/yyyy)	5/1/2023	--	Provided by Hawaiian Electric.
	Construction End Date (mm/dd/yyyy)	9/1/2026	--	Provided by Hawaiian Electric.
	Construction Site Area	N/A	acres	Provided by Hawaiian Electric.
Distribution Feeder Ties	**Switch Installation**	Yes		
	Vans	2	#	Confirmed by Hawaiian Electric.
	Boom Truck	1	#	
	Flat Bed	1	#	
	Pick-Up Truck	1	#	
	Generator	1	#	
	Number of Days	2	days	Provided by Hawaiian Electric.
	Number of Workers	8	workers	Confirmed by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	5	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
	Transformer Installation	Yes		
	Pick-Up Truck	2	#	Confirmed by Hawaiian Electric.
	Hyliner	1	#	
	Number of Days	2	days	Provided by Hawaiian Electric.
	Number of Workers	5	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	5	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
	Voltage Regulators Installation	Yes		
	Pick-Up Truck	2	#	Provided by Hawaiian Electric.
	Hyliner	1	#	
	Number of Days	2	days	Provided by Hawaiian Electric.
	Number of Workers	5	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	5	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.
Hazard Tree Removal				
General	**General Subprogram Project Construction**			
	Construction Start Date (mm/dd/yyyy)	6/1/2023	--	Provided by Hawaiian Electric.
	Construction End Date (mm/dd/yyyy)	9/30/2026	--	Provided by Hawaiian Electric.
	Construction Site Area	N/A	acres	Provided by Hawaiian Electric.
Hazard Tree Removal	**Tree Removal**	Yes		
	Pick-Up Truck	2	#	Provided by Hawaiian Electric.
	Bucket Truck	1	#	
	Number of Days	800	days	Provided by Hawaiian Electric.
	Number of Workers	4	workers	Provided by Hawaiian Electric.
	Excavated Material to be Removed	0	ft^3	Confirmed by Hawaiian Electric.
	Worker Trip Length to/from the Site	5	miles/one-way trip	Provided by Hawaiian Electric.
	Offsite Hauling Trip Length	0	miles/one-way trip	Confirmed by Hawaiian Electric.

Abbreviations:
- number
ft^3 - cubic feet

References:
1. Valley-Ivyglen and Alberhill System Project. Available at: https://www.cpuc.ca.gov/environment/info/ene/alberhill/Alberhill.html

RAMBOLL

Appendix Table A1
Raw Materials Extraction & Manufacturing GHG Emissions Calculations
Resilience Projects GHG Analysis (Maui)
Maui, HI

System	Description	Total Items[1]	Weight per Item (kg)[1]	Rating (MVA)[1]	Lifecycle GHG Emission Factor	Units	Note	GHG Emissions (MT CO_2e)
Transmission Hardening	Wood Pole	130	2,502	--	0.11	kg CO_2e/kg	2	34
	Steel Pole with Concrete Foundation - Steel Pole	15	2,994	--	4.4	kg CO_2e/kg	3	197
	Steel Pole with Concrete Foundation - Concrete Foundation	15	18,370	--	0.10	kg CO_2e/kg	4	29
Critical Pole Hardening	Steel Pole (Self-Supporting, Direct-Buried)	40	2,994	--	4.4	kg CO_2e/kg	3	525
	Wood Pole	40	2,268	--	0.11	kg CO_2e/kg	2	10
Critical Circuit Hardening	Steel Pole (Self-Supporting, Direct-Buried)	40	2,994	--	4.4	kg CO_2e/kg	3	525
	Wood Pole	40	2,268	--	0.11	kg CO_2e/kg	2	10
Wildfire Mitigation	Conductor + Bulk of System	1	158,308	--	8.2	kg CO_2e/kg	5	1,302
	Steel Pole (Self-Supporting, Direct-Buried)	16	2,994	--	4.4	kg CO_2e/kg	3	210
	Thermal Cameras	16	18	--	18	kg CO_2e/kg	6	5.2
	Weather Stations	8	36	--	36	kg CO_2e/kg	7	11
Substation Flood Monitors	Flood Monitors - Sensor	4	4.5	--	4.4	kg CO_2e/kg	8	0.080
	Flood Monitors - Casing & Cable	4	0.91	--	2.6	kg CO_2e/kg	9	0.0094
Distribution Feeder Ties	Voltage Regulator	6	964	--	4.4	kg CO_2e/kg	9	25
	Transformer (Rating 3-500 kVA)	6	--	0.50	6,237	kg CO_2e/item	10	37
	Switch	2	159	--	2.7	kg CO_2e/kg	11	0.85
	Transformer - Concrete Pad	2	20,718	--	0.10	kg CO_2e/kg	12	4.3
							Total	**2,927**

Notes:

1. Project specifications, assumptions and references are provided in Table 2.
2. The GHG emission factor for the Wood Pole - Sub-Transmission and Wood Pole - Distribution is estimated from Bolin and Smith, 2011 (Table 2). This factor represents total CO_2e emissions per utility pole for the pole production and treating life cycle stages. As defined by Bolin and Smith, 2011, pole production for the wood pole includes: "replanting a harvested area of forest, growing and maintaining the forest plantation until harvest, harvesting of the trees, drying, and milling and associated transportation" and treating includes: "pole peeling, pole drying, preservative manufacture and transport, treatment, storage of untreated and treated poles, releases, and transportation of poles to the utility yard". The estimated emissions from Bolin and Smith were conservatively scaled based on the weight of each pole.
3. The GHG emission factor for the Steel Pole with Concrete Foundation - Steel Pole and Steel (Self-Supporting) Pole is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Classen, M., market for steel, chromium steel 18/8, hot rolled, global geography ("GLO", e.g. value represents activities which are considered to be an average valid for all countries in the world, and are calculated as the average of the regional datasets that contain information for the activity), System Model Allocation, cut-off by classification (“Allocation, cut-off by classification”, e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
4. The GHG emission factor for the Concrete Foundations of Steel Pole with Concrete Foundation is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Martineau, G., market for concrete, 20MPa, North America geography ("RNA", e.g. value represents activities which are considered to be an average valid for all countries in North America, and are calculated as the average of the regional datasets that contain information for the activity), System Model Allocation, cut-off by classification (“Allocation, cut-off by classification”, e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1. The emission factor is normalized based on the density of concrete, approximately 2,335 kg/m^3, provided in documentation of the dataset.
5. The GHG emission factor for the Conductor + Bulk of System is an estimate from Jorge, et al. (2011a) estimated emissions for a 150 kV overhead transmission line (Figure 1a), scaled based on the weight of the transmission line. The estimated emissions for an overhead transmission line are used because the transmission line material for this Project is of similar material to that of the overhead transmission line from Jorge, et al. (2011a). This factor represents total CO_2e emissions per kg of transmission line for components such as conductors, insulators, installation, and usage. Installation and usage together account for less than approximately 4% of total emissions, so these are conservatively included in addition to the Construction emissions estimated in Tables A3.
6. The GHG emission factor for Thermal Cameras is derived from Hillerström, H. and Troborg, U (2010) materials and manufacturing CO_2 emissions for a security camera as provided in Table 7. The emission factor was normalized based on the weight of the security camera used in the study, AXIS Q6032-E.
7. The GHG emission factor for the Weather Stations is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Hischier, R., market for electronics, for control units, global geography ("GLO", e.g. value represents activities which are considered to be an average valid for all countries in the world, and are calculated as the average of the regional datasets that contain information for the activity), System Model Allocation, cut-off by classification (“Allocation, cut-off by classification”, e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
8. The GHG emission factor for the Flood Monitors - Sensor is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Classen, M., market for steel, chromium steel 18/8, hot rolled, global geography ("GLO", e.g. value represents activities which are considered to be an average valid for all countries in the world, and are calculated as the average of the regional datasets that contain information for the activity), System Model Allocation, cut-off by classification (“Allocation, cut-off by classification”, e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
9. The GHG emission factor for the Flood Monitors - Casing & Cable is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Hischier, R., market for polyvinylchloride, bulk polymerised, global geography ("GLO", e.g. value represents activities which are considered to be an average valid for all countries in the world, and are calculated as the average of the regional datasets that contain information for the activity), System Model Allocation, cut-off by classification (“Allocation, cut-off by classification”, e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
10. The GHG emission factor for the Transformer is estimated from Jorge, et al. (2011b, Figure 1). These factors represent the CO_2e emissions per item associated with raw material extraction and production for the transformer. Jorge et al., 2011b estimated emissions from transformers of ratings between 0.35 to 500 MVA; the emission factor for the Project's transformer was calculated based on the emissions per transformer rating for the Jorge transformer with the closest rating (using geometric mean) to the Project's transformer, scaled to the Project's rating.
11. The GHG emission factor for the Switch is estimated from Jorge, et al., 2011b (Figure 2). This factor represent the CO_2e emissions per item associated with raw material extraction and production for the Switch. The emission factor for the Switch is based on the emission factor for the Center Breaker Disconnector from Jorge et al., 2011b, normalized based on weight provided in Table S14 of Jorge, et al. 2011b.
12. The GHG emissions factor for the Transformer - Concrete Pad is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Martineau, G., market for concrete, 20MPa, North America geography ("RNA", e.g. value represents activities which are considered to be an average valid for all countries in North America, and are calculated as the average of the regional datasets that contain information for the activity), System Model Allocation, cut-off by classification (“Allocation, cut-off by classification”, e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1. The emission factor is normalized based on the density of concrete, approximately 2,335 kg/m3, provided in documentation of the dataset.

Abbreviations:

CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
GHG - greenhouse gas
GWP - global warming potential
IPCC - Intergovernmental Panel on Climate Change
kg - kilogram
kV - kilovolts
kVA - kilovolt-ampere
m^3 - cubic meter
MPa - megapascal
MT - metric ton
MVA - megavolt-ampere

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Appendix Table A2
Material Transportation GHG Emissions Calculations
Resilience Projects GHG Analysis (Maui)
Maui, HI

Mode of Travel	Emission Factors[1,2]							
	CO_2	units	CH_4	units	N_2O	units	CO_2e	units
Truck	0.21	kg/ton-mi	2.0E-06	kg/ton-mi	4.9E-06	kg/ton-mi	0.15	kg/MT-km
Ship	--	kg/ton-mi	--	kg/ton-mi	--	kg/ton-mi	0.0066	kg/MT-km

Transportation Emissions:

Shipment Item		Weight per Item (kg)	Total Items	Net Weight (MT)[3]	Phase	Origin	Destination	Mode[4]	Trip length (mi or nmi)[5]	Trip Type[6]	GHG Emissions (MT CO_2e) Per Segment	GHG Emissions (MT CO_2e) Per Shipment Item Type
Transmission Hardening	Wood Pole	2,502	130	325	Upstream	Tacoma, Washington (Manufacturer/Warehouse)	Tacoma (Port)	Truck	5.0	One-Way	0.38	15.1
						Tacoma (Port)	Los Angeles (Port)	Ship	1,165	One-Way	4.7	
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	8.9	
						Honolulu Harbor (Port)	Kahului Harbor (Port)	Ship	100	One-Way	0.40	
						Kahului Harbor (Port)	Site	Truck	5.0	Roundtrip	0.76	
					Downstream	Site	Hawai'i Materials Recycling	Truck	23	Roundtrip	3.5	3.5
	Steel Pole with Concrete Foundation	21,364	15	320	Upstream	Valley, Nebraska (Manufacturer/Warehouse)	Los Angeles (Port)	Truck	1,562	One-Way	117	127
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	8.8	
						Honolulu Harbor (Port)	Kahului Harbor (Port)	Ship	100	One-Way	0.39	
						Kahului Harbor (Port)	Site	Truck	5.0	Roundtrip	0.75	
					Downstream	Site	Hawai'i Materials Recycling	Truck	23	Roundtrip	3.5	3.5
	Steel Pole (Self-Supporting, Direct-Buried)	2,994	40	120	Upstream	Valley, Nebraska (Manufacturer/Warehouse)	Los Angeles (Port)	Truck	1,562	One-Way	44	47
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	3.3	
						Honolulu Harbor (Port)	Kahului Harbor (Port)	Ship	100	One-Way	0.15	
						Kahului Harbor (Port)	Site	Truck	5.0	Roundtrip	0.28	
					Downstream	Site	Kahului Harbor (Port)	Truck	5.0	Roundtrip	0.28	4.4
						Kahului Harbor (Port)	Honolulu Harbor (Port)	Ship	100	One-Way	0.15	
						Honolulu Harbor (Port)	Los Angeles (Port)	Ship	2,231	One-Way	3.3	
						Los Angeles (Port)	Los Angeles (Scrap Yard)	Truck	25	One-Way	0.70	
	Wood Pole	2,268	40	91	Upstream	Tacoma, Washington (Manufacturer/Warehouse)	Tacoma (Port)	Truck	5.0	One-Way	0.11	4.2
						Tacoma (Port)	Los Angeles (Port)	Ship	1,165	One-Way	1.3	
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	2.5	
						Honolulu Harbor (Port)	Kahului Harbor (Port)	Ship	100	One-Way	0.11	
						Kahului Harbor (Port)	Site	Truck	5.0	Roundtrip	0.21	
					Downstream	Site	Hawai'i Materials Recycling	Truck	23	Roundtrip	1.0	1.0
	Steel Pole (Self-Supporting, Direct-Buried)	2,994	40	120	Upstream	Valley, Nebraska (Manufacturer/Warehouse)	Los Angeles (Port)	Truck	1,562	One-Way	44	47
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	3.3	
						Honolulu Harbor (Port)	Kahului Harbor (Port)	Ship	100	One-Way	0.15	
						Kahului Harbor (Port)	Site	Truck	5.0	Roundtrip	0.28	
					Downstream	Site	Kahului Harbor (Port)	Truck	5.0	Roundtrip	0.28	4.4
						Kahului Harbor (Port)	Honolulu Harbor (Port)	Ship	100	One-Way	0.15	
						Honolulu Harbor (Port)	Los Angeles (Port)	Ship	2,231	One-Way	3.3	
						Los Angeles (Port)	Los Angeles (Scrap Yard)	Truck	25	One-Way	0.70	
	Wood Pole	2,268	40	91	Upstream	Tacoma, Washington (Manufacturer/Warehouse)	Tacoma (Port)	Truck	5.0	One-Way	0.11	4.2
						Tacoma (Port)	Los Angeles (Port)	Ship	1,165	One-Way	1.3	
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	2.5	
						Honolulu Harbor (Port)	Kahului Harbor (Port)	Ship	100	One-Way	0.11	
						Kahului Harbor (Port)	Site	Truck	5.0	Roundtrip	0.21	
					Downstream	Site	Hawai'i Materials Recycling	Truck	23	Roundtrip	1.0	1.0
Wildfire Mitigation	Conductor + Bulk of System	158,308	1	158	Upstream	Florence, Alabama (Manufacturer/Warehouse)	Los Angeles (Port)	Truck	2,013	One-Way	75	80
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	4.3	
						Honolulu Harbor (Port)	Kahului Harbor (Port)	Ship	100	One-Way	0.195	
						Kahului Harbor (Port)	Site	Truck	5.0	Roundtrip	0.37	
					Downstream	Site	Kahului Harbor (Port)	Truck	5.0	Roundtrip	0.37	5.8
						Kahului Harbor (Port)	Honolulu Harbor (Port)	Ship	100	One-Way	0.195	
						Honolulu Harbor (Port)	Los Angeles (Port)	Ship	2,231	One-Way	4.3	
						Los Angeles (Port)	Los Angeles (Scrap Yard)	Truck	25	One-Way	0.93	
	Steel Pole (Self-Supporting, Direct-Buried)	2,994	16	48	Upstream	Valley, Nebraska (Manufacturer/Warehouse)	Los Angeles (Port)	Truck	1,562	One-Way	18	19
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	1.3	
						Honolulu Harbor (Port)	Kahului Harbor (Port)	Ship	100	One-Way	0.059	
						Kahului Harbor (Port)	Site	Truck	5.0	Roundtrip	0.112	
					Downstream	Site	Kahului Harbor (Port)	Truck	5.0	Roundtrip	0.112	1.8
						Kahului Harbor (Port)	Honolulu Harbor (Port)	Ship	100	One-Way	0.059	
						Honolulu Harbor (Port)	Los Angeles (Port)	Ship	2,231	One-Way	1.3	
						Los Angeles (Port)	Los Angeles (Scrap Yard)	Truck	25	One-Way	0.28	
	Thermal Cameras	18	16	0.29	Upstream	Goleta, California (Manufacturer/Warehouse)	Los Angeles (Port)	Truck	125	One-Way	0.0085	0.017
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	0.0080	
						Honolulu Harbor (Port)	Kahului Harbor (Port)	Ship	100	One-Way	3.6E-04	
						Kahului Harbor (Port)	Site	Truck	5.0	Roundtrip	6.8E-04	
					Downstream	Site	Kahului Harbor (Port)	Truck	5.0	Roundtrip	6.8E-04	0.011
						Kahului Harbor (Port)	Honolulu Harbor (Port)	Ship	100	One-Way	3.6E-04	
						Honolulu Harbor (Port)	Los Angeles (Port)	Ship	2,231	One-Way	0.0080	
						Los Angeles (Port)	Los Angeles (Scrap Yard)	Truck	25	One-Way	0.0017	
	Weather Stations	36	8	0.29	Upstream	Hillsboro, Oregon (Manufacturer/Warehouse)	Portland (Port)	Truck	32	One-Way	0.0022	0.015
						Portland (Port)	Los Angeles (Port)	Ship	979	One-Way	0.0035	
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	0.0080	
						Honolulu Harbor (Port)	Kahului Harbor (Port)	Ship	100	One-Way	3.6E-04	
						Kahului Harbor (Port)	Site	Truck	5.0	Roundtrip	6.8E-04	
Wildfire Mitigation	Weather Stations	36	8	0.29	Downstream	Site	Kahului Harbor (Port)	Truck	5.0	Roundtrip	6.8E-04	0.011
						Kahului Harbor (Port)	Honolulu Harbor (Port)	Ship	100	One-Way	3.6E-04	
						Honolulu Harbor (Port)	Los Angeles (Port)	Ship	2,231	One-Way	0.0080	
						Los Angeles (Port)	Los Angeles (Scrap Yard)	Truck	25	One-Way	0.0017	

Appendix Table A2
Material Transportation GHG Emissions Calculations
Resilience Projects GHG Analysis (Maui)
Maui, HI

Mode of Travel	Emission Factors[1,2]							
	CO_2	units	CH_4	units	N_2O	units	CO_2e	units
Truck	0.21	kg/ton-mi	2.0E-06	kg/ton-mi	4.9E-06	kg/ton-mi	0.15	kg/MT-km
Ship	--	kg/ton-mi	--	kg/ton-mi	--	kg/ton-mi	0.0066	kg/MT-km

Transportation Emissions:

Shipment Item		Weight per Item (kg)	Total Items	Net Weight (MT)[3]	Phase	Origin	Destination	Mode[4]	Trip length (mi or nmi)[5]	Trip Type[6]	GHG Emissions (MT CO_2e) Per Segment	GHG Emissions (MT CO_2e) Per Shipment Item Type
Substation Flood Monitors	Flood Monitors	5.4	4	0.022	Upstream	Batavia, New York (Manufacturer/Warehouse)	Los Angeles (Port)	Truck	2,586	One-Way	0.013	0.014
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	6.0E-04	
						Honolulu Harbor (Port)	Kahului Harbor (Port)	Ship	100	One-Way	2.7E-05	
						Kahului Harbor (Port)	Site	Truck	5.0	Roundtrip	5.1E-05	
					Downstream	Site	Kahului Harbor (Port)	Truck	5.0	Roundtrip	5.1E-05	8.0E-04
						Kahului Harbor (Port)	Honolulu Harbor (Port)	Ship	100	One-Way	2.7E-05	
						Honolulu Harbor (Port)	Los Angeles (Port)	Ship	2,231	One-Way	6.0E-04	
						Los Angeles (Port)	Los Angeles (Scrap Yard)	Truck	25	One-Way	1.3E-04	
Distribution Feeder Ties	Voltage Regulator	964	6	5.8	Upstream	Tacoma, Washington (Manufacturer/Warehouse)	Tacoma (Port)	Truck	5.0	One-Way	0.0068	0.27
						Tacoma (Port)	Los Angeles (Port)	Ship	1,165	One-Way	0.083	
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	0.16	
						Honolulu Harbor (Port)	Kahului Harbor (Port)	Ship	100	One-Way	0.0071	
						Kahului Harbor (Port)	Site	Truck	5.0	Roundtrip	0.014	
					Downstream	Site	Kahului Harbor (Port)	Truck	5.0	Roundtrip	0.014	0.21
						Kahului Harbor (Port)	Honolulu Harbor (Port)	Ship	100	One-Way	0.0071	
						Honolulu Harbor (Port)	Los Angeles (Port)	Ship	2,231	One-Way	0.16	
						Los Angeles (Port)	Los Angeles (Scrap Yard)	Truck	25	One-Way	0.034	
	Transformer (Rating 3-500 kVA)	1,494	6	9.0	Upstream	San Luis Potosi, Mexico (Manufacturer/Warehouse)	Mexico (Port)	Truck	467	One-Way	1.0	1.4
						Mexico (Port)	Los Angeles (Port)	Ship	1,006	One-Way	0.11	
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	0.25	
						Honolulu Harbor (Port)	Kahului Harbor (Port)	Ship	100	One-Way	0.011	
						Kahului Harbor (Port)	Site	Truck	5.0	Roundtrip	0.021	
					Downstream	Site	Kahului Harbor (Port)	Truck	5.0	Roundtrip	0.021	0.33
						Kahului Harbor (Port)	Honolulu Harbor (Port)	Ship	100	One-Way	0.011	
						Honolulu Harbor (Port)	Los Angeles (Port)	Ship	2,231	One-Way	0.25	
						Los Angeles (Port)	Los Angeles (Scrap Yard)	Truck	25	One-Way	0.052	
	Switch	159	2	0.32	Upstream	Stockton, California (Manufacturer/Warehouse)	Los Angeles (Port)	Truck	362	One-Way	0.027	0.037
						Los Angeles (Port)	Honolulu Harbor (Port)	Ship	2,231	One-Way	0.0087	
						Honolulu Harbor (Port)	Kahului Harbor (Port)	Ship	100	One-Way	3.9E-04	
						Kahului Harbor (Port)	Site	Truck	5.0	Roundtrip	7.4E-04	
					Downstream	Site	Kahului Harbor (Port)	Truck	5.0	Roundtrip	7.4E-04	0.012
						Kahului Harbor (Port)	Honolulu Harbor (Port)	Ship	100	One-Way	3.9E-04	
						Honolulu Harbor (Port)	Los Angeles (Port)	Ship	2,231	One-Way	0.0087	
						Los Angeles (Port)	Los Angeles (Scrap Yard)	Truck	25	One-Way	0.0019	
	Transformer - Concrete Pad	20,718	2	41	Upstream	Maui, Hawai'i (Manufacturer/Warehouse)	Site	Truck	25	Roundtrip	0.48	0.48
					Downstream	Site	Hawai'i Materials Recycling	Truck	23	Roundtrip	0.45	0.45
Total Upstream GHG Emissions (MT CO_2e)[7]												**346**
Total Downstream GHG Emissions (MT CO_2e)[8]												**26**
Total GHG Emissions (MT CO_2e)												**373**

Notes:

1. The emission factors for road transportation are taken from US Environmental Protection Agency (EPA) Scope 3 Inventory Guidance, which recommends emission factors from Table 8 of Emission Factors for Greenhouse Gas Inventories.
2. The emission factor for shipping is based on the Global Maritime Emission Factor for dry (i.e., non-refrigerated) cargo shipping over all trade lanes for 2020 with a 70% utilization factor, assuming an average load weight of 10 tons in each container.
3. The net weight is determined based on the weight of each item and the quantity of each item.
4. For a given transportation segment, if the mode of travel is not known and if multiple travel modes are available, the most emissions-intensive mode is selected.
5. The trip lengths for each leg of travel were estimated based on the following assumptions:
   (a) Shipping distances were estimated using the Sea Distance tool, available at https://sea-distances.org.
   (b) Truck distances were estimated by using Google Maps to determine driving distances between the locations.
6. GHG emissions are per segment (i.e. one-way travel) with the exception of estimated emissions to or from the site. These segments consider roundtrip travel and multiply the per segment GHG emissions by two to account for roundtrip travel. This approach conservatively treats the empty return trip as loaded.
7. Upstream transportation emissions include emissions from transporting the project materials from manufacturing to the project site.
8. Downstream transportation emissions include emissions from transporting the project materials from the project site to disposal at the scrap yard.

Abbreviations:

CH_4 - methane
CN - Canadian National
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
GHG - greenhouse gas
GWP - global warming potential
kg - kilogram
km - kilometer
mi - mile
MT - metric ton
nmi - nautical mile
N_2O - nitrous oxide

References:

EPA. Scope 3 Inventory Guidance. Available at: https://www.epa.gov/climateleadership/scope-3-inventory-guidance
EPA (2022). Emission Factors for Greenhouse Gas Inventories. April 1. Available at: https://www.epa.gov/system/files/documents/2022-04/ghg_emission_factors_hub.pdf
Global Maritime Emission Factors. Available at: https://www.bsr.org/files/clean-cargo/BSR-Clean-Cargo-Emissions-Report-2021.pdf

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Appendix Table A3
Construction GHG Emissions Calculations
Resilience Projects GHG Analysis (Maui)
Maui, HI

Construction Schedule[1]:

System	Construction Activity	Number of Workers	Days
Transmission Hardening	Wood Pole Installation	8	65
	Steel Pole Installation	8	15
Critical Pole Hardening	Wood Pole Installation	8	30
	Wood Pole Installation - Helicopter	12	10
	Steel Pole Installation	8	30
	Steel Pole Installation - Helicopter	12	10
Critical Circuit Hardening	Wood Pole Installation	8	20
	Steel Pole Installation	8	20
Wildfire Mitigation	Steel Pole Installation	8	16
	Overhead Cable Installation	8	85
	Install Thermal Cameras	4	8
	Install Weather Stations	4	8
Substation Flood Monitors	Install Flood Monitors	4	4
Distribution Feeder Ties	Switch Installation	8	2
	Transformer Installation	5	2
	Voltage Regulators Installation	5	2
Hazard Tree Removal	Tree Removal	4	800

Installation Offroad Emissions:

Phase	Construction Subphase	Equipment Type[1]	Total Items[1]	Avg. Usage Hours per Day	Utilization Rate	Hours of Operation (hr / project)	Horsepower[2]	Load[2]	EF (g / bhp-hr)[3]			GHG Emissions[4] (MT CO_2e)
									CO_2	CH_4	CO_2e	
Transmission Hardening	Wood Pole Installation	Strato-Tower	1	8	0.80	416	376	0.38	475	0.15	479	28
		Pick-Up Truck	2	8	0.80	832	376	0.38	475	0.15	479	57
		Hyliner	1	8	0.80	416	367	0.29	472	0.15	477	21.1
	Steel Pole Installation	Strato-Tower	1	8	0.80	96	376	0.38	475	0.15	479	6.6
		Pick-Up Truck	2	8	0.80	192	376	0.38	475	0.15	479	13.2
		Hyliner	1	8	0.80	96	367	0.29	472	0.15	477	4.9
Critical Pole Hardening	Wood Pole Installation	Strato-Tower	1	8	0.80	192	376	0.38	475	0.15	479	13
		Pick-Up Truck	2	8	0.80	384	376	0.38	475	0.15	479	26
		Hyliner	1	8	0.80	192	367	0.29	472	0.15	477	9.7
	Wood Pole Installation - Helicopter	Helicopter	1	6	0.80	48	9,000	--	393	0.011	393	170
	Steel Pole Installation	Strato-Tower	1	8	0.80	192	376	0.38	475	0.15	479	13
		Pick-Up Truck	2	8	0.80	384	376	0.38	475	0.15	479	26
		Hyliner	1	8	0.80	192	367	0.29	472	0.15	477	9.7
	Steel Pole Installation - Helicopter	Helicopter	1	6	0.80	48	9,000	--	393	0.011	393	170
Critical Circuit Hardening	Wood Pole Installation	Strato-Tower	1	8	0.80	128	376	0.38	475	0.15	479	8.8
		Pick-Up Truck	2	8	0.80	256	376	0.38	475	0.15	479	18
		Hyliner	1	8	0.80	128	367	0.29	472	0.15	477	6.5
	Steel Pole Installation	Strato-Tower	1	8	0.80	128	376	0.38	475	0.15	479	8.8
		Pick-Up Truck	2	8	0.80	256	376	0.38	475	0.15	479	18
		Hyliner	1	8	0.80	128	367	0.29	472	0.15	477	6.5

Appendix Table A3
Construction GHG Emissions Calculations
Resilience Projects GHG Analysis (Maui)
Maui, HI

Phase	Construction Subphase	Equipment Type[1]	Total Items[1]	Avg. Usage Hours per Day	Utilization Rate	Hours of Operation (hr/project)	Horsepower[2]	Load[2]	EF (g/bhp-hr)[3]			GHG Emissions[4] (MT CO_2e)
									CO_2	CH_4	CO_2e	
Wildfire Mitigation	Steel Pole Installation	Strato-Tower	1	8	0.80	102	376	0.38	475	0.15	480	7.0
		Pick-Up Truck	2	8	0.80	205	376	0.38	475	0.15	480	14
		Hyliner	1	8	0.80	102	367	0.29	472	0.15	476	5.2
	Overhead Cable Installation	Strato-Tower	1	8	0.80	544	376	0.38	475	0.15	480	37
		Pick-Up Truck	2	8	0.80	1088	376	0.38	475	0.15	480	75
		Hyliner	1	8	0.80	544	367	0.29	472	0.15	476	27.6
	Install Thermal Cameras	Bucket Truck	1	8	0.80	51	376	0.38	475	0.15	480	3.5
		Pick-Up Truck	1	8	0.80	51	376	0.38	475	0.15	480	3.5
	Install Weather Stations	Bucket Truck	1	8	0.80	51	376	0.38	475	0.15	480	3.5
		Pick-Up Truck	1	8	0.80	51	376	0.38	475	0.15	480	3.5
Substation Flood Monitors	Install Flood Monitors	Bucket Truck	1	8	0.80	26	376	0.38	475	0.15	479	1.8
		Pick-Up Truck	1	8	0.80	26	376	0.38	475	0.15	479	1.8
Distribution Feeder Ties	Switch Installation	Vans	2	8	0.80	26	376	0.38	475	0.15	479	1.8
		Boom Truck	1	8	0.80	13	376	0.38	475	0.15	479	0.88
		Flat Bed	1	8	0.80	13	376	0.38	475	0.15	479	0.88
		Pick-Up Truck	1	8	0.80	13	376	0.38	475	0.15	479	0.88
		Generator	1	8	0.80	13	14	0.74	568	0.063	570	0.08
	Transformer Installation	Pick-Up Truck	2	8	0.80	26	376	0.38	475	0.15	479	1.8
		Hyliner	1	8	0.80	13	367	0.29	472	0.15	477	0.65
	Voltage Regulators Installation	Pick-Up Truck	2	8	0.80	26	376	0.38	475	0.15	479	1.8
		Hyliner	1	8	0.80	13	367	0.29	472	0.15	477	0.65
Hazard Tree Removal	Tree Removal	Pick-Up Truck	2	8	0.80	10,240	376	0.38	475	0.15	479	701
		Bucket Truck	1	8	0.80	5,120	376	0.38	475	0.15	479	351
Total Offroad Emissions from Construction Activity												**1,879**

Installation Onroad Emissions:

Phase	Construction Subphase	Average Trip Rates (trips/day)		Trip Length (mi/trip)		CO_2e Hauling EF[6]		CO_2e Worker EF[6]		GHG Emissions[7] (MT CO_2e)
		Worker[5]	Hauling	Worker	Hauling	(g/trip)	(g/mi)	(g/trip)	(g/mi)	
Transmission Hardening	Wood Pole Installation	16	0	5	0	251	736	86	302	1.66
	Steel Pole Installation	16	0	5	0	251	736	86	302	0.38
Critical Pole Hardening	Wood Pole Installation	16	0	5	0	251	736	86	302	0.77
	Wood Pole Installation - Helicopter	24	0	5	0	251	736	86	302	0.38
	Steel Pole Installation	16	0	5	0	251	736	86	302	0.77
	Steel Pole Installation - Helicopter	24	0	5	0	251	736	86	302	0.38
Critical Circuit Hardening	Wood Pole Installation	16	0	5	0	251	736	86	302	0.51
	Steel Pole Installation	16	0	5	0	251	736	86	302	0.51
Wildfire Mitigation	Steel Pole Installation	16	0	5	0	247	723	84	294	0.40
	Overhead Cable Installation	16	0	5	0	247	723	84	294	2.11
	Install Thermal Cameras	8	0	5	0	247	723	84	294	0.099
	Install Weather Stations	8	0	5	0	247	723	84	294	0.099

Appendix Table A3
Construction GHG Emissions Calculations
Resilience Projects GHG Analysis (Maui)
Maui, HI

Phase	Construction Subphase	Average Trip Rates (trips/day)		Trip Length (mi/trip)		CO_2e Hauling EF[6]		CO_2e Worker EF[6]		GHG Emissions[7] (MT CO_2e)
		Worker[5]	Hauling	Worker	Hauling	(g/trip)	(g/mi)	(g/trip)	(g/mi)	
Substation Flood Monitors	Install Flood Monitors	8	0	5	0	251	736	86	302	0.051
Distribution Feeder Ties	Switch Installation	16	0	5	0	251	736	86	302	0.051
	Transformer Installation	10	0	5	0	251	736	86	302	0.032
	Voltage Regulators Installation	10	0	5	0	251	736	86	302	0.032
Hazard Tree Removal	Tree Removal	8	0	5	0	251	736	86	302	10
Total Onroad Emissions from Construction Activity										**18**
Total Construction Emissions										**1,897**

Notes:

1. Project specifications, assumptions and references are provided in Table 3. Each piece of construction equipment was modeled using a comparable piece of equipment from CalEEMod's off-road equipment list.
2. Unless specifically provided by the developer, horsepower and load factor were assumed to be consistent with CalEEMod® v2022.1., default assumptions.
3. Emission factors associated with offroad equipment are from CARB OFFROAD2021 for calendar year 2023, based on the construction start year of each subprogram project. This CARB database provides GHG emission factors for various equipment types and sizes. While more stringent criteria air pollutant requirements may result in lower criteria pollutant emission factors in California than Hawai'i, the fuel economy and therefore the GHG emission factors from offroad equipment are not expected to vary regionally. The OFFROAD database does not contain emission factors for N_2O emissions, which are expected to be minimal compared to overall offroad GHG emissions.
4. Offroad GHG emissions are calculated using a g/bhp-hr emission factor. This emission factor is multiplied by the hours of operation, horsepower, and load for each piece of equipment, then converted from grams to metric tons.
5. The number of home-to-work trips per day associated with each construction subphase activity was determined by multiplying the number of workers by two.
6. Emission factors associated with worker and hauling trips were estimated from California statewide emission factors generated using EMFAC2021 for calendar year 2023 and 2024, based on the construction start year of each subprogram project. The worker fleet assumes only light duty vehicles (EMFAC classes LDA, LDT1, and LDT2) and the hauling fleet assumes heavy duty trucks (EMFAC classes HHDT, LHDT1, LHDT2, MDV, and MHDT). Mobile emission factors from California's EMFAC database represent a reasonable estimate of mobile emission factors for the Project. Hawai'i does not maintain a publicly-accessible database like EMFAC that could be used to assess location-specific vehicle fleet data in future years. However, 2015 data on average fuel economy for the existing light-duty fleets show relatively minor differences between Hawai'i, California, and US-average vehicles. Given that onroad vehicles represent a small portion of lifecycle emissions for the Project, any adjustments to these emission factors would not result in significant changes to the resulting emissions.
7. Onroad GHG emissions are calculated using g/trip and g/mi emission factors. The g/trip emission factors are multiplied by the trips per day, and the g/mi emission factors are multiplied by the miles per trip and trips per day. These emission rates are then multiplied by the number of days in each subphase, and converted from grams to metric tons.

Appendix Table A3
Construction GHG Emissions Calculations
Resilience Projects GHG Analysis (Maui)
Maui, HI

Abbreviations:

bhp - brake horsepower
CalEEMod - California Emissions Estimator MODel
CARB - California Air Resources Board
CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
EF - emissions factor
EMFAC - EMission FACtor model
g - gram
GHG - greenhouse gas
HHDT - heavy-heavy-duty truck
hr - hour
kg - kilogram
LDA - light-duty automobile
LDT - light-duty truck
LHDT - light-heavy-duty truck
MDV - medium-duty vehicle
MHDT - medium-heavy-duty truck
mi - mile
MT - metric ton
N_2O - nitrous oxide

References:

California Emissions Estimator Model (CalEEMod®) v2022.1 Appendix G. Available at: https://www.caleemod.com/documents/user-guide/08_Appendix%20G.xlsx
California Air Resources Board (CARB) 2022. OFFROAD 2021. Available at: https://ww2.arb.ca.gov/our-work/programs/mobile-source-emissions-inventory/msei-modeling-tools.
California Air Resources Board (CARB) 2022. EMFAC2021 v1.0.2. Available at: https://arb.ca.gov/emfac/emissions-inventory.

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Appendix Table A4
Decommissioning & Disposal GHG Emissions Calculations
Resilience Projects GHG Analysis (Maui)
Maui, HI

Decommissioning and Disposal:

System	Stages	Components	Total Items[1]	Weight per Item (kg)[1]	Lifecycle GHG Emission Factor	Units	Note	GHG Emissions (MT CO_2e)
Transmission Hardening	Disposal	Wood Pole	130	2,502	0.11	kg CO_2e/kg disposed	2	36
		Steel Pole with Concrete Foundation - Steel Pole	15	2,994	0.0083	kg CO_2e/kg disposed	3	0.37
		Steel Pole with Concrete Foundation - Concrete Foundation	15	18,370	0.0083	kg CO_2e/kg disposed	4	2.3
Critical Pole Hardening	Disposal	Steel Pole (Self-Supporting, Direct-Buried)	40	2,994	0.0083	kg CO_2e/kg disposed	3	1.0
		Wood Pole	40	2,268	0.11	kg CO_2e/kg disposed	2	10
Critical Circuit Hardening	Disposal	Steel Pole (Self-Supporting, Direct-Buried)	40	2,994	0.0083	kg CO_2e/kg disposed	3	1.0
		Wood Pole	40	2,268	0.11	kg CO_2e/kg disposed	2	10
Wildfire Mitigation	Disposal	Conductor + Bulk of System	1	158,308	0.017	kg CO_2e/kg disposed	5	2.7
		Steel Pole (Self-Supporting, Direct-Buried)	16	2,994	0.0083	kg CO_2e/kg disposed	3	0.40
		Thermal Cameras	16	18	0.32	kg CO_2e/kg disposed	6	0.092
		Weather Stations	8	36	0.32	kg CO_2e/kg disposed	7	0.092
Substation Flood Monitors	Disposal	Flood Monitors - Sensor	4	4.5	0.0083	kg CO_2e/kg disposed	8	1.5E-04
		Flood Monitors - Casing & Cable	4	0.91	0.48	kg CO_2e/kg disposed	9	0.0017
Distribution Feeder Ties	Disposal	Voltage Regulator	6	964	0.0083	kg CO_2e/kg disposed	10	0.048
		Transformer (Rating 3-500 kVA)	6	1,494	0.32	kg CO_2e/kg disposed	11	2.9
		Switch	2	159	0.32	kg CO_2e/kg disposed	12	0.10
		Transformer - Concrete Pad	2	20,718	0.0083	kg CO_2e/kg disposed	13	0.34
Proposed Project	Decommissioning	Infrastructure System Decommissioning					14	25
Total Decommissioning and Disposal Emissions								**93**

Notes:

1. Project specifications, assumptions and references are provided in Table 2.
2. The GHG emission factor for the Wood Pole - Sub-Transmission and Wood Pole - Distribution is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Doka, G., market for waste wood, untreated, Rest of world geography ("RoW", e.g. datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database for specific regions), System Model Allocation, cut-off by classification ("Allocation, cut-off by classification", e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
3. The GHG emission factor for the Steel Pole with Concrete Foundation - Steel Pole and Steel (Self-Supporting) Pole is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Hischier, R., market for scrap steel, Rest of world geography ("RoW", e.g. datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database for specific regions), System Model Allocation, cut-off by classification ("Allocation, cut-off by classification", e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
4. The GHG emission factor for the Concrete Foundations of Steel Pole with Concrete Foundation is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Doka, G., market for waste concrete, Rest of world geography ("RoW", e.g. datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database for specific regions), System Model Allocation, cut-off by classification ("Allocation, cut-off by classification", e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
5. The GHG emission factor for the Conductor + Bulk of System is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Doka, G., market for scrap aluminium, Rest of world geography ("RoW", e.g. datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database for specific regions), System Model Allocation, cut-off by classification ("Allocation, cut-off by classification", e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
6. The GHG emission factor for the Thermal Cameras is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Hischier, R., market for used industrial electronic device, WEEE collection, Rest of world geography ("RoW", e.g. datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database for specific regions), System Model Allocation, cut-off by classification ("Allocation, cut-off by classification", e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
7. The GHG emission factor for the Weather Stations is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Hischier, R., market for used industrial electronic device, WEEE collection, Rest of world geography ("RoW", e.g. datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database for specific regions), System Model Allocation, cut-off by classification ("Allocation, cut-off by classification", e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
8. The GHG emission factor for the Flood Monitors - Sensor is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Hischier, R., market for scrap steel, Rest of world geography ("RoW", e.g. datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database for specific regions), System Model Allocation, cut-off by classification ("Allocation, cut-off by classification", e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
9. The GHG emission factor for the Flood Monitors - Casing & Cable is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP for Doka, G., market for waste polyvinylchloride, Rest of world geography ("RoW", e.g. datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database for specific regions), System Model Allocation, cut-off by classification ("Allocation, cut-off by classification", e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
10. The GHG emission factor for the Voltage Regulator is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Hischier, R., market for scrap steel, Rest of world geography ("RoW", e.g. datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database for specific regions), System Model Allocation, cut-off by classification ("Allocation, cut-off by classification", e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
11. The GHG emission factor for the Transformer is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Hischier, R., market for used industrial electronic device, WEEE collection, Rest of world geography ("RoW", e.g. datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database for specific regions), System Model Allocation, cut-off by classification ("Allocation, cut-off by classification", e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
12. The GHG emission factor for the Switch is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Hischier, R., market for used industrial electronic device, WEEE collection, Rest of world geography ("RoW", e.g. datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database for specific regions), System Model Allocation, cut-off by classification ("Allocation, cut-off by classification", e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
13. The GHG emission factor for the Transformer - Concrete Pad is obtained from ecoinvent using the IPCC Fifth Assessment Report GWP from Doka, G., market for waste concrete, Rest of world geography ("RoW", e.g. datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database for specific regions), System Model Allocation, cut-off by classification ("Allocation, cut-off by classification", e.g. a producer is fully responsible for the disposal of its wastes and does not receive any credit for the provision of any recyclable materials), ecoinvent database version 3.7.1.
14. Infrastructure system decommissioning emissions are assumed to be a percentage of construction emissions, as detailed in the Decommissioning and Disposal of Proposed Project, Decommissioning Intensity Relative to Construction inputs in Table 2, which includes all subprograms except Hazard Tree Removal.

Abbreviations:

CO_2e - carbon dioxide equivalent
GHG - greenhouse gas
GLO - global
GWP - global warming potential
IPCC - Intergovernmental Panel on Climate Change
kg - kilogram
kVA - kilovolt-ampere
MT - metric ton
RoW - rest of world
WEEE - Waste Electrical and Electronic Equipment

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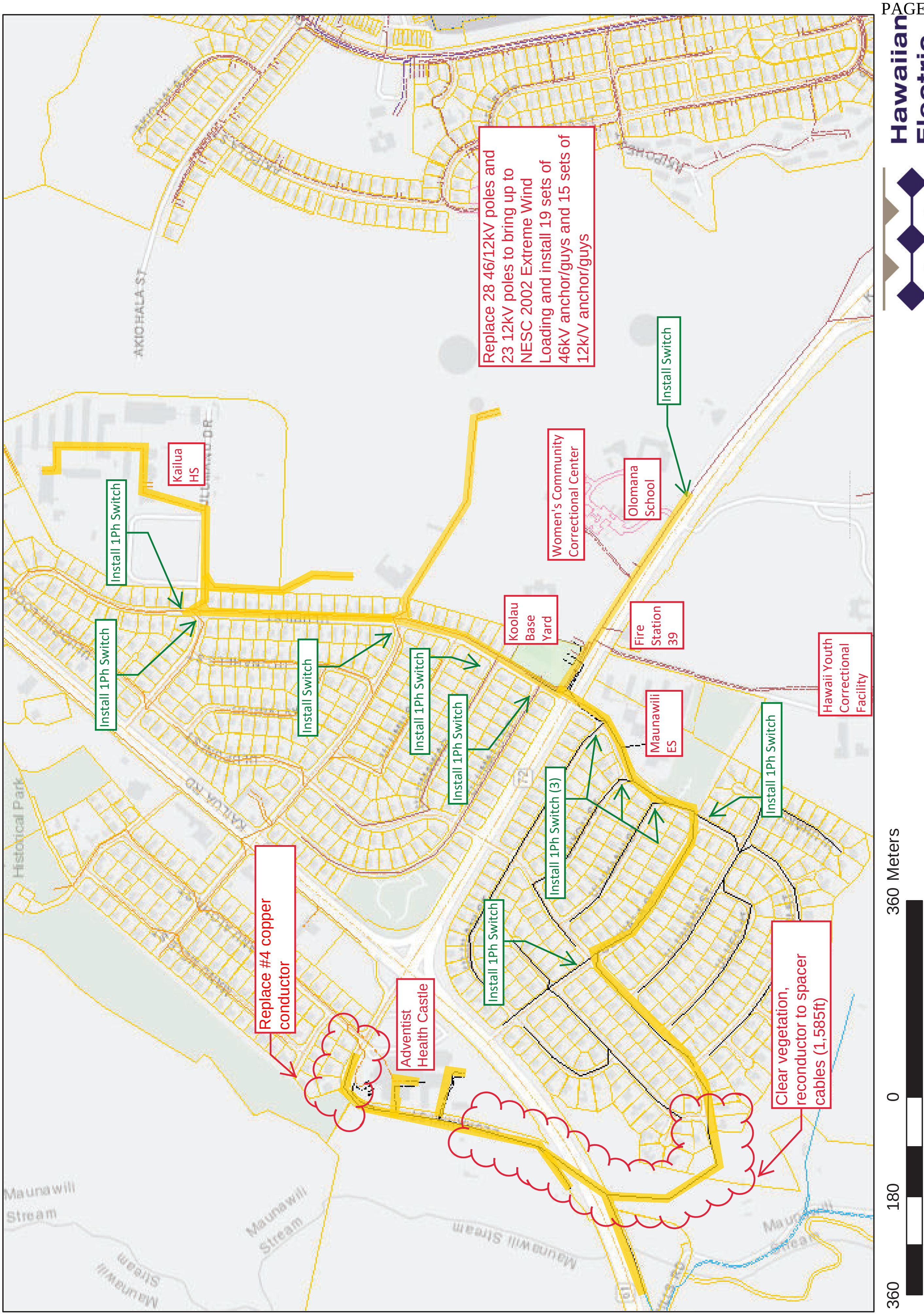
Exhibit H

Climate Adaptation Transmission and Distribution Resilience Program Application

Critical Customer Circuit Example

Hawaiian Electric



Blue Chip Economic Indicators®

Top Analysts' Forecasts of the U.S. Economic Outlook for the Year Ahead

Vol. 47, No. 4, April 11, 2022

Wolters Kluwer

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Blue Chip Economic Indicators® (ISSN: 0193-4600) is published monthly by CCH Incorporated, 28 Liberty St., 44th Floor, New York, NY 10005-1400. Printed in the U.S.A.

Subscriptions: For information on annual subscriptions, format options (PDF, Excel, online), multiple-copy rates and/or site-license agreements please contact Peggy Hayner at: peggy.hayner@wolterskluwer.com.

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Russia/Ukraine War and Inflation Continue to Weigh on Economy

U.S. Growth Seen at 3.2% This Year. Two themes dominate the U.S. macroeconomic scene at present: inflation and the Russia/Ukraine war. But despite the drama in both of these themes, the U.S. economy is projected by the Blue Chip Economic Indicators forecast panel to remain on a moderate and rather orderly GDP growth path. Following 5.7% growth in GDP for all of 2021, the panel forecasts growth of 3.2% this year and 2.3% in 2023. These projections are marginally less than the March forecasts of 3.5% and 2.5% for this year and next, respectively.

Inflation at 5.7% This Year. At the same time, U.S. inflation is expected to be higher, at least over the near term. The Federal Reserve targets the personal consumption expenditure price index and the Blue Chip panel projects that it will average 5.7% this year over its 2021 average, compared to 5.2% in the March forecast. Inflation is expected to be especially elevated during the first half of this year, with Q1 now estimated at an annual rate of 7.0% over Q4 2021 versus 6.6% in the March forecast. In Q2, while inflation would be moderately slower at a 5.8% seasonally adjusted annual rate over Q1, that is clearly stronger than the 4.9% that the panel estimated back in March. Also higher than the March forecasts are 3.5% for Q3 2022 and 2.9% for Q4 2022. And all these estimates are well above the Federal Reserve's inflation target of 2%.

These inflation forecasts, while unsettling, are not nearly so unsettling as the war in eastern Europe. It will likely have many ramifications. Just today, April 7, as we are preparing this material for publication, the U.S. Congress has passed legislation stripping Russia of its "most-favored-nation" status. The actual limit on trade with Russia will not be great, but the action is one example of how serious the U.S. Government, including the Congress, considers the Russian action against Ukraine to be.

The War Seen as Biggest Threat to Global Stability. Even though the U.S. does not have a direct role in the Russia/Ukraine conflict, the Blue Chip panel sees considerable reaction to the war in general. In a Special Question (see page 14) that inquired about panelists' assessment of the greatest threat to global financial stability, the largest share of the panelists chose "a further escalation of the conflict in Ukraine." More concretely, panelists indicated that their expectations concerned the impact on several aspects of the economy: U.S. real GDP growth, U.S. CPI inflation and global growth. Notably, only about half of the respondents expect Federal Reserve policy to be affected.

Federal Reserve policy is important, of course, in fighting the current inflation surge. Following the recent 25-basis-point increase in the federal funds rate, panelists look for more monetary policy tightening actions. These include the possibility of a 50-basis-point increase in the funds rate, and the beginning shortly of outright reductions in the size of the Fed's balance sheet. The Fed's purchases of Treasury securities and mortgage-backed bonds were concluded in early March, and the Federal Open Market Committee (FOMC) discussed at its March 15-16 meeting that it might soon begin to make outright reductions in its holdings of those assets. According to another Special Question, the Blue Chip panel expects that to happen later this quarter. The FOMC has meetings scheduled on May 3-4 and June 14-15. Overall, the panel looks for the federal funds rate to approach 2% by late this year and to go up another 60-70 basis points in 2023.

Supply-Chain Issues Major Inflation Cause, Predate War. Do note, despite comments from some government officials, that the current inflation surge began well before the Russia/Ukraine war. That event has, of course, exacerbated the problem, especially for food and energy prices, but it started earlier. Supply-chain issues are a major contributor; they set in at least in part because of the COVID situation. Notably, about 60% of the Blue Chip panel now indicate in another Special Question that COVID is no longer a major factor in their near-term outlook, but it has obviously had a major role in the shape of events and expectations for the last couple of years, even including the transfer of parts and products around the world. Panelists looks for supply-chain bottlenecks, COVID-related and otherwise, to continue complicating production roughly through the end of this year.

Inventory Change This Year Likely Among Largest Ever. The supply-chain issues do raise the cost of doing business. We can also describe their varying impacts on overall patterns of demand in the economy. Inventories plunged during much of 2021, subtracting from overall GDP growth. But they rebounded sharply in the fourth quarter, expanding $193.2 billion (SAAR), a record amount for a measure that dates back to 1947. Going forward, the Blue Chip panel projects that the inventory change will average $107.2 billion each quarter this year. The biggest yearly increase was in 2015, when inventories rose $137.6 billion.

The sizable swing in inventories would accompany fairly ordinary growth rates in personal consumption expenditures, 3.1% this year after 7.9% in 2021, and in business fixed investment, 5.4% this year after 7.4% last year

Carol Stone, CBE (Haver Analytics, New York, NY)

2022 Real GDP Forecast Decreases to 3.2% from 3.5% Last Month

April 2022 Forecast for 2022 SOURCE:	Percent Change 2022 From 2021 (Full Year-Over-Prior Year)										Average For 2022			Total Units-2022		2022
	1 Real GDP (Chained) (2012$)	2 GDP Price Index	3 Nominal GDP (Cur.$)	4 Consumer Price Index	5 Indust. Prod. (Total)	6 Dis. Pers. Income (2012$)	7 Personal Cons. Exp. (2012$)	8 Non-Res. Fix. Inv. (2012$)	9 Corp. Profits (Cur.$)	10 PCE Price Index	11 Treas. Bills 3-mo.	12 Treas. Notes 10-Year	13 Unempl. Rate (Civ.)	14 Housing Starts (Mil.)	15 Auto&Light Truck Sales (Mil.)	16 Net Exports (2012$)
Morgan Stanley, US***	4.4 H	6.3	10.7 H	6.8	4.1	-3.2	3.5	6.5	na	5.5	1.6 H	2.5	3.4	1.57	16.0	-1508.4
Action Economics	4.0	5.6	9.8	6.7	5.2	-4.1	3.1	6.7	19.7 H	5.7	0.8	2.1	3.6	1.72	16.0	na
RDQ Economics	3.8	6.1	10.1	7.1	5.5	-2.9	3.8	1.8 L	11.2	5.9	1.3	2.6	3.4	1.75	15.0	-1491.5
BNP Paribas North America	3.7	na	na	7.5	na	na	na	na	na	6.2	na	na	3.6	na	na	na
PNC Financial Services Group	3.7	5.4	9.3	6.4	4.3	-2.8	3.5	3.2	na	5.4	1.1	2.4	3.6	1.75	15.8	-1348.4
UCLA Anderson Forecast*	3.7	5.1	8.8	6.4	4.6	-2.9	2.9	7.1	na	5.9	1.4	2.8	3.5	1.66	15.8	-1322.3
Amherst Pierpont Securities	3.6	5.7	9.5	7.1	5.0	-3.5	3.7	5.7	9.0	5.8	1.2	2.6	3.4	1.64	15.4	-1425.0
Northern Trust Company**	3.6	5.3	9.0	6.8	4.0	-3.3	3.4	4.8	6.0	5.9	1.1	2.5	3.6	1.65	15.6	-1348.1
Point72 Asset Management*	3.6	6.1	10.1	7.0	5.1	-3.9	3.7	6.3	10.0	5.6	1.4	2.5	3.3 L	1.62	15.8	-1461.1
Barclays, US*	3.5	5.2	9.1	6.3	2.7	na	2.9	3.7	na	5.2	na	2.1	3.6	1.74	na	-1335.7
Inforum	3.5	5.6	9.4	6.3	4.7	-3.5	3.2	5.5	6.0	5.5	1.1	2.4	3.6	1.67	15.5	-1371.0
Moody's Analytics, US	3.5	4.9	8.6	5.8	4.8	-3.4	3.5	7.7	5.6	5.0	0.6 L	2.1	3.6	1.81 H	16.4	-1471.5
National Assn. of Home Builders	3.5	4.4	7.9	6.2	na	-4.2	3.0	6.5	na	5.4	na	2.0	3.5	1.67	na	-1387.2
Nomura Securities, US	3.5	5.0	8.5	7.5	3.6	na	4.0 H	7.0	na	6.1	na	2.7	3.5	1.63	15.1	-1465.4
UBS	3.5	4.2	7.8	6.1	2.0 L	-3.9	3.1	6.0	na	4.9	1.3	2.2	3.6	1.64	na	-1483.3
Bank of America-Merrill Lynch, US**	3.3	6.5	10.1	7.5	3.9	na	3.4	5.0	na	na	na	2.5	3.4	1.60	14.7	-1470.8
Fannie Mae	3.3	5.9	9.2	6.8	na	na	2.6	5.8	na	5.8	1.2	2.3	3.6	1.62	16.7 H	-1197.3
FedEx Corporation, US	3.3	5.9	9.3	7.0	4.5	-3.8	3.1	5.4	4.5	5.8	1.3	2.6	3.7	1.62	15.5	-1405.0
JP MorganChase, US	3.3	5.0	8.4	6.8	4.3	-4.6	3.2	5.3	9.7	5.8	na	2.4	3.5	1.69	16.4	-1554.3 L
National Retail Federation	3.3	5.0	8.3	6.3	4.6	-3.2	3.3	5.1	na	5.5	0.9	2.3	3.5	1.66	15.8	-1385.0
Comerica**	3.2	6.8 H	10.1	7.6 H	4.5	-6.0 L	3.0	5.0	-0.3	6.9 H	1.3	2.3	3.7	1.79	15.1	-1463.0
Credit Suisse	3.2	5.3	8.8	7.6 H	4.8	na	2.9	5.1	na	6.3	na	na	3.6	na	na	-1378.8
Ford Motor Company*	3.2	5.9	9.1	6.2	5.9 H	-4.2	3.6	6.3	na	5.7	1.0	2.3	3.5	1.63	na	-1461.7
Naroff Economic Advisors*	3.2	5.3	8.6	6.8	3.6	-4.6	2.8	5.6	na	5.4	1.3	2.9 H	3.5	1.70	15.8	-1414.7
Societe Generale	3.2	4.3	7.8	6.9	5.3	-4.3	3.5	6.7	1.2	5.5	1.2	2.2	3.6	1.70	14.2	-1501.7
Daiwa Capital Markets America	3.1	5.8	9.0	6.8	4.5	-3.3	3.4	4.4	7.6	5.7	1.3	2.7	3.5	1.59	14.7	-1523.0
Georgia State University*	3.1	5.4	8.8	7.5	5.1	-4.1	2.9	6.2	0.1	5.4	0.8	2.7	3.6	1.59	15.1	-1390.8
Goldman Sachs & Co.**	3.1	6.3	9.7	7.2	2.5	-4.1	2.9	4.9	na	5.9	1.6 H	2.5	3.5	1.68	na	-1456.4
MacroFin Analytics & Rutgers Bus School	3.1	5.1	8.3	6.1	4.9	-3.8	2.9	5.7	5.1	5.2	1.2	2.8	3.6	1.62	15.9	-1379.3
NatWest Markets	3.1	4.0	7.2	7.0	3.0	-3.5	3.5	5.5	na	5.7	1.4	2.5	3.4	1.55	16.0	-1451.0
Oxford Economics, US	3.1	5.5	8.9	7.4	4.9	-4.6	3.3	5.4	-6.8 L	5.9	1.3	2.5	3.5	1.67	15.2	-1394.2
Regions Financial Corporation	3.1	6.0	9.3	7.4	4.8	-4.2	2.9	6.9	5.2	6.1	1.3	2.4	3.5	1.69	14.9	-1429.5
Swiss Re	3.1	na	na	6.9	4.2	-1.4	3.5	3.8	4.8	6.1	1.1	2.2	4.4 H	na	14.2	-1325.9
ACT Research*	3.0	5.4	8.4	6.2	4.6	-3.6	3.3	5.4	5.2	6.0	0.9	2.4	3.5	1.72	15.0	-1480.0
BMO Capital Markets*	3.0	6.0	9.4	7.5	4.5	-5.1	3.2	5.0	9.7	6.4	1.3	2.4	3.5	1.68	15.1	-1423.0
Eaton Corporation	3.0	5.5	8.5	7.0	4.4	-3.4	2.9	5.6	na	5.0	1.5	2.4	3.6	1.60	15.0	-1291.2
Econoclast	3.0	5.8	8.8	7.4	4.2	-4.1	2.5	4.9	9.5	5.9	1.3	2.4	3.6	1.66	15.3	-1401.0
Economist Intelligence Unit, UK	3.0	5.6	8.8	6.6	4.2	-3.2	2.9	5.1	na	na	1.1	2.7	4.1	1.48 L	15.2	-1336.5
General Motors Corporation, US	3.0	5.5	8.5	7.0	4.9	-4.5	2.5	5.6	na	6.2	1.3	2.5	3.6	1.59	na	-1363.4
The Conference Board, US*	3.0	na	na	na	na	-3.4	2.8	4.5	na	5.8	na	na	3.5	na	na	-1379.0
Bank of the West	2.9	5.3	8.2	6.9	4.9	-1.5	3.3	6.7	10.4	5.5	1.1	2.5	3.5	1.67	14.3	-1470.3
Thru the Cycle*	2.9	5.4	8.3	7.5	4.9	-3.8	2.9	4.8	2.2	6.2	1.1	2.5	3.7	1.58	15.2	-1404.6
Wells Fargo, US	2.8	6.5	9.3	7.4	4.8	-4.3	2.5	5.1	7.6	6.0	1.6 H	2.6	3.5	1.65	15.1	-1462.8
Grant Thorton/Diane Swonk	2.7	6.0	8.7	6.4	4.5	-4.6	2.5	5.2	0.1	5.8	0.6 L	2.6	3.8	1.56	14.5	-1381.0
SOM Economics, Inc.	2.7	5.5	8.3	6.3	4.3	na	3.1	4.3	7.5	5.5	1.1	2.7	3.6	1.57	15.2	-1426.0
Visa	2.6	5.9	8.7	6.7	na	-5.3	3.2	8.2 H	1.0	5.8	1.3	2.6	3.6	1.62	14.3	-1486.9
ACIMA Private Wealth, US	2.3 L	3.7 L	6.0 L	3.5 L	4.3	0.8 H	1.6 L	3.5	10.0	3.4 L	0.6 L	1.8 L	4.1	1.65	14.0 L	-1187.5 H
2022 Consensus: April Avg.	**3.2**	**5.5**	**8.9**	**6.8**	**4.4**	**-3.7**	**3.1**	**5.4**	**6.0**	**5.7**	**1.2**	**2.4**	**3.6**	**1.65**	**15.3**	**-1411.0**
Top 10 Avg.	3.8	6.3	9.9	7.5	5.2	-2.4	3.6	7.0	10.7	6.3	1.4	2.7	3.8	1.74	16.1	-1305.6
Bottom 10 Avg.	2.8	4.6	7.8	5.9	3.4	-4.8	2.6	3.9	1.2	5.0	0.8	2.1	3.4	1.57	14.5	-1497.1
Previous Avg.	3.5	5.2	8.8	6.2	4.5	-3.5	3.2	5.5	5.7	5.2	0.8	2.1	3.6	1.62	15.6	-1371.6
Historical data 2018	2.9	2.4	5.4	2.4	3.2	3.4	2.9	6.4	8.3	2.1	2.0	2.9	3.9	1.25	17.2	-864.2
2019	2.3	1.8	4.1	1.8	-0.8	2.3	2.2	4.3	2.7	1.5	2.1	2.1	3.7	1.29	17.0	-905.3
2020	-3.4	1.3	-2.2	1.2	-7.2	6.2	-3.8	-5.3	-5.2	1.2	0.4	0.9	8.1	1.38	14.5	-942.7
2021	5.7	4.2	10.1	4.7	5.6	2.2	7.9	7.4	25	3.9	0.0	1.4	5.4	1.60	14.9	-1284.3
Number of Forecasts Changed From a Month Ago:																
Down	36	5	17	2	16	19	25	19	13	3	0	2	25	4	25	33
Same	10	8	4	6	9	11	9	10	6	9	4	4	17	12	11	7
Up	1	31	23	38	17	10	12	17	8	32	35	38	5	27	1	5
April Median	3.2	5.5	8.8	6.9	4.5	-3.8	3.1	5.4	6.0	5.8	1.2	2.5	3.6	1.65	15.2	-1414.7
April Diffusion Index	13%	80%	57%	89%	51%	39%	36%	48%	41%	83%	95%	91%	29%	77%	18%	19%

***Denotes the number of times an organization or individual has won the annual Lawrence R. Klein Award for Blue Chip Forecast Accuracy.**

2023 Real GDP Forecast Decreases to 2.3% from 2.5% Last Month

April 2022 Forecast for 2023	Percent Change 2023 From 2022 (Full Year-Over-Prior Year)										Average For 2023			Total Units-2023		2023
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
SOURCE:	Real GDP (Chained) (2012$)	GDP Price Index	Nominal GDP (Cur.$)	Consumer Price Index	Indust. Prod. (Total)	Dis. Pers. Income (2012$)	Personal Cons. Exp. (2012$)	Non-Res. Fix. Inv. (2012$)	Corp. Profits (Cur.$)	PCE Price Index	Treas. Bills 3-mo.	Treas. Notes 10-Year	Unempl. Rate (Civ.)	Housing Starts (Mil.)	Auto&Light Truck Sales (Mil.)	Net Exports (2012$)
RDQ Economics	3.8 H	4.1	8.1 H	4.5 H	5.1 H	3.4	3.4 H	4.5	8.0 H	4.0	2.9	3.7	2.8	1.85	18.0	-1614.4
Morgan Stanley, US***	3.7	4.0	7.7	2.4	2.5	4.0	2.9	5.6	na	2.5	3.0	na	3.1	1.69	16.5	-1571.6
Amherst Pierpont Securities	3.3	3.5	7.0	3.7	2.9	2.9	2.9	5.3	5.4	3.3	3.2 H	3.6	3.0	1.62	16.3	-1400.0
Action Economics	3.1	2.4	5.6	2.8	2.9	2.5	2.4	6.1	1.3	2.5	1.6	2.4	3.3	1.77	18.8 H	na
Moody's Analytics, US	3.1	2.6	5.8	2.3	1.9	4.1	2.8	5.4	6.3	2.3	1.5	2.8	3.4	1.89 H	17.9	-1468.6
Point72 Asset Management*	3.0	2.9	6.0	3.2	3.8	2.9	3.0	5.6	6.5	2.7	2.9	3.1	2.6	1.55	16.8	-1509.7
National Assn. of Home Builders	2.9	2.6	5.5	2.6	na	3.8	2.4	4.3	na	2.5	na	2.6	3.4	1.61	na	-1283.0
Regions Financial Corporation	2.8	3.0	5.9	3.2	3.1	2.8	2.4	6.0	2.8	3.1	2.6	2.9	3.2	1.65	16.2	-1426.5
Ford Motor Company*	2.7	2.8	5.5	1.9	2.6	3.5	1.7	4.1	na	2.4	2.1	2.7	3.5	1.53	na	-1283.9
Northern Trust Company**	2.7	3.2	5.9	3.0	2.4	2.3	2.8	4.3	1.9	2.8	2.6	3.0	3.4	1.71	17.2	-1313.1
Inforum	2.6	2.8	5.5	2.7	2.4	2.5	2.3	4.2	2.6	2.7	2.3	3.1	3.6	1.59	16.6	-1370.1
SOM Economics, Inc.	2.6	3.0	5.6	2.9	2.8	na	2.5	3.8	3.0	2.9	2.7	3.4	3.6	1.43	16.4	-1352.0
Visa	2.6	2.2	4.9	2.9	na	1.6	2.3	7.6 H	2.0	2.2	2.3	3.1	3.4	1.53	16.8	-1562.0
ACT Research*	2.5	2.7	5.3	3.5	2.8	2.6	2.2	4.2	2.8	2.5	1.7	2.8	3.4	1.65	16.5	-1490.0
BNP Paribas North America	2.5	na	na	3.4	na	na	na	na	na	2.8	na	na	2.4 L	na	na	na
Fannie Mae	2.5	3.3	5.9	2.7	na	na	2.2	3.3	na	2.7	2.8	2.4	3.7	1.53	16.4	-1156.7
National Retail Federation	2.5	2.5	5.0	2.6	3.2	2.4	2.2	4.5	na	2.5	1.6	2.6	3.3	1.55	16.0	-1462.0
Societe Generale	2.5	2.6	5.2	3.5	2.5	1.3	2.1	4.9	-4.1	3.1	2.3	2.2	3.4	1.76	15.1	-1517.0
UBS	2.4	2.0	4.4	1.5 L	1.7	2.1	1.8	6.5	na	1.5 L	2.1	2.4	3.3	1.56	na	-1552.7
UCLA Anderson Forecast*	2.4	3.4	5.8	2.4	2.2	2.7	2.7	2.2	na	2.2	2.4	3.1	3.6	1.62	17.1	-1315.4
Barclays, US*	2.3	2.3	4.7	2.2	1.6	na	2.0	3.2	na	2.1	na	na	3.4	1.79	na	-1350.7
BMO Capital Markets*	2.3	2.8	5.1	3.2	2.3	1.1	2.5	3.4	5.1	3.0	2.7	2.9	3.3	1.65	16.2	-1464.0
FedEx Corporation, US	2.3	2.6	5.0	2.9	2.5	2.5	2.3	3.6	3.1	2.6	2.8	3.2	3.6	1.62	17.7	-1400.0
General Motors Corporation, US	2.3	2.9	5.2	3.0	2.0	3.2	1.8	2.9	na	2.5	2.6	3.1	3.8	1.48	na	-1212.3
JP MorganChase, US	2.3	2.4	4.8	3.0	1.7	2.8	2.8	4.2	4.0	2.7	na	na	3.3	1.74	17.5	-1704.9 L
NatWest Markets	2.3	2.3	4.7	2.9	2.0	2.0	2.7	3.3	na	3.1	2.8	2.5	3.0	1.35	15.7	-1484.8
ACIMA Private Wealth, US	2.2	1.5 L	3.7 L	2.1	2.5	2.0	2.4	3.3	7.0	2.6	0.9 L	1.7 L	4.3	1.77	15.7	-1275.0
Credit Suisse	2.2	3.0	5.2	3.8	na	na	2.0	4.7	na	3.0	na	na	3.4	na	na	-1390.0
Georgia State University*	2.2	3.2	5.5	3.8	1.8	4.5 H	2.4	3.2	-3.0	2.7	2.0	3.6	3.8	1.39	16.0	-1285.3
The Conference Board, US*	2.2	na	na	na	na	1.7	1.7	3.9	na	3.0	na	na	2.9	na	na	-1396.2
Econoclast	2.1	2.7	4.8	3.2	2.6	1.9	1.8	4.0	4.5	3.0	2.4	2.9	3.5	1.64	15.9	-1438.0
Goldman Sachs & Co.**	2.1	3.5	5.6	3.4	1.9	2.5	2.1	3.3	na	3.0	3.0	2.8	3.3	1.73	na	-1421.5
MacroFin Analytics & Rutgers Bus School	2.1	2.4	4.4	2.4	2.7	2.4	2.2	4.2	2.4	2.3	2.4	3.9	3.5	1.33	17.3	-1298.8
Wells Fargo, US	2.1	3.0	5.1	2.9	3.1	1.7	1.6	4.2	2.0	3.0	3.1	2.7	3.3	1.52	16.6	-1504.3
Oxford Economics, US	2.0	2.0	4.1	1.7	1.7	2.8	2.0	2.9	-4.8 L	1.8	2.6	2.8	3.4	1.62	16.6	-1317.0
PNC Financial Services Group	2.0	2.9	4.9	2.5	1.8	3.5	2.2	4.4	na	2.4	2.6	3.0	3.5	1.57	16.8	-1343.3
Comerica**	1.9	3.2	5.1	4.5 H	-0.5	-0.2 L	1.7	4.1	4.1	4.3 H	2.5	2.6	3.6	1.84	17.4	-1351.0
Daiwa Capital Markets America	1.9	3.7	5.7	3.7	2.1	2.4	1.8	2.8	2.9	3.5	3.0	3.5	3.7	1.45	16.8	-1534.0
Eaton Corporation	1.9	2.6	4.5	3.6	2.5	2.6	1.9	4.9	na	3.0	2.1	2.0	3.9	1.44	16.6	-1225.8
Economist Intelligence Unit, UK	1.9	3.1	5.0	2.7	2.4	1.9	2.4	4.4	na	na	2.4	4.1 H	3.8	1.40	16.5	-1433.5
Thru the Cycle*	1.9	3.0	4.9	3.9	2.5	1.7	2.2	3.3	-4.4	3.8	2.1	2.3	3.8	1.47	16.6	-1432.8
Bank of America-Merrill Lynch, US**	1.8	4.5 H	6.4	3.6	1.6	na	2.3	5.2	na	na	na	2.3	3.2	1.60	17.5	-1544.9
Bank of the West	1.8	3.0	4.8	3.5	2.7	3.2	2.1	3.5	1.3	3.3	2.7	3.4	3.6	1.56	14.1 L	-1445.4
Naroff Economic Advisors*	1.8	2.7	4.5	3.0	2.1	0.7	2.4	5.7	na	2.9	2.9	3.5	3.5	1.56	16.6	-1515.1
Swiss Re	1.5	na	na	3.2	-1.4 L	2.0	1.6	-0.2 L	0.7	4.2	2.0	2.3	6.5 H	na	15.3	-1095.0 H
Grant Thorton/Diane Swonk	1.4	2.7	4.1	2.1	0.8	2.8	1.2 L	0.9	0.9	2.0	1.2	3.1	4.9	1.30 L	14.4	-1223.0
Nomura Securities, US	1.3 L	2.6	3.9	3.9	0.2	na	2.1	3.1	na	3.0	na	2.9	3.5	1.47	17.0	-1489.8
2023 Consensus: April Avg.	**2.3**	**2.9**	**5.3**	**3.0**	**2.2**	**2.5**	**2.2**	**4.1**	**2.4**	**2.8**	**2.4**	**2.9**	**3.5**	**1.59**	**16.6**	**-1405.0**
Top 10 Avg.	3.1	3.6	6.5	3.9	3.2	3.6	2.9	5.9	5.4	3.6	3.0	3.6	4.2	1.79	17.6	-1233.9
Bottom 10 Avg.	1.7	2.2	4.3	2.1	0.9	1.3	1.7	2.4	-0.8	2.1	1.7	2.3	3.0	1.40	15.4	-1562.6
Previous Avg.	2.5	2.7	5.2	2.6	2.4	2.5	2.3	4.3	2.7	2.5	1.7	2.6	3.4	1.58	16.7	-1375.0
Number of Forecasts Changed From a Month Ago:																
Down	23	6	17	6	18	17	26	19	13	7	0	3	12	14	17	31
Same	18	12	9	7	16	14	11	15	10	6	5	5	19	16	16	8
Up	6	25	17	33	7	9	8	11	4	30	34	33	15	13	4	5
April Median	2.3	2.8	5.2	3.0	2.4	2.5	2.2	4.2	2.8	2.7	2.5	2.9	3.4	1.59	16.6	-1421.5
April Diffusion Index	32%	72%	50%	79%	37%	40%	30%	41%	33%	77%	94%	87%	53%	49%	32%	20%

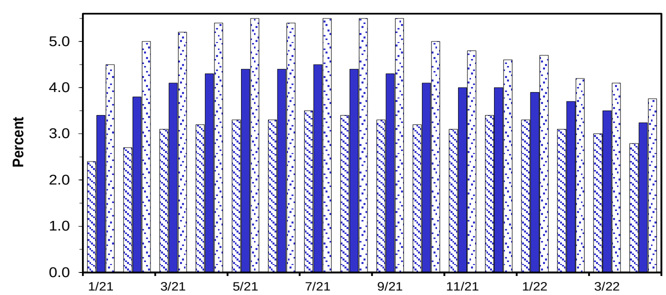
***Denotes the number of times an organization or individual has won the annual Lawrence R. Klein Award for Blue Chip Forecast Accuracy.**

BASIC DATA SOURCES: [1]Gross Domestic Product (GDP), chained 2012$, National Income and Product Accounts (NIPA), Bureau of Economic Analysis (BEA); [2]GDP Chained Price Index, NIPA, BEA; [3]GDP, current dollars, NIPA, BEA; [4]Consumer Price Index-All Urban Consumers, Bureau of Labor Statistics (BLS); [5]Total Industrial Production, Federal Reserve Board (FRB); [6]Disposable Personal Income, 2012$, NIPA, BEA; [7]Personal Consumption Expenditures, 2012$, NIPA, BEA; [8]Non-residential Fixed Investment, 2012$, NIPA, BEA; [9]Corporate Profits Before Taxes, current dollars, with inventory valuation and capital consumption adjustments, NIPA, BEA; [10]PCE Price Index, NIPA, BEA; [11]Treasury Bill Rate, 3-month, secondary market, bank discount basis, FRB; [12]Treasury note yield, 10-year, constant maturity basis, FRB; [13]Unemployment Rate, civilian work force, BLS; [14]Housing Starts, Bureau of Census; [15]Total U.S. Auto and Light Truck Sales (includes imports), BEA; [16]Net Exports of Goods and Services, 2012$, NIPA, BEA.

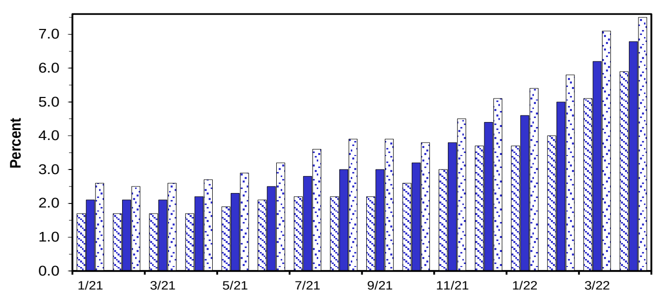
Previous Consensus Forecasts

Consensus Forecast For 2022	Real GDP Chained	GDP Price Index	Nominal GDP (Cur. $)	Consumer Price Index	Indust. Prod. (Total)	Real Dis. Pers. Income	Real Personal Cons. Exp.	Real Non-Res. Fix. Inv.	Corp. Profits (Cur. $)	PCE Price Index	Treas. Bills 3-mo.	Treas. Notes 10-Year	Unempl. Rate (Civ.)	Housing Starts (Mil.)	Auto/Truck Sales (Mil.)	Real Net Exports
January 2021 Consensus	3.4	1.9	5.4	2.1	3.4	1.1	3.6	5.0	5.6	1.9	0.2	1.5	5.0	1.47	16.6	-1081.7
February 2021 Consensus	3.8	2.0	5.9	2.1	3.7	0.0	3.9	5.5	5.0	1.9	0.2	1.6	4.7	1.51	16.8	-1170.2
March 2021 Consensus	4.1	2.0	6.1	2.1	3.7	-0.7	4.2	5.8	5.1	2.0	0.2	1.9	4.5	1.53	16.8	-1232.1
April 2021 Consensus	4.3	2.1	6.4	2.2	3.9	-0.7	4.4	6.0	5.4	2.0	0.2	2.0	4.2	1.54	16.9	-1244.1
May 2021 Consensus	4.4	2.2	6.7	2.3	4.2	-1.1	4.4	6.0	6.3	2.1	0.2	2.1	4.2	1.56	17.0	-1261.2
June 2021 Consensus	4.4	2.4	6.8	2.5	4.2	-1.3	4.3	5.9	6.9	2.3	0.1	2.1	4.2	1.57	16.9	-1259.1
July 2021 Consensus	4.5	2.5	7.0	2.8	4.3	-1.0	4.3	6.0	7.9	2.5	0.1	2.0	4.4	1.58	16.9	-1270.9
August 2021 Consensus	4.4	2.6	7.1	3.0	4.3	-1.4	4.1	6.0	7.5	2.5	0.1	1.9	4.4	1.57	16.8	-1285.8
September 2021 Consensus	4.3	2.8	7.1	3.0	4.2	-1.5	3.7	5.8	5.9	2.6	0.1	1.8	4.3	1.55	16.5	-1266.3
October 2021 Consensus	4.1	3.0	7.3	3.2	4.1	-1.6	3.6	5.6	5.6	2.8	0.1	1.9	4.3	1.57	16.3	-1283.3
November 2021 Consensus	4.0	3.3	7.4	3.8	3.8	-2.0	3.6	5.4	5.5	3.2	0.2	1.9	4.1	1.56	16.0	-1336.7
December 2021 Consensus	4.0	3.7	7.8	4.4	3.9	-2.4	3.7	5.3	4.9	3.6	0.3	1.9	3.8	1.57	15.9	-1329.7
January 2022 Consensus	3.9	3.9	8.0	4.6	4.1	-2.4	3.7	5.2	5.7	3.9	0.4	1.9	3.8	1.59	15.7	-1335.8
February 2022 Consensus	3.7	4.4	8.2	5.0	4.0	-2.9	3.3	5.0	5.4	4.2	0.7	2.1	3.7	1.60	15.8	-1340.2
March 2022 Consensus	3.5	5.2	8.8	6.2	4.5	-3.5	3.2	5.5	5.7	5.2	0.8	2.1	3.6	1.62	15.6	-1371.6
April 2022 Consensus	3.2	5.5	8.9	6.8	4.4	-3.7	3.1	5.4	6.0	5.7	1.2	2.4	3.6	1.65	15.3	-1411.0
Difference From Jan. 2021 Forecast	-0.2	3.6	3.5	4.7	1.0	-4.8	-0.5	0.4	0.4	3.8	1.0	0.9	-1.4	0.18	-1.3	-329.3
Forecast High	4.5	5.5	8.9	6.8	4.5	1.1	4.4	6.0	7.9	5.7	1.2	2.4	5.0	1.65	17.0	-1081.7
Forecast Low	3.2	1.9	5.4	2.1	3.4	-3.7	3.1	5.0	4.9	1.9	0.1	1.5	3.6	1.47	15.3	-1411.0
Consensus Forecast For 2023	Real GDP Chained	GDP Price Index	Nominal GDP (Cur. $)	Consumer Price Index	Indust. Prod. (Total)	Real Dis. Pers. Income	Real Personal Cons. Exp.	Real Non-Res. Fix. Inv.	Corp. Profits (Cur. $)	PCE Price Index	Treas. Bills 3-mo.	Treas. Notes 10-Year	Unempl. Rate (Civ.)	Housing Starts (Mil.)	Auto/Truck Sales (Mil.)	Real Net Exports
January 2022 Consensus	2.6	2.5	5.2	2.4	2.6	2.4	2.4	4.4	3.2	2.3	1.1	2.3	3.5	1.56	16.8	-1356.3
February 2022 Consensus	2.6	2.5	5.1	2.5	2.5	2.6	2.5	4.4	2.8	2.3	1.6	2.5	3.4	1.56	16.9	-1353.5
March 2022 Consensus	2.5	2.7	5.2	2.6	2.4	2.5	2.3	4.3	2.7	2.5	1.7	2.6	3.4	1.58	16.7	-1375.0
April 2022 Consensus	2.3	2.9	5.3	3.0	2.2	2.5	2.2	4.1	2.4	2.8	2.4	2.9	3.5	1.59	16.6	-1405.0
Difference From Jan. 2022 Forecast	-0.3	0.4	0.1	0.6	-0.4	0.1	-0.2	-0.3	-0.8	0.5	1.3	0.6	0.0	0.03	-0.2	-48.7
Forecast High	2.6	2.9	5.3	3.0	2.6	2.6	2.5	4.4	3.2	2.8	2.4	2.9	3.5	1.59	16.9	-1353.5
Forecast Low	2.3	2.5	5.1	2.4	2.2	2.4	2.2	4.1	2.4	2.3	1.1	2.3	3.4	1.56	16.6	-1405.0

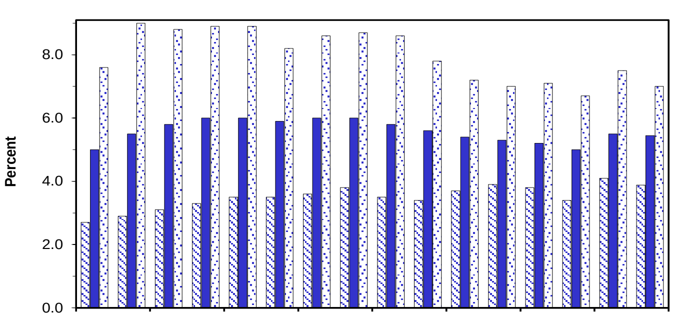
Bottom 10, Consensus, and Top 10 Forecasts of Y/Y % Change in Real GDP in 2022



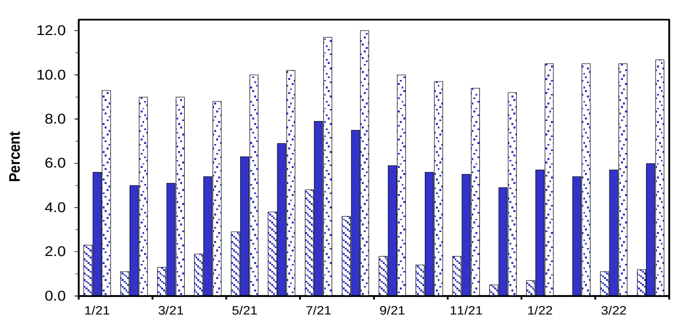
Bottom 10, Consensus, and Top 10 Forecasts of Y/Y % Change in Consumer Price Index in 2022



Bottom 10, Consensus, and Top 10 Forecasts of Y/Y %Chg in Real Nonresidential Fixed Investment in 2022



Bottom 10, Consensus, and Top 10 Forecasts of Y/Y % Change in Corporate Profits in 2022



3. Blue Chip Consensus: Percent Change From Prior Quarter At Annual Rate And Averages For Quarter.*

Actuals	Real GDP	GDP Price Index	CPI	PPI	IP	Disp Personal Income	PCE	PCE Price Index	Core PCE Price Index	Nonres Fixed Inv	Unem-ployment Rate	3-Mo. Treas. Bills	10-Yr Treas Notes	Chg in Bus Inv	Real Net Exports
	% Change From Prior Quarter At Annual Rate										Average For Quarter				
2021 1Q	6.3	4.3	4.1	8.8	4.0	54.7	11.4	3.8	2.7	12.9	6.2	0.1	1.3	-88.3	-1226.1
2Q	6.7	6.1	8.2	10.8	6.5	-29.1	12.0	6.5	6.1	9.2	5.9	0.0	1.6	-168.5	-1244.5
3Q	2.3	6.0	6.7	10.5	3.4	-4.1	2.0	5.3	4.6	1.7	5.1	0.0	1.3	-66.8	-1316.6
4Q	6.9	7.1	7.9	8.5	3.7	-5.6	2.5	6.4	5.0	2.9	4.2	0.1	1.5	193.2	-1350.1
Blue Chip Forecasts	% Change From Prior Quarter At Annual										Average For Quarter				
2022 1Q Consensus	**0.9**	**6.1**	**8.6**	**11.0**	**6.1**	**-2.8**	**3.0**	**7.0**	**5.7**	**8.4**	**3.8a**	**0.3a**	**1.9a**	**111.4**	**-1417.4**
Top 10 Avg.	2.0	7.5	9.2	14.1	8.4	-0.4	4.2	7.8	6.4	11.7	na	na	na	158.7	-1345.1
Bot. 10 Avg.	-0.2	4.7	7.5	8.3	2.6	-5.2	1.4	6.1	5.1	5.3	na	na	na	58.2	-1476.4
2Q Consensus	**3.1**	**5.4**	**6.8**	**7.9**	**4.3**	**0.8**	**2.6**	**5.8**	**4.6**	**6.3**	**3.6**	**1.0**	**2.5**	**110.0**	**-1416.1**
Top 10 Avg.	4.8	7.0	9.0	11.1	6.8	4.4	4.8	7.6	5.8	9.5	3.8	1.3	2.7	166.1	-1324.2
Bot. 10 Avg.	1.6	3.6	4.8	5.1	2.1	-2.2	0.9	4.2	3.5	3.1	3.4	0.7	2.2	57.1	-1495.9
3Q Consensus	**2.7**	**3.7**	**3.7**	**4.4**	**3.0**	**2.0**	**2.4**	**3.5**	**3.6**	**5.1**	**3.5**	**1.5**	**2.6**	**107.3**	**-1411.7**
Top 10 Avg.	3.9	5.1	5.5	7.0	4.7	3.6	3.6	4.9	4.7	7.7	3.8	1.9	3.0	159.6	-1305.5
Bot. 10 Avg.	1.3	2.4	2.0	2.2	1.6	-0.2	0.8	2.4	2.5	2.9	3.3	1.1	2.3	58.0	-1510.2
4Q Consensus	**2.4**	**3.1**	**3.1**	**3.2**	**2.3**	**2.3**	**2.3**	**2.9**	**3.0**	**4.7**	**3.5**	**1.9**	**2.8**	**100.1**	**-1405.5**
Top 10 Avg.	3.5	4.4	4.6	5.5	3.9	3.6	3.2	4.3	4.2	6.6	4.0	2.3	3.2	153.0	-1276.5
Bot. 10 Avg.	1.4	1.9	1.4	0.9	0.4	0.7	1.4	1.6	1.8	2.8	3.2	1.5	2.3	49.0	-1527.5
2023 1Q Consensus	**2.3**	**2.8**	**2.9**	**2.6**	**1.9**	**2.6**	**2.2**	**2.7**	**2.8**	**4.1**	**3.5**	**2.2**	**2.9**	**93.6**	**-1405.5**
Top 10 Avg.	3.1	3.7	3.8	4.1	3.3	4.3	2.9	3.4	3.6	6.1	4.2	2.6	3.5	149.2	-1268.1
Bot. 10 Avg.	1.4	2.0	2.0	1.0	0.4	1.1	1.6	1.9	1.9	2.1	3.1	1.7	2.3	37.0	-1541.6
2Q Consensus	**2.2**	**2.7**	**2.5**	**2.3**	**1.8**	**2.7**	**2.2**	**2.4**	**2.6**	**3.7**	**3.5**	**2.4**	**2.9**	**83.3**	**-1402.7**
Top 10 Avg.	2.9	3.7	3.3	3.6	3.0	4.0	2.9	3.0	3.2	5.8	4.2	2.9	3.6	137.5	-1240.7
Bot. 10 Avg.	1.4	1.8	1.6	0.8	0.0	1.5	1.6	1.8	2.1	1.6	3.0	1.7	2.3	24.1	-1557.0
3Q Consensus	**2.1**	**2.4**	**2.5**	**2.1**	**1.8**	**2.7**	**2.1**	**2.3**	**2.4**	**3.4**	**3.5**	**2.5**	**3.0**	**79.9**	**-1400.8**
Top 10 Avg.	2.8	3.1	3.2	3.1	2.8	4.0	2.8	2.8	3.0	5.5	4.4	3.1	3.7	133.3	-1217.8
Bot. 10 Avg.	1.3	1.7	1.9	0.9	0.5	1.5	1.4	1.8	1.9	1.3	2.9	1.8	2.3	27.0	-1571.5
4Q Consensus	**2.0**	**2.3**	**2.4**	**2.1**	**1.8**	**2.7**	**2.0**	**2.2**	**2.4**	**3.2**	**3.6**	**2.6**	**3.0**	**76.2**	**-1399.9**
Top 10 Avg.	2.8	3.1	3.1	3.0	2.7	4.2	2.8	2.7	2.9	5.1	4.4	3.2	3.7	127.6	-1202.0
Bot. 10 Avg.	1.2	1.6	1.9	1.2	0.7	1.5	1.1	1.7	1.8	1.3	2.8	1.8	2.3	27.9	-1584.0

4. Blue Chip Consensus: Quarterly Annualized Values And Percent Change From Same Quarter In Prior Year.*

Real Gross Domestic Product

	Billions of Chained 2012$ (SAAR)			% Change From Same Quarter In Prior Year		
	Actual	**Forecast**		Actual	**Forecast**	
Quarter	2021	2022	2023	2021	2022	2023
1Q	19055.7	**19852.1**	**20372.4**	0.5	**4.2**	**2.6**
2Q	19368.3	**20004.4**	**20482.3**	12.2	**3.3**	**2.4**
3Q	19478.9	**20136.4**	**20588.4**	4.9	**3.4**	**2.2**
4Q	19806.3	**20258.1**	**20688.9**	5.5	**2.3**	**2.1**

GDP Chained Price Index

	Index 2012 = 100 (SAAR)			% Change From Same Quarter In Prior Year		
	Actual	**Forecast**		Actual	**Forecast**	
Quarter	2021	2022	2023	2021	2022	2023
1Q	115.8	**123.2**	**127.8**	2.1	**6.3**	**3.7**
2Q	117.5	**124.8**	**128.6**	4.1	**6.2**	**3.1**
3Q	119.3	**125.9**	**129.4**	4.6	**5.6**	**2.7**
4Q	121.3	**126.9**	**130.1**	5.9	**4.6**	**2.5**

Total Industrial Production

	Index 2017 = 100 (SAAR)			% Change From Same Quarter In Prior Year		
	Actual	**Forecast**		Actual	**Forecast**	
Quarter	2021	2022	2023	2021	2022	2023
1Q	98.3	**103.1**	**106.1**	-1.6	**4.9**	**2.9**
2Q	99.9	**104.2**	**106.6**	14.7	**4.3**	**2.3**
3Q	100.7	**105.0**	**107.1**	5.5	**4.3**	**2.0**
4Q	101.6	**105.6**	**107.5**	4.4	**3.9**	**1.8**

Consumer Price Index

	Index 1982-1984 = 100 (SAAR)			% Change From Same Quarter In Prior Year		
	Actual	**Forecast**		Actual	**Forecast**	
Quarter	2021	2022	2023	2021	2022	2023
1Q	263.5	**284.2**	**295.9**	1.9	**7.8**	**4.1**
2Q	268.8	**288.9**	**297.7**	4.8	**7.5**	**3.0**
3Q	273.2	**291.6**	**299.5**	5.3	**6.7**	**2.7**
4Q	278.4	**293.8**	**301.3**	6.7	**5.5**	**2.6**

***See explanatory notes on inside of back cover for details of how these data are compiled.**

BLUE CHIP INTERNATIONAL CONSENSUS FORECASTS

	ANNUAL DATA						END OF YEAR			
	Real Economic Growth % Change GDP		Inflation % Change Consumer Prices		Current Account In Billions Of U.S. Dollars		Exchange Rate Against U.S. $*		Interest Rates 3-Month	
CANADA	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**
April 2022 Consensus	**3.7**	**3.1**	**5.0**	**2.6**	**2.5**	**-6.4**	**1.25**	**1.25**	**1.52**	**2.12**
Top 3 Avg.	4.2	3.7	5.7	3.0	13.9	1.7	1.28	1.28	1.87	2.38
Bottom 3 Avg.	3.1	2.5	4.3	2.3	-10.1	-14.5	1.23	1.22	1.16	1.86
Last Month Avg.	3.7	3.2	4.5	2.4	-5.1	-15.3	1.26	1.25	1.31	1.97
	2020	**2021**	**2020**	**2021**	**2020**	**2021**	**Latest**	**Year Ago**	**Latest**	**Year Ago**
Actual	-5.2	4.6	0.7	3.4	-29.2	1.2	1.25	1.26	1.18	0.19
MEXICO	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**
April 2022 Consensus	**1.8**	**2.4**	**6.3**	**4.1**	**-2.1**	**-10.1**	**20.65**	**20.97**	**7.51**	**7.54**
Top 3 Avg.	2.0	2.9	7.3	5.1	8.4	-2.0	21.31	22.03	7.68	7.72
Bottom 3 Avg.	1.5	1.9	5.2	3.4	-11.4	-18.6	19.93	19.85	7.26	7.30
Last Month Avg.	2.0	2.4	5.4	3.9	-3.4	-10.4	20.93	21.19	7.03	7.12
	2020	**2021**	**2020**	**2021**	**2020**	**2021**	**Latest**	**Year Ago**	**Latest**	**Year Ago**
Actual	-8.2	4.8	3.4	5.7	26.2	-4.9	19.82	20.32	7.42	4.17
JAPAN	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**
April 2022 Consensus	**2.3**	**1.9**	**1.6**	**0.8**	**84.1**	**134.0**	**119.0**	**116.5**	**-0.04**	**-0.04**
Top 3 Avg.	2.8	2.6	2.0	1.1	104.8	143.8	124.7	121.2	0.00	0.01
Bottom 3 Avg.	1.7	1.2	1.2	0.3	63.3	124.2	114.6	112.0	-0.09	-0.09
Last Month Avg.	2.6	1.8	1.2	0.8	118.1	157.0	115.9	115.0	-0.05	-0.05
	2020	**2021**	**2020**	**2021**	**2020**	**2021**	**Latest**	**Year Ago**	**Latest**	**Year Ago**
Actual	-4.5	1.7	0.0	-0.2	148.8	141.7	122.9	110.6	0.00	-0.07
UNITED KINGDOM	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**
April 2022 Consensus	**3.5**	**1.8**	**6.7**	**3.1**	**-105.0**	**-92.0**	**1.32**	**1.38**	**1.29**	**1.74**
Top 3 Avg.	4.1	2.6	7.6	3.8	-67.3	-75.7	1.38	1.46	1.45	2.23
Bottom 3 Avg.	2.6	0.8	5.3	2.4	-141.4	-108.3	1.24	1.31	1.14	1.29
Last Month Avg.	3.7	1.9	6.0	2.8	-108.2	-109.6	1.36	1.42	1.29	1.78
	2020	**2021**	**2020**	**2021**	**2020**	**2021**	**Latest**	**Year Ago**	**Latest**	**Year Ago**
Actual	-9.3	7.4	0.9	2.6	-69.9	-82.6	1.31	1.38	1.04	0.09
SOUTH KOREA	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**
April 2022 Consensus	**2.9**	**2.7**	**3.3**	**1.8**	**53.6**	**65.7**	**1187**	**1153**	**1.77**	**2.03**
Top 3 Avg.	3.2	3.5	3.8	2.1	66.6	77.6	1221	1189	1.81	2.06
Bottom 3 Avg.	2.4	2.1	2.9	1.5	39.7	50.7	1142	1112	1.74	2.00
Last Month Avg.	2.9	2.5	3.1	1.8	69.4	72.8	1173	1147	1.69	1.97
	2020	**2021**	**2020**	**2021**	**2020**	**2021**	**Latest**	**Year Ago**	**Latest**	**Year Ago**
Actual	-0.9	4.0	0.5	2.5	75.9	88.3	1215	1132	1.54	0.76
GERMANY	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**
April 2022 Consensus	**2.3**	**2.7**	**6.2**	**2.3**	**185.5**	**211.4**	**1.13**	**1.17**	**-0.42**	**-0.12**
Top 3 Avg.	2.6	3.4	6.9	3.0	220.3	244.3	1.18	1.23	-0.28	0.09
Bottom 3 Avg.	1.9	1.9	5.4	1.5	150.6	178.4	1.07	1.12	-0.57	-0.32
Last Month Avg.	2.7	2.9	4.8	1.9	207.1	236.2	1.14	1.18	-0.48	-0.37
	2020	**2021**	**2020**	**2021**	**2020**	**2021**	**Latest**	**Year Ago**	**Latest**	**Year Ago**
Actual	-4.9	2.9	0.4	3.2	274.5	313.8	1.10	1.18	-0.46	-0.54
TAIWAN	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**
April 2022 Consensus	**3.6**	**2.9**	**2.5**	**1.7**	**103.6**	**105.2**	**28.06**	**27.77**	**0.68**	**0.88**
Top 3 Avg.	4.4	3.7	2.8	2.1	113.9	114.1	28.65	28.43	0.72	0.95
Bottom 3 Avg.	2.9	2.2	2.2	1.2	93.7	94.0	27.48	27.11	0.62	0.79
Last Month Avg.	3.5	3.0	2.4	1.6	107.5	108.4	27.70	27.31	0.62	0.82
	2020	**2021**	**2020**	**2021**	**2020**	**2021**	**Latest**	**Year Ago**	**Latest**	**Year Ago**
Actual	3.4	6.4	-0.2	2.0	95.0	116.1	28.71	28.51	0.73	0.48
NETHERLANDS	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**
April 2022 Consensus	**3.0**	**1.9**	**7.2**	**1.7**	**89.8**	**100.2**	**1.13**	**1.17**	**-0.42**	**-0.12**
Top 3 Avg.	3.3	2.1	8.2	2.3	104.4	118.8	1.18	1.23	-0.28	0.09
Bottom 3 Avg.	2.7	1.8	6.1	1.2	75.2	81.7	1.07	1.12	-0.57	-0.32
Last Month Avg.	3.4	2.1	5.7	1.5	104.4	113.6	1.14	1.18	-0.48	-0.37
	2020	**2021**	**2020**	**2021**	**2020**	**2021**	**Latest**	**Year Ago**	**Latest**	**Year Ago**
Actual	-3.8	5.0	1.1	2.8	63.6	96.6	1.10	1.18	-0.46	-0.54

BLUE CHIP INTERNATIONAL CONSENSUS FORECASTS

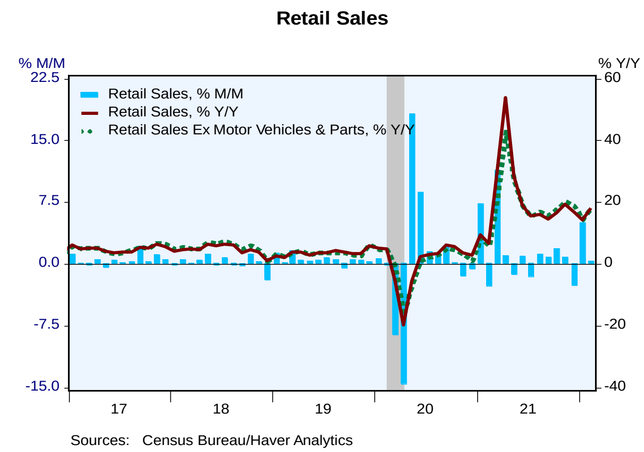
	ANNUAL DATA						END OF YEAR			
	Real Economic Growth % Change GDP		Inflation % Change Consumer Prices		Current Account In Billions Of U.S. Dollars		Exchange Rate Against U.S. $		Interest Rates 3-Month	
RUSSIA	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**
April 2022 Consensus	**-10.1**	**-1.1**	**17.1**	**11.5**	**216.0**	**197.1**	**101.08**	**97.56**	**17.91**	**11.53**
Top 3 Avg.	-7.0	4.0	22.7	18.5	344.7	325.2	114.97	115.33	20.04	13.28
Bottom 3 Avg.	-13.3	-5.7	12.1	5.7	86.6	76.5	82.97	77.03	15.78	9.78
Last Month Avg.	-7.2	-0.7	14.1	9.6	170.6	134.4	90.93	88.24	14.44	9.91
	2020	**2021**	**2020**	**2021**	**2020**	**2021**	**Latest**	**Year Ago**	**Latest**	**Year Ago**
Actual	-3.0	4.2	3.4	6.7	36.0	122.0	84.62	76.36	45.49	4.81
FRANCE	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**
April 2022 Consensus	**3.1**	**2.1**	**4.5**	**2.0**	**-60.4**	**-46.3**	**1.13**	**1.17**	**-0.42**	**-0.12**
Top 3 Avg.	3.5	2.5	5.1	2.5	-38.7	-26.2	1.18	1.23	-0.28	0.09
Bottom 3 Avg.	2.8	1.7	3.8	1.4	-82.1	-66.4	1.07	1.12	-0.57	-0.32
Last Month Avg.	3.4	2.2	3.8	1.8	-61.5	-51.1	1.14	1.18	-0.48	-0.37
	2020	**2021**	**2020**	**2021**	**2020**	**2021**	**Latest**	**Year Ago**	**Latest**	**Year Ago**
Actual	-8.0	7.0	0.5	2.1	-49.0	-17.7	1.10	1.18	-0.46	-0.54
BRAZIL	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**
April 2022 Consensus	**0.4**	**1.8**	**8.6**	**4.4**	**-14.5**	**-31.2**	**5.25**	**5.20**	**12.31**	**8.36**
Top 3 Avg.	1.0	2.4	9.6	4.9	7.9	-16.4	5.46	5.44	12.85	8.92
Bottom 3 Avg.	-0.3	1.1	7.1	3.9	-35.2	-48.0	4.99	4.95	11.72	7.85
Last Month Avg.	0.7	1.7	8.1	4.2	-21.2	-34.0	5.47	5.35	11.47	8.16
	2020	**2021**	**2020**	**2021**	**2020**	**2021**	**Latest**	**Year Ago**	**Latest**	**Year Ago**
Actual	-3.9	4.6	3.2	8.3	-24.5	-27.9	4.70	5.68	12.42	3.31
HONG KONG	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**
April 2022 Consensus	**1.6**	**3.1**	**2.6**	**2.2**	**19.2**	**16.7**	**7.82**	**7.80**	**1.14**	**1.72**
Top 3 Avg.	2.4	3.8	3.4	2.7	29.7	25.7	7.84	7.81	1.46	1.98
Bottom 3 Avg.	0.9	2.5	2.1	1.9	8.9	7.1	7.79	7.79	0.77	1.40
Last Month Avg.	1.8	3.3	2.5	1.9	20.3	17.9	7.80	7.79	1.05	1.71
	2020	**2021**	**2020**	**2021**	**2020**	**2021**	**Latest**	**Year Ago**	**Latest**	**Year Ago**
Actual	-6.5	6.4	0.3	1.6	24.1	41.4	7.83	7.78	0.53	0.23
INDIA	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**
April 2022 Consensus	**7.5**	**6.1**	**5.8**	**4.9**	**-77.1**	**-75.8**	**76.47**	**76.33**	**4.66**	**5.07**
Top 3 Avg.	8.5	7.2	6.7	5.3	-43.8	-57.7	77.57	78.00	4.82	5.22
Bottom 3 Avg.	6.9	5.2	4.9	4.3	-104.4	-90.1	75.63	74.70	4.51	4.91
Last Month Avg.	7.6	6.1	5.7	4.9	-68.2	-68.4	75.88	75.88	4.62	5.08
	2020	**2021**	**2020**	**2021**	**2020**	**2021**	**Latest**	**Year Ago**	**Latest**	**Year Ago**
Actual	-6.5	8.1	6.6	5.1	32.7	-34.6	75.78	73.11	3.83	3.27
CHINA	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**
April 2022 Consensus	**5.0**	**5.2**	**2.2**	**2.3**	**262.8**	**220.4**	**6.47**	**6.37**	**2.34**	**2.49**
Top 3 Avg.	5.6	5.6	2.6	3.0	324.7	278.6	6.61	6.53	2.43	2.56
Bottom 3 Avg.	4.4	4.8	1.7	1.9	206.8	171.6	6.33	6.23	2.29	2.44
Last Month Avg.	5.2	5.0	2.5	2.5	301.2	254.8	6.45	6.40	2.38	2.49
	2020	**2021**	**2020**	**2021**	**2020**	**2021**	**Latest**	**Year Ago**	**Latest**	**Year Ago**
Actual	2.2	8.1	2.5	0.8	248.8	317.3	6.36	6.57	2.37	2.63
AUSTRALIA	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**
April 2022 Consensus	**3.8**	**3.0**	**3.7**	**2.4**	**52.3**	**14.5**	**0.75**	**0.76**	**0.72**	**1.51**
Top 3 Avg.	4.3	3.5	4.5	2.9	72.4	19.7	0.78	0.79	0.86	1.88
Bottom 3 Avg.	3.2	2.6	3.1	2.1	32.1	7.4	0.71	0.72	0.58	1.17
Last Month Avg.	3.7	3.0	3.4	2.3	31.3	9.0	0.74	0.74	0.56	1.03
	2020	**2021**	**2020**	**2021**	**2020**	**2021**	**Latest**	**Year Ago**	**Latest**	**Year Ago**
Actual	-2.2	4.7	0.8	2.9	35.5	56.7	0.75	0.76	0.20	-0.17
EURO AREA	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**
April 2022 Consensus	**2.7**	**2.4**	**5.9**	**2.1**	**333.3**	**334.1**	**1.13**	**1.17**	**-0.42**	**-0.12**
Top 3 Avg.	3.3	2.7	6.8	2.8	452.4	402.1	1.18	1.23	-0.28	0.09
Bottom 3 Avg.	1.9	1.6	4.4	1.4	214.2	271.8	1.07	1.12	-0.57	-0.32
Last Month Avg.	3.1	2.5	4.7	1.8	387.3	380.2	1.14	1.18	-0.48	-0.37
	2020	**2021**	**2020**	**2021**	**2020**	**2021**	**Latest**	**Year Ago**	**Latest**	**Year Ago**
Actual	-6.5	5.3	0.3	2.6	257.1	345.9	1.10	1.18	-0.46	-0.54

2021 GDP for Russia is not yet available. The cited figure is the consensus forecast from the December 10, 2021 Blue Chip Economic Indicators.

Contributors to Blue Chip International Survey: ACIMA Private Wealth, US; Bank of America-Merrill Lynch, US; Barclays, US; BMO Capital Markets, US; Credit Suisse, US; Eaton Corporation, US; Economist Intelligence Unit, UK; FedEx Corporation, US; General Motors Corporation, US; Grupo de Economistas y Asociados, Mexico; US; IHS Markit, US; JPMorgan Chase, US; Moody's Analytics, US; Nomura Securities, US; Northern Trust, US; Oxford Economics, US; S&P Global, US; Wells Fargo, US.

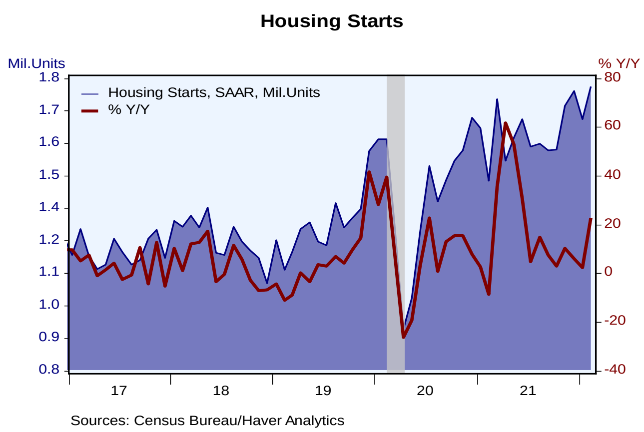
Recent Developments:

Retail Sales Rose a Modest 0.3% in February, the Sixth M/M Rise in Seven Months



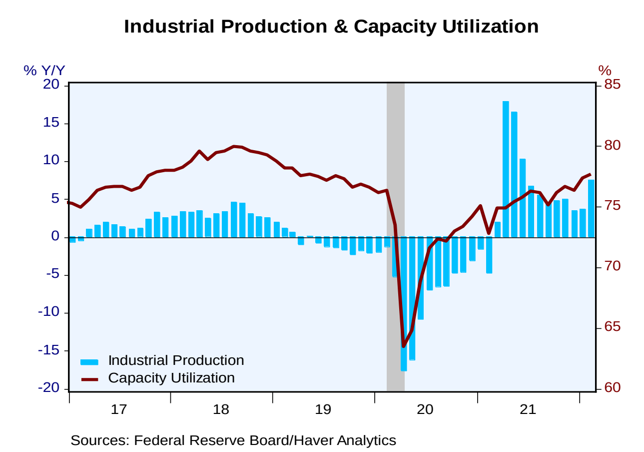
Total retail sales rose 0.3% m/m (17.6% y/y) in February after a 4.9% January rise and a 2.7% December drop. Excluding motor vehicles & parts, retail sales increased 0.2% (17.7% y/y) after a 4.4% rebound. Sales of motor vehicles & parts rose 0.8% (17.2% y/y) after a 6.9% gain. Nonauto sales excl. gasoline & building materials fell 1.2% (+12.9% y/y) vs. a 6.7% rise. Gasoline station sales rebounded 5.3% (36.4% y/y), the ninth m/m rise in 10 months. Clothing & accessory store sales rose 1.1% (30.6% y/y), the fifth m/m rise in six months. Building materials & garden equipt. store sales grew 0.9% (14.8% y/y), the seventh straight m/m gain. Nonstore retail sales, however, fell 3.7% (+13.8% y/y) after having recovered 20.6%. Furniture & home furnishing store sales dropped 1.0% (+7.4% y/y) vs. a 7.5% rebound. Electronics & appliance store sales fell 0.6% (+2.6% y/y), the third m/m fall in four months. General merchandise store sales eased 0.2% (+12.8% y/y) after a 4.5% rebound. Health & personal care store sales fell 1.8% (+8.9% y/y) vs. three straight m/m gains. Food & bev. store sales declined 0.5% (+7.9% y/y). Restaurant & drinking place sales rose 2.5% (33.0% y/y) vs. two successive m/m drops.

February Housing Starts Rebounded 6.8% to 1.769 Million AR, the Highest Level since June 2006



Total housing starts rose 6.8% m/m (22.3% y/y) to 1.769 mil. saar in February after a 5.5% drop to 1.657 mil. in January and a 3.0% rise to 1.754 mil. in December. Single-family starts grew 5.7% (13.7% y/y) to 1.215 mil., the first rise in three months, after a 4.4% decline to 1.150 mil. Multi-family starts rebounded 9.3% (46.6% y/y) to 554,000, the highest level since Jan. '20, after an 8.0% drop to 507,000. Starts in the Northeast recovered 28.7% (19.3% y/y) to 130,000 vs. a 27.9% fall to 101,000. Starts in the Midwest advanced 15.3% (66.2% y/y) to 226,000 following a 39.5% plunge to 196,000. Starts in the South rose 11.4% (31.9% y/y) to 1.017 mil., the highest level since Mar. '06, on top of a 1.4% rise to 913,000. In contrast, starts in the West fell 11.4% (-8.1% y/y) to 396,000 vs. a 14.6% rebound to 447,000. Building permits declined 1.6% (+8.1% y/y) to 1.865 mil. after a 0.5% gain to 1.895 mil. Single-family permits slipped 0.7% (+5.2% y/y) to 1.205 mil., the first m/m fall since September, after a 7.5% rise to 1.213 mil. Multi-family permits slid 3.2% (+13.6% y/y) to 660,000, the lowest level since November, after a 9.9% drop to 682,000.

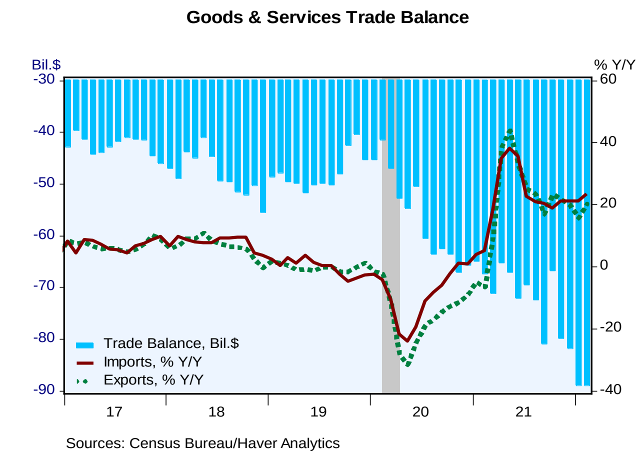
Industrial Production Grew 0.5% in February, the Fourth M/M Gain in Five Months



Total industrial production rose 0.5% m/m (7.5% y/y) in February after a 1.4% January rise and a 0.4% December drop. The Feb. IP was 2.3% above its pre-pandemic level. Mfg. production grew 1.2% (7.4% y/y) after a 0.1% uptick, with durable goods up 1.3% (7.2% y/y) and nondurable goods up 1.1% (8.4% y/y). Aircraft production rose 2.5% (7.2% y/y), the fifth m/m rise in six months. Output of selected high-tech products grew 1.8% (7.8% y/y) after no change. Business equipt. rose 1.9% (6.2% y/y), the first m/m rise since November. Construction supplies recovered 1.6% (8.8% y/y), the seventh m/m rise in eight months. Materials production grew 0.5% (9.4% y/y), the fourth m/m rise in five months. Mining activity ticked up 0.1% (17.3% y/y) after a 1.3% rise. Motor vehicles, however, fell 3.5% (0.0% y/y), the third straight m/m fall. Utilities output slid 2.7% (-1.2% y/y) vs. a 10.4% jump. Consumer goods output declined 0.4% (+3.5% y/y), with durable consumer goods down 1.4% (+3.4% y/y) and nondurable consumer goods down 0.1% (+3.5% y/y). Capacity utilization rose to 77.6%, the highest since May 2019, from 77.3%. Mfg. capacity utilization rose to 78.0%, the highest since Sept. 2018, from 77.1%.

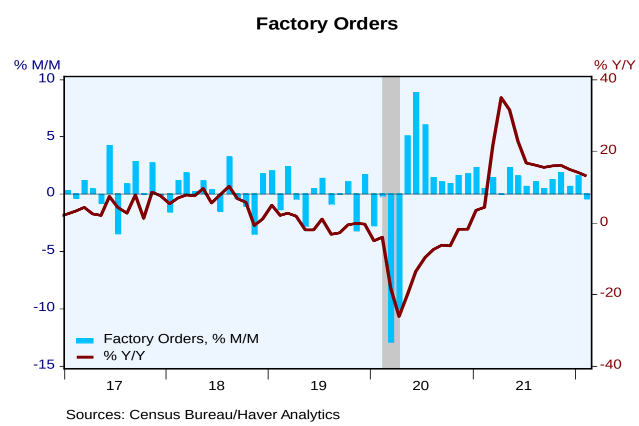
Recent Developments:

February Trade Deficit Eased to $89.19 Billion from a Record High



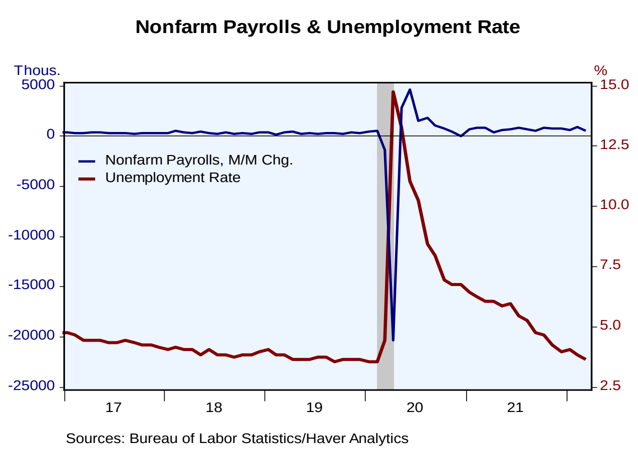
The U.S. trade deficit in goods & services fell marginally to $89.19 bil. in February from a record $89.23 bil. in January, still well above the $67.55 bil. in Feb. '21. Exports rose 1.8% m/m (19.9% y/y), the fourth monthly rise in five months, after a 1.7% drop. Imports grew 1.3% (23.1% y/y), the seventh straight m/m gain, on top of a 1.1% rise. The deficit in goods trade fell to $107.47 bil. from a record $108.60 bil. Goods exports recovered 1.8% (21.6% y/y), led by rises of 6.7% (34.4% y/y) in consumer goods, 4.6% (6.9% y/y) in foods, feeds & bev., and 3.0% (31.2% y/y) in industrial supplies. Imports of goods rose 0.6% (21.5% y/y), led by rises of 5.5% (40.3% y/y) in industrial supplies, 5.0% (12.2% y/y) in other goods, 1.4% (16.5% y/y) in capital goods, and 0.7% (20.2% y/y) in consumer goods. Petroleum imports jumped 18.6% (75.6% y/y), mostly due to higher prices. Nonpetroleum imports fell 0.8% (+17.9% y/y). The surplus on services trade fell to $18.29 bil. from $19.37 bil. Services exports rose 2.0% (16.2% y/y) while services imports rose 5.0% (32.3% y/y). The real (infl-adj.) goods trade deficit fell to $116.28 bil. from a record $117.89 bil. The goods trade deficit with China rose to a record $41.21 bil.

Factory Orders Fell 0.5% in February, the First M/M Fall since April 2021



Factory orders fell 0.5% m/m (+12.6% y/y) in Feb. after gains of 1.5% in Jan. and 0.7% in Dec. Factory orders excl. transportation rose 0.4% (13.4% y/y), the 12th straight m/m rise. Durable goods orders slid 2.1% (+10.3% y/y), the first m/m decline since Sept. Transportation equipt. orders fell 5.3% (+8.7% y/y), led by m/m orders drops in nondefense aircraft & parts (-30.4%) and motor vehicles & parts (-0.6%). Machinery orders decreased 2.9% (+12.3% y/y) vs. a 3.0% rise. Orders for computers & electronic products slid 1.1% (+4.3% y/y) vs. a 0.4% rebound. Primary metal orders fell 0.9% (+19.7% y/y), the largest m/m fall since August. To the upside, orders for furniture rebounded 2.7% (5.3% y/y), the third m/m rise in four months. Electrical equipt. & parts orders rose 0.6% (7.8% y/y) vs. a 0.3% decline. Orders for fabricated metal products edged up 0.1% (11.3% y/y), the third m/m gain in four months. Nondurable goods orders grew 1.2% (15.1% y/y), the 12th straight m/m gain. Factory shipments rose 0.6% (13.7% y/y), the 12th successive m/m rise. Unfilled orders increased 0.4% (8.4% y/y). Inventories rose 0.6% (9.7% y/y), the 17th straight m/m rise.

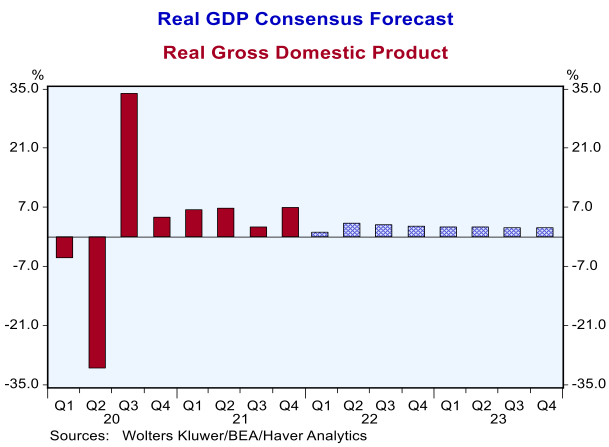
March Job Gains Slowed to a Still-Strong 431K; Jobless Rate Fell to 3.6%



Nonfarm payrolls rose 431K (4.5% y/y) in March after upwardly revised gains of 750K in Feb. and 504K in Jan. but were down 1.6 million or 1.0% from their pre-COVID (Feb. '20) level. The jobless rate fell to 3.6% from 3.8%. The total unemployment rate, incl. those marginally attached & working part-time for econ. reasons, fell to 6.9%, the lowest since Jan. '20, from 7.2%. Total priv. payrolls rose 426K (5.0% y/y) after a 739K gain, with priv. svcs. jobs up 366K (5.4% y/y) and goods-producing jobs up 60K (3.3% y/y). Jobs rose in leisure & hospitality (+112K), prof. & business svcs. (+102K), and retail trade (+49K). Mfg. jobs rose 38K (3.2% y/y), the 11th consecutive m/m rise, with gains in durable goods (+22K) and nondurable goods (+16K). Gov't. jobs rose 5K (1.4% y/y), the smallest of five straight m/m rises. Avg. hourly earnings rose 0.4% m/m after a 0.1% uptick, raising the y/y rate to 5.6%, the highest since May '20, from 5.2%. The avg. workweek eased to 34.6 hrs. from 34.7 hrs. The 0.2%-pt. decline in the jobless rate to 3.6% reflected a 318K drop in unemployed and gains of 736K in civilian employment and 418K in the labor force. The participation rate rose to 62.4%, a two-year high, from 62.3%.

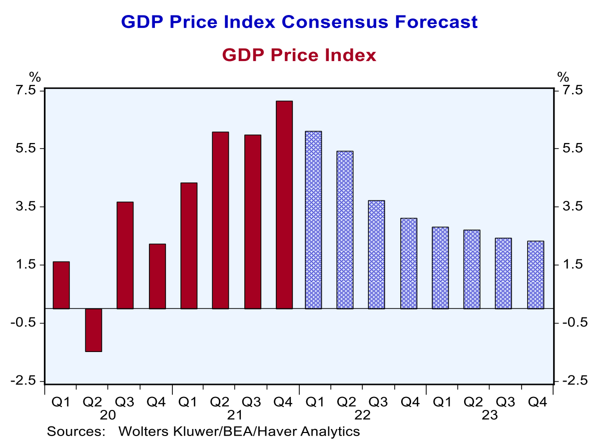
Quarterly U.S. Forecasts:

Real GDP



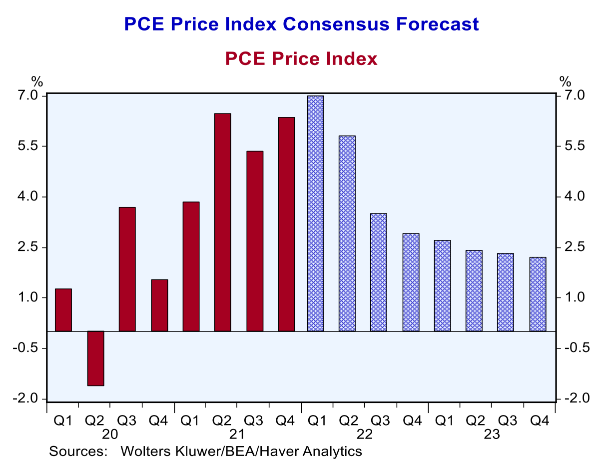
U.S. real GDP growth in 2021 Q4 was revised down to 6.9% q/q saar in the third estimate from 7.0% in the second estimate. Growth in demand was revised slightly weaker with final sales growth revised down to 1.5% from 2.0%. A downward revision to personal consumption expenditures growth accounted for much of the downward revision to overall demand. PCE growth was revised down to 2.5% q/q from 3.1% in the second estimate. Inventories rose more in the third estimate than they had in the second. This boosted their contribution to overall GDP growth to 5.3%-points from 4.9%-points. This outsize contribution from inventory building would normally generate expectations of a sharp slowdown in growth in the next quarter. However, inventory depletion had previously been so large that further rebuilding is likely going forward, though probably at a slower pace. Indeed, our forecasters look for inventory building to be a small drag on Q1 GDP growth. With consumption tepid so far in Q1 and inventories likely exerting a drag, our forecast panel expects a sharp slowing of GDP growth to 0.9% in Q1 with only a modest rebound to 3.1% in Q2.

Chained GDP Price Index



Overall inflation in Q4 was unrevised but continued to run hot. The GDP price index increased 7.1% q/q saar, the same as in the second estimate, and still the fastest rate since 1981 Q3. No revision had been expected. The rate of Q4 inflation was not revised for most major categories. The rise in the PCE price index was revised up slightly to 6.4% from 6.3%. By contrast, prices of residential investment were revised down slightly to an 11.9% rise vs. 12.1% in the second estimate, still their fourth consecutive quarterly double-digit increase. Looking ahead, the Russian invasion of Ukraine has significantly boosted already elevated energy and agricultural prices. Since the end of Q4, the global price of oil is up more than 37% while the price of wheat has risen more than 35%. These increases have not yet appeared in the GDP price index. Blue Chip forecasters have been consistently raising their inflation forecasts over the past six months and now look for a 6.1% rise in the GDP price index in Q1, up from 5.6% in March, and a 5.4% increase in Q2 versus 4.7% last month. Inflation is expected to average 3.4% in the second half of 2022.

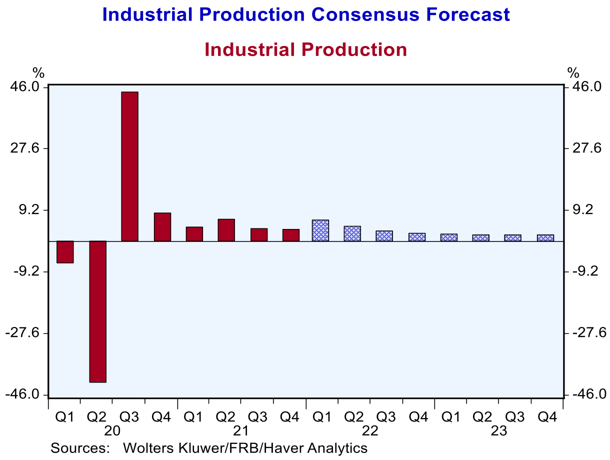
Chained PCE Price Index



As has the GDP price index, the PCE price index has also continued to soar. The 6.3% q/q saar increase in Q4 in the second estimate of GDP was revised up slightly to 6.4%, while the core reading was unrevised at 5.0%. However, there is likely more acceleration to come, notably due to the fallout from the Russian invasion of Ukraine. That invasion has pushed prices of key commodities even higher and will likely further exacerbate supply-chain bottlenecks. The headline PCE price index has risen either 0.5% m/m or 0.6% m/m not annualized in each month since last October. So far in the first two months of 2022 Q1, the headline index is up at a 6.8% annual rate from the Q4 average, while the core index (excluding food and energy prices) has risen 5.7%. Both rates are meaningfully higher than in Q4. Blue Chip forecasters have abandoned their view that last year's acceleration in inflation would be temporary. They now expect PCE price inflation to remain above the Fed's 2% target over the forecast horizon with a 7.0% increase in Q1, up from 6.6% in last month's forecast, followed by a modest slowdown to 5.8% in Q2 and 3.2% in the second half of 2022.

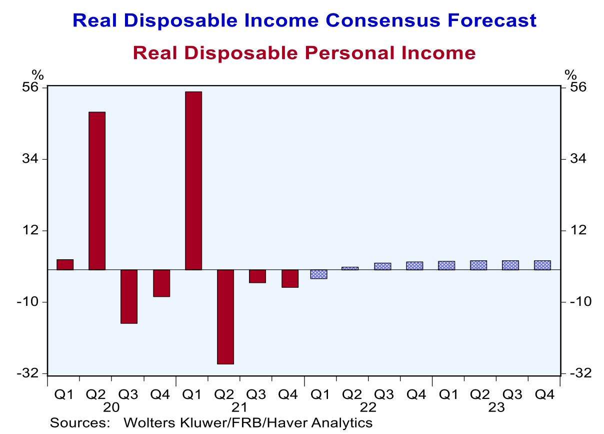
Quarterly U.S. Forecasts:

Industrial Production



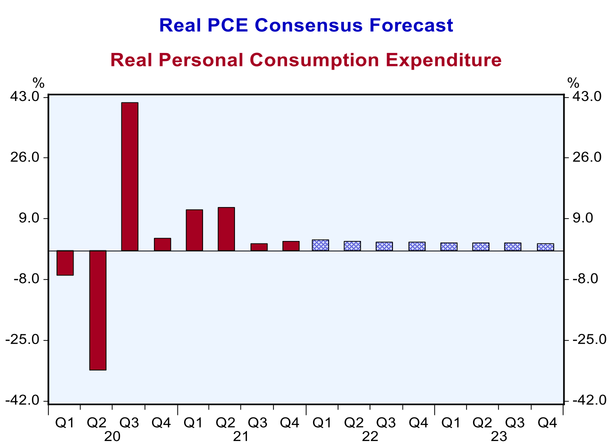
Total industrial production (IP) rose 0.5% m/m in February (7.5% y/y), reflecting a gain in manufacturing (1.2% m/m) and a marginal rise in mining (0.1% m/m) offsetting a decline in utilities (-2.7% m/m). Total IP is now 2.3% above its pre-pandemic (February 2020) level. Three broad headwind categories may possibly weigh on IP growth going forward. First, the shortage of electronic components continues to restrain motor vehicle production, which declined 3.5% in February. At least one producer has announced further cuts, potentially hampering motor vehicle output in March. Second, while progress is being achieved to solve labor shortages, the March ISM report continues to underscore the demand-driven and supply-constrained challenges. The manufacturing ISM index edged down to 57.1 in March from 58.6 in February and the production component dropped to 54.5 from 58.5 in February. Third, the COVID-related lockdown of factories in China could affect U.S. manufacturing supply chains. The April Blue Chip panelists estimate a rise in IP of 6.1% q/q saar in Q1 2022. Last month, the panelists had projected a 5.7% q/q rise for Q1. They project a rise of 4.3% q/q saar in Q2, consistent with a rise of 4.4% for the full year.

Real Disposable Personal Income



Personal income rose 0.5% m/m in February (6.0% y/y), driven by a 0.8% m/m (11.5% y/y) rise in wages and salaries, with monthly gains in both private and government compensation. Disposable personal income (DPI) rose 0.4% m/m (4.6% y/y). When adjusted for inflation, both personal income and DPI posted small monthly declines of 0.1% and 0.2%, respectively. Robust increases in wages should continue to support income growth in months ahead and partially offset the headwinds related to both inflation and declines in government social benefits linked to the pandemic. For the first two months of last quarter, the decline in real DPI was close to the 2.6% q/q saar projected for Q1 2022 by the Blue Chip panelists in March. The April Blue Chip consensus estimate for Q1 2022 looks for a steeper decline of 2.8% q/q saar. The panelists also project slightly smaller increases of 0.8% q/q saar and 2.0% in Q2 and Q3, respectively, from their March estimates of 0.9% and 2.2%. The April projections are consistent with a 3.7% y/y decline for the entire year, compared with the 3.5% contraction projected in March, followed by an expected 2.5% y/y rebound in 2023.

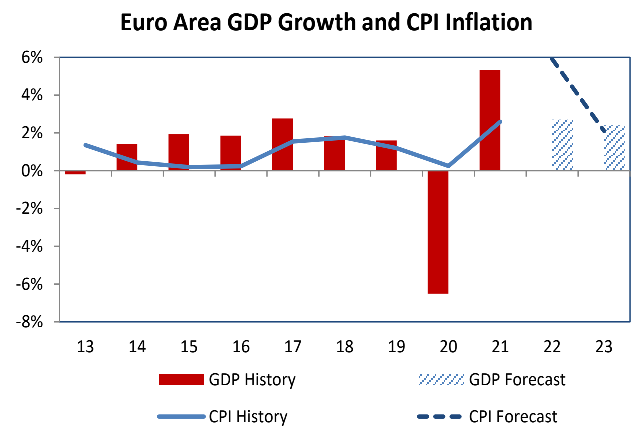
Real Personal Consumption Expenditures



Real PCE growth for Q4 was revised down meaningfully to 2.5% q/q saar in the third estimate from 3.1% in the second and 3.3% in the advance report as rising inflation continues to take a bite out of households' purchasing power. The downward revision reflected slower growth in spending on both goods and services than previously estimated. Ongoing improvement in labor market conditions is providing a firm foundation for consumer spending. However, the relentless rise in inflation, the recent invasion of Ukraine by Russia and the move to less accommodative monetary policy by the Fed are denting consumer sentiment even as COVID is becoming less of a concern. Consumer spending ended Q4 on weak footing as the Omicron wave began to soar. However, spending recovered quickly during January, with the Omicron wave receding as quickly as it had risen, but then was softer than expected in February with real spending declining 0.4% m/m not annualized. Real PCE thus far in Q1 is up 3.8% at an annual rate from the Q4 average. Blue Chip forecasters apparently look for further weakness in consumer spending in March as they anticipate spending growth of 3.0% in Q1 with a modest slowdown to 2.6% in Q2.

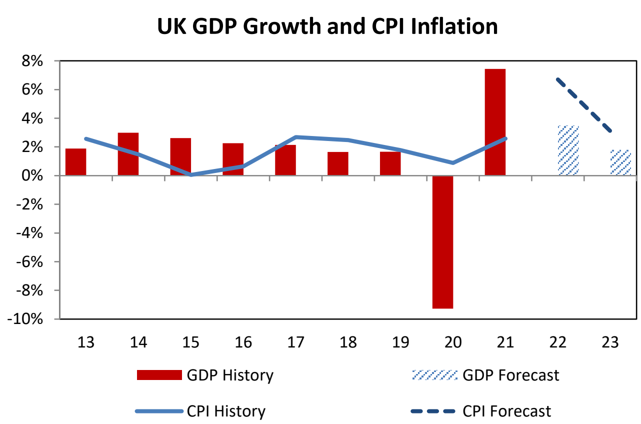
International Forecasts:

Euro area



The Russian war on Ukraine is already impacting the Euro area economy. The European Commission consumer confidence index plummeted to -18.7% in March from -8.8% in February and the economic sentiment index dropped to 108.5 last month from 113.9 in February. The manufacturing PMI index declined to 56.5 in March from 58.2 in February, the PMI's future output index (NSA) fell to 54.4 from 68.5 in February and 69.3 in March 2021, while inflation climbed further. The HICP consumer price index rose 7.5% y/y last month, up from a 5.8% rise in February. Food prices reported with the flash HICP estimate rose 5.0% y/y and energy prices rose 44.7% y/y. The labor markets are tight. The unemployment rate dipped in February to a record low 6.8%. But the war-induced economic uncertainties may tame expectations for wage growth acceleration. For now, the ECB appears set to pursue the path of monetary policy normalization announced in March, potentially putting the burden on fiscal policy to offset any economic growth shortfall due to the war shock. The April Blue Chip panelists revised down their 2022 GDP growth projection to 2.7% from 3.1% held last month and revised up their inflation projection to 5.9% from 4.7%.

UK



The Russia/Ukraine conflict has rapidly replaced COVID as the key source of downside risk for the UK economy. While UK activity indicators have held up relatively well so far, those that measure confidence or expectations—as opposed to output or spending—have weakened sharply. The GFK index of consumer confidence, for example, fell to -31 in March from an already weak -26 in February. And while the composite PMI increased to 60.9 in March from 59.9 in February, the expectations balance slumped to its lowest level for 17 months. Manufacturing components also saw a marked slowdown. A difficult UK inflation picture, in the meantime, shows no signs of abating, as headline CPI inflation rose to 6.2% y/y in February from 5.5% in January. Finally, while the Bank of England raised its policy rate 25 bps at its March meeting, the third increase in as many meetings, it softened its rhetoric in an apparent response to the increased economic uncertainty posed by the Russian invasion of Ukraine. Against this backdrop Blue Chip panelists are now forecasting UK GDP growth of 3.5% in 2022 and 1.8% in 2023, both are down from 3.7% and 1.9%, respectively, in the March survey.

China

While market attention in North America and Europe has mostly shifted to the economic impact of the Russian invasion of Ukraine, the Chinese economy remains dominated by COVID. As new cases continue to soar, the Chinese government's zero-COVID policy has led to strict and widespread lockdowns that have significantly restrained production and exacerbated already severe supply-chain problems. March readings on the PMIs clearly showed the strain on the economy. The Markit manufacturing PMI fell 2.3-pts to 48.1, well below the critical 50 level that separates expansion from contraction, led by a 6.2-point drop in new orders and a 3.7-point decline in output. The service-sector PMI was even weaker, plunging 8.2-points to 42.0 in March, its lowest reading since the initial pandemic lockdown in February 2020. Moreover, supply delivery times continued to lengthen. On the brighter side, Chinese inflation has remained well contained, in contrast to inflation in North America and Europe. China's CPI was up just 0.9% y/y in February (the latest reading). Monetary policy has eased over the past several months with more accommodation expected ahead. Blue Chip forecasters have lowered their 2022 outlook for real GDP growth to 5.0% from 5.2% last month with a modest pickup to 5.2% in 2023.

Databank:

2022 Historical Data

Monthly Indicator	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Retail and Food Service Sales (a)	4.9	0.3	....	....	....	....	....	....	....	....	....	....
Auto & Light Truck Sales (b)	15.02	13.97	13.33	....	....	....	....	....	....	....	....	....
Personal Income (a, current $)	0.1	0.5	....	....	....	....	....	....	....	....	....	....
Personal Consumption (a, current $)	2.7	0.2	....	....	....	....	....	....	....	....	....	....
Consumer Credit (e)	2.4	11.3	....	....	....	....	....	....	....	....	....	....
Consumer Sentiment (U. of Mich.)	67.2	62.8	59.4	....	....	....	....	....	....	....	....	....
Household Employment (c)	1199	548	736	....	....	....	....	....	....	....	....	....
Nonfarm Payroll Employment (c)	504	750	431	....	....	....	....	....	....	....	....	....
Unemployment Rate (%)	4.0	3.8	3.6	....	....	....	....	....	....	....	....	....
Average Hourly Earnings (All, cur. $)	31.56	31.60	31.73	....	....	....	....	....	....	....	....	....
Average Workweek (All, hrs.)	34.6	34.7	34.6	....	....	....	....	....	....	....	....	....
Industrial Production (d)	3.6	7.5	....	....	....	....	....	....	....	....	....	....
Capacity Utilization (%)	77.3	77.6	....	....	....	....	....	....	....	....	....	....
ISM Manufacturing Index (g)	57.6	58.6	57.1	....	....	....	....	....	....	....	....	....
ISM Nonmanufacturing Index (g)	59.9	56.5	58.3	....	....	....	....	....	....	....	....	....
Housing Starts (b)	1.657	1.769	....	....	....	....	....	....	....	....	....	....
Housing Permits (b)	1.895	1.865	....	....	....	....	....	....	....	....	....	....
New Home Sales (1-family, c)	788	772	....	....	....	....	....	....	....	....	....	....
Construction Expenditures (a)	1.6	0.5	....	....	....	....	....	....	....	....	....	....
Consumer Price Index (nsa, d)	7.5	7.9	....	....	....	....	....	....	....	....	....	....
CPI ex. Food and Energy (nsa, d)	6.0	6.4	....	....	....	....	....	....	....	....	....	....
PCE Chain Price Index (d)	6.0	6.4	....	....	....	....	....	....	....	....	....	....
Core PCE Chain Price Index (d)	5.2	5.4	....	....	....	....	....	....	....	....	....	....
Producer Price Index (nsa, d)	10.0	10.0	....	....	....	....	....	....	....	....	....	....
Durable Goods Orders (a)	1.5	-2.1	....	....	....	....	....	....	....	....	....	....
Leading Economic Indicators (a)	-0.5	0.3	....	....	....	....	....	....	....	....	....	....
Balance of Trade & Services (f)	-89.2	-89.2	....	....	....	....	....	....	....	....	....	....
Federal Funds Rate (%)	0.08	0.08	0.20	....	....	....	....	....	....	....	....	....
3-Mo. Treasury Bill Rate (%)	0.15	0.31	0.45	....	....	....	....	....	....	....	....	....
10-Year Treasury Note Yield (%)	1.76	1.93	2.13	....	....	....	....	....	....	....	....	....

2021 Historical Data

Monthly Indicator	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Retail and Food Service Sales (a)	7.2	-2.8	11.4	0.9	-1.4	0.9	-1.6	1.2	0.7	1.8	0.7	-2.7
Auto & Light Truck Sales (b)	16.78	15.93	17.64	18.30	16.89	15.47	14.66	13.09	12.29	13.05	13.04	12.54
Personal Income (a, current $)	9.9	-7.2	21.0	-13.3	-2.0	0.3	1.3	0.4	-0.9	0.6	0.5	0.4
Personal Consumption (a, current $)	3.3	-1.1	5.2	1.0	0.0	1.1	0.1	1.1	0.6	1.4	0.5	-0.9
Consumer Credit (e)	-0.1	6.6	4.4	4.7	9.4	9.7	3.9	3.3	7.2	3.8	10.6	5.6
Consumer Sentiment (U. of Mich.)	79.0	76.8	84.9	88.3	82.9	85.5	81.2	70.3	72.8	71.7	67.4	70.6
Household Employment (c)	121	363	573	319	291	62	1092	463	639	428	1090	651
Nonfarm Payroll Employment (c)	520	710	704	263	447	557	689	517	424	677	647	588
Unemployment Rate (%)	6.4	6.2	6.0	6.0	5.8	5.9	5.4	5.2	4.7	4.6	4.2	3.9
Average Hourly Earnings (All, cur. $)	29.93	30.04	30.06	30.20	30.36	30.52	30.67	30.76	30.92	31.11	31.23	31.38
Average Workweek (All, hrs.)	35.0	34.6	34.9	34.9	34.9	34.8	34.8	34.7	34.8	34.8	34.8	34.8
Industrial Production (d)	-1.7	-4.9	1.8	17.9	16.4	10.2	6.6	5.4	4.5	4.7	5.0	3.4
Capacity Utilization (%)	75.0	72.7	74.8	74.8	75.3	75.7	76.2	76.1	75.1	76.1	76.6	76.3
ISM Manufacturing Index (g)	59.4	60.9	63.7	60.6	61.6	60.9	59.9	59.7	60.5	60.8	60.6	58.8
ISM Nonmanufacturing Index (g)	58.5	55.9	62.2	62.7	63.2	60.7	64.1	62.2	62.6	66.7	68.4	62.3
Housing Starts (b)	1.625	1.447	1.725	1.514	1.594	1.657	1.562	1.573	1.550	1.552	1.703	1.754
Housing Permits (b)	1.883	1.726	1.755	1.733	1.683	1.594	1.630	1.721	1.586	1.653	1.717	1.885
New Home Sales (1-family, c)	993	823	873	796	733	683	704	668	725	667	753	860
Construction Expenditures (a)	3.0	-1.1	1.0	0.3	0.7	1.0	0.1	1.0	1.0	0.9	1.0	1.6
Consumer Price Index (nsa, d)	1.4	1.7	2.6	4.2	5.0	5.4	5.4	5.3	5.4	6.2	6.8	7.0
CPI ex. Food and Energy (nsa, d)	1.4	1.3	1.6	3.0	3.8	4.5	4.3	4.0	4.0	4.6	4.9	5.5
PCE Chain Price Index (d)	1.4	1.6	2.5	3.6	4.0	4.0	4.2	4.2	4.4	5.1	5.6	5.8
Core PCE Chain Price Index (d)	1.5	1.5	2.0	3.1	3.5	3.6	3.6	3.6	3.7	4.2	4.7	4.9
Producer Price Index (nsa, d)	1.6	3.0	4.1	6.5	7.0	7.6	8.0	8.7	8.8	8.9	9.9	9.9
Durable Goods Orders (a)	2.4	1.3	1.3	-0.7	3.2	0.8	0.5	1.3	-0.4	0.1	3.2	1.2
Leading Economic Indicators (a)	0.6	-0.1	1.1	1.1	0.9	0.6	1.0	0.7	0.2	0.6	0.8	0.8
Balance of Trade & Services (f)	-65.1	-67.5	-71.4	-65.4	-67.3	-72.2	-69.7	-72.5	-81.2	-66.9	-80.1	-82.0
Federal Funds Rate (%)	0.09	0.08	0.07	0.07	0.06	0.08	0.10	0.09	0.08	0.08	0.08	0.08
3-Mo. Treasury Bill Rate (%)	0.08	0.04	0.03	0.02	0.02	0.04	0.05	0.05	0.04	0.05	0.05	0.06
10-Year Treasury Note Yield (%)	1.08	1.26	1.61	1.64	1.62	1.52	1.32	1.28	1.37	1.58	1.56	1.47

(a) month-over-month % change; (b) mil, saar; (c) month-over-month change, thousands; (d) year-over-year % change; (e) annualized % change; (f) $ bil

Special Questions:

1 a. How much do you expect the FFR to be increased in: 2022? 191 bps 2023? 67 bps

b. Do you anticipate any 50bp FFR increases in 2022? Yes 72% No 28%
Do you anticipate any 50bp FFR increases in 2023? Yes 2% No 98%

c. When do you expect the Fed to begin to reduce its asset holdings?

Q2-2022	Q3-2022	Q4-2022	Later
81%	14%	2%	2%

d. Do you think that by removing monetary accommodation the US Fed will be successful in slowing inflation without precipitating a recession? Yes 72% No 28%

2 a. What do you think is the neutral (long-run) Fed funds rate? 2.46%

b. When do you think the neutral FFR will be achieved?

End of 2023	End of 2024	End of 2025	End of 2026	Later
78%	19%	0%	0%	3%

3. With economic growth slowing and inflation still rising, do you foresee a period of "stagflation" such as existed throughout the 1970s? Yes 15% No 85%

4. Has the crisis in Ukraine caused any meaningful changes in your expectations for 2022 on:

	Yes	No
US real GDP growth?	74%	26%
US CPI inflation?	98%	2%
Global real GDP growth?	92%	8%
US Fed's monetary policy?	49%	51%
ECB's monetary policy?	71%	29%

5 a. What is your estimate of the US federal government deficit for: FY 2022? $1.2 tril FY 2023? $1.0 tril

b. Have your deficit estimates been affected by the Ukraine crisis? Yes 17% No 83%

c. Do you expect rising interest rates to provide a meaningful boost to the federal budget deficit? Yes 32% No 68%

d. If so, will the increase in debt service costs restrain the use of fiscal policy to support economic growth? Yes 25% No 75%

6. Is COVID still a major factor in your near-term economic forecast? Yes 41% No 59%

7. How long do you expect supply-chain bottlenecks to provide a significant boost to inflation?

0-6 months	7-9 months	10-12 months	13-24 months	> 24 months
15%	51%	29%	5%	0%

8. In your view which of the following factors poses the biggest risk to global financial stability at present?

More intense financial instability in emerging economies triggered by e.g. a sovereign debt default in Russia	0%
A further escalation of the conflict in Ukraine accompanied by even higher energy and food prices	45%
Growing alarm about the outlook for global growth triggered by e.g. higher food and energy prices, ebbing purchasing power, tighter global fiscal policies	13%
A much more aggressive response from Central Banks to persistently high levels of inflation	35%
The discovery of another dangerous mutation of the COVID virus that is both more transmissible and more immune to existing vaccines	8%

Viewpoints: A Sampling of Views on the Economy, Financial Markets and Government Policy Excerpted from Recent Reports Issued by Our Blue Chip Panel Members and Others

Governments Step In To Shield Consumers

Energy subsidies to shield consumers could blunt central banks' fight against inflation.

The role of government has been a key theme during the pandemic. The extent to which administrations provided resources to cushion households and businesses from COVID-19 caught many by surprise. While the worst of the virus is likely behind us, its economic complications are far from over. Energy prices are under extreme pressure now, and governments are asking what they can and should do to soften the blow.

Households in major economies are paying record retail fuel prices. European gas prices more than tripled last year. Pressure is growing even in unlikely locations such as Mexico, which is a net exporter of crude oil, but relies heavily on imports of refined petroleum products from the U.S.

High energy prices can have ripple effects throughout an economy and breed discontent. This has prompted governments to intervene. Subsidies have been employed to bring costs below market rates, lowering the burden on households.

This week, Turkey's government announced energy price caps for consumers and a temporary support mechanism for power plants. To make good on his election promise, Mexican President Andrés Manuel López Obrador cut taxes on gasoline sales to zero. According to Oxford Economics, Mexico's price cap is likely to cost taxpayers about 1.2% of gross domestic product (GDP).

Over 20 European nations have acted to soften the blow of high energy prices. France announced a cap on the price of natural gas until April 2022, which was ultimately extended until the end of the year. A fuel-voucher program and a reduction of the electricity tax rate are also under consideration. The payouts to over 38 million French citizens are expected to cost €3.8 billion.

Electricity prices for German households are the highest in the European Union, prompting significant responses (over €15 billion) from the government. In early February, the U.K. announced £350 (or $460) in assistance, covering most households, to help pay rising energy bills.

Government support will help to offset the hit to consumers, who in many cases are still struggling to recover from the COVID-19 shock. On the other hand, subsidies are a form of economic stimulus, which are being inserted into economies that are already overheated. This could blunt central banks' fight against inflation. And subsidies will put a dent in public coffers at a time that countries are trying to reduce pandemic support and square their accounts.

Episodes like these serve as a reminder of the tradeoffs that governments face between tackling longstanding fossil fuel subsidies and switching to cleaner energy. From a transition standpoint, expensive oil and natural gas are not necessarily bad outcomes. Rising prices will compel consumers to purchase and businesses to invest in green energy. Providing short-term succor to households will delay progress towards long-term climate goals.

Policymakers unveiled innovative policies quickly to support their economies through the worst of the COVID-19 crisis. They might do well to tread cautiously in trying to ameliorate post-pandemic price problems.

Vaibhav Tandon (Northern Trust)

Oil Intensity: Return on Investment

Output is not falling, but the amount of energy required to fuel that activity is diminishing.

Some are concerned that high energy prices will send us back to the 1970s, but this is a very different era. While oil is still a foundational element of economic activity, the world is less reliant on fuel for output than it was a generation ago. We also use it more efficiently: the world's energy intensity, or output per unit of energy produced, has been on a steady decline for decades.

Structurally, advanced economies are less dependent on oil as a raw input. The output mix has shifted away from goods and toward services; manufacturing's share of U.S. gross domestic product has fallen from 28.5% in 1973 to 16.7% in 2021. And the amount of energy used in manufacturing processes has declined significantly over that interval.

The energy shocks of the 1970s showed the importance of energy efficiency. While early technological gains for more than a hundred years focused on what was possible (consider the inefficient but world-changing steam engine), more recent developments have focused on how to generate energy with less fuel.

Environmentalism was one driver, but often, greater efficiencies simply made strong business cases for themselves. Containerized shipping on ever-larger vessels allowed more goods to move with less effort. Seemingly minor adaptations, like reductions in car and truck engine idling, add up at scale. The pandemic revealed further opportunities to use less energy, like virtual meetings reducing some of the need for business travel.

Technological investments are also enabling greater efficiency. Nothing comparable to today's personal computers and internet existed in the 1970s. Remote work opportunities have only grown since the onset of the pandemic, eliminating the need for commuting. Modern knowledge work is scarcely comparable to the factory jobs of old.

Transportation represents the majority of petroleum use, and vehicles offer an easy measure of progress. Even as they have grown in size and weight, efficiency of all types of vehicles has risen for 15 years and stands far higher than the depths set by the large, inefficient engines of the 1970s.

This is not meant to make light of the higher costs of energy. The planes, ships, trains and trucks that keep the supply chain moving all rely on petroleum, a burden that will push up final prices. Many essential jobs cannot be performed remotely. Telling consumers that their vehicles are more efficient does not ease the pain of budgets squeezed by fuel prices.

Few recollections of the 1970s are favorable, be they fashion, popular music or economics. But efficiency gains since then will help prevent another decade of oil-driven pain.

Ryan James Boyle (Northern Trust)

Calendar of Upcoming Economic Data Releases

Monday	Tuesday	Wednesday	Thursday	Friday
April 11	**12** CPI & Real Earnings (Mar) Cleveland Fed Median CPI(Mar) Monthly Treasury Statement (Mar) NFIB (Mar) Kansas City Financial Stress Index (Mar) OPEC Crude Oil Spot Prices (Mar)	**13** Producer Prices (Mar) Transportation Services Index (Feb) EIA Crude Oil Stocks Mortgage Applications	**14** Import & Export Prices (Mar) Advance Retail Sales (Mar) MTIS (Feb) Consumer Sentiment (Apr, Preliminary) Weekly Jobless Claims	**15** IP & Capacity Utilization (Mar) Empire State Mfg Survey (Apr) TIC Data (Feb)
18 Business Leaders Survey (Apr) Home Builders (Apr)	**19** New Residential Construction (Mar)	**20** Existing Home Sales (Mar)| EIA Crude Oil Stocks Mortgage Applications	**21** Philadelphia Fed Mfg Business Outlook Survey (Apr) Composite Indexes (Mar) Weekly Jobless Claims	**22** S&P Global Flash PMIs (Apr) Alternate Measures of Labor Underutilization (Q1)
25 NABE Business Conditions Survey (Q1) Chicago Fed National Activity Index (Mar) Texas Manuf Outlook (Apr) Treasury Auction Allotments (May) Steel Imports for Consumption (Mar, Preliminary) Retail Trade Revisions	**26** Adv Durable Goods (Mar) FHFA & Case-Shiller HPI (Feb) New Residential Sales (Mar) Consumer Confidence (Apr) H.6 Money Stock (Mar) Final Building Permits (Mar) Philly Fed Nonmfg Bus (Apr) Richmond Fed Mfg & Service Sector Surveys (Apr) Texas Service Sector (Apr)	**27** Advance Trade & Inventories (Mar) BED (Q3) Housing Vacancies (Q1) Pending Home Sales (Mar) EIA Crude Oil Stocks Mortgage Applications	**28** GDP (Q1, Advance) Kansas City Fed Manufacturing Survey (Apr) Weekly Jobless Claims	**29** Employment Cost Index (Q1 plus Revisions) Personal Income (Mar) Underlying NIPA Tables (Q1, Advance) Consumer Sentiment (Apr, Fin) Agricultural Prices (Mar) Dallas Fed Trimmed-Mean PCE (Mar) Chicago PMI (Apr)
May 2 ISM Manufacturing (Apr) S&P Global Mfg PMI (Apr) Construction (Mar)	**3** Manufacturers' Shipments, Inventories & Orders (Mar) JOLTS (Mar) First Time Housing Affordability (Q1) FOMC Meeting	**4** BEA Auto & Truck Sales (Apr) ADP Employment Report (Apr) International Trade (Mar) ISM Services PMI (Apr) S&P Global Services PMI (Apr) EIA Crude Oil Stocks Mortgage Applications FOMC Meeting	**5** Productivity & Costs (Q1) Public Debt (Apr) Challenger Employment Report (Apr) Weekly Jobless Claims	**6** Employment Situation (Apr) Consumer Credit (Mar)
9 Wholesale Trade (Mar) Treasury Auction Allotments (Apr)	**10** NFIB (Apr) Kansas City Fed Labor Market Conditions Indicators (Apr) Kansas City Financial Stress Index (Apr) Senior Loan Officer Survey (Q2)	**11** CPI (Apr) Real Earnings (Apr) Transportation Services Index (Mar) Cleveland Fed Median CPI (Apr) Monthly Treasury (Apr) EIA Crude Oil Stocks Mortgage Applications	**12** Producer Prices (Apr) OPEC Crude Oil Spot Prices (Apr) Weekly Jobless Claims	**13** Import & Export Prices (Apr) Housing Affordability (Mar) Consumer Sentiment (May, Prelimnary) Survey of Professional Forecasters (Q2)
16 Empire State Mfg Survey (May) TIC Data (Mar)	**17** Advance Retail Sales (Apr) IP & Capacity Utilization (Apr) MTIS (Mar) Business Leaders Survey (May) Home Builders (May)	**18** New Residential Construction (Apr) CEO Confidence Survey (Q2) EIA Crude Oil Stocks Mortgage Applications	**19** Existing Home Sales (Apr) Philadelphia Fed Mfg Business Outlook Survey (May) Weekly Jobless Claims	**20** Advance Quarterly Services (Q1)

EXPLANATORY NOTES

For 46 years, ***Blue Chip Economic Indicators'*** monthly survey of leading business economists has provided private and public sector decision-makers timely and accurate forecasts of U.S. economic growth, inflation and a host of other critical indicators of business activity. The newsletter utilizes a standardized format that provides a fast read on the prevailing economic outlook. The survey is conducted over two days, generally during the first week of each month. Forecasts of U.S. economic activity are collected from more than 50 leading business economists each month. The newsletter is generally finished on the third day following completion of the survey and delivered to subscribers via e-mail or first class mail.

The hallmark of ***Blue Chip Economic Indicators*** is its *consensus forecasts*. Numerous studies have shown that by averaging the opinions of many experts, the resulting consensus forecasts tend to be more accurate over time than those of any single forecaster.

Annual Forecasts On pages 2 and 3 of the newsletter are individual and consensus forecasts of U.S. economic performance for this year and next. The names of the institutions that contribute forecasts to these pages are listed on the left of the page. They are ranked from top to bottom based on how fast they expect the U.S. economy to expand in the current year. Some of these institutions have one or more asterisks (*) after their names, denoting how many times they have won the annual *Lawrence R. Klein Award for Blue Chip Forecast Accuracy*. The award winner is determined by W.P. Carey School of Business at Arizona State University.

Across the top of pages 2 and 3 is a list of the variables for which the individual cooperators have provided forecasts. Definitions and organizations that issue estimates for these variables are found at the bottom of page 3. For columns 1-10, the forecasts are for the year-over-year percent change in each variable. Columns 11-13 represent average percentage levels of the year in question. Column 16 is an inflation-adjusted dollar level, measured in billions of chained 2012 dollars. High and low forecasts from the panel members for each variable are denoted with an "H" or "L".

Immediately below the forecasts of the individual contributors are this month's consensus forecasts. The consensus is derived by averaging our panel members' forecasts for each variable. Below the consensus forecasts are averages of this month's ten highest and ten lowest forecasts for each variable. Below them are last month's consensus forecasts. To put the forecasts in context, we include four years of historical data for each variable at the bottom of page 2. Please note that these figures can change due to government revisions of previously released estimates. Below the historical data are the number of forecasts changed from a month ago for each variable, the median forecast for each variable and a diffusion index. The diffusion index serves as a leading indicator of future changes in the consensus forecast. A reading above 50% hints of future increases in the consensus; a reading below 50% hints of future declines. The diffusion index is calculated by adding to the number of forecasters who raised their forecasts for a particular variable this month, half the number of those who left their forecasts unchanged, then dividing the sum by the total number of those contributing forecasts.

Historical Annual Consensus Forecasts Page 4 contains the forecasts from previous issues for the current and subsequent year so that subscribers can see how the outlook has changed over time. Each issue also includes graphs and analysis focusing on noteworthy changes and trends in the consensus outlook.

Quarterly Forecasts Page 5 contains quarterly historical data and consensus forecasts of the U.S. economy's performance. For columns 1-10, the forecasts are for the quarter-over-quarter, seasonally-adjusted, annualized percent change in each variable. Columns 11-13 represent average percentage levels for the quarter in question. Columns 14 and 15 represent seasonally-adjusted, annualized levels for the quarter, measured in billions of inflation-adjusted dollars. As is the case on pages 2-3, the consensus quarterly forecasts on the top half of page 5 are simple averages of our contributors' forecasts. The high-10 and low-10 forecasts are averages of the 10 highest and 10 lowest forecasts for each variable. At the bottom of page 5 are additional quarterly consensus forecasts for Real GDP, GDP Price Index, Industrial Production and Consumer Price Index. These figures are produced by taking the annualized quarterly consensus forecasts found on the top of page 5 and computing a quarterly dollar value for Real GDP, and average quarterly index levels for the GDP Price Index, Industrial Production and the Consumer Price Index. We then compute a year-over-year percentage change between the relevant quarter and the corresponding quarter of the previous year.

International Forecasts Pages 6-7 contain historical data and consensus forecasts of five key economic variables for 15 of the U.S.'s largest trading partners. A list of the institutions contributing forecasts to these pages can be found at the bottom of page 7. Columns 1 and 2 are forecasts of the year-over-year percent change in inflation-adjusted economic growth and consumer price inflation for this year and next. Column 3 is each nation's estimated current account surplus or deficit, reported in billions of current U.S. dollars. Column 4 is the estimated value of each nation's currency versus the U.S. dollar at the end of this year and next. Column 5 is the estimated level of interest rates on 3-month interest rates in each nation at the end of this year and next. Immediately below this month's consensus and the top 3 and bottom 3 averages for each variable are last month's forecasts and a limited amount of historical data. The historical data may change from month-to-month due to government revisions.

Special Questions On page 14, we report on panel members' answers to our special questions. Individuals' responses to the special questions are never displayed, only consensus, top-10 and bottom-10 results. *In March and October, we publish our semiannual, long-range surveys*. In addition to our usual forecasts for this year and next, the semiannual, long-range survey results provide subscribers with consensus forecasts of all the variables found on pages 2 and 3 for the each of the following five years, plus an average for the five-year period after that.

Blue Chip Econometric Detail With the March, June, September and December issues, subscribers also receive a four-page quarterly supplement entitled *Blue Chip Econometric Detail*. The supplement contains forecasts of an expanded list of economic and financial variables that are derived from the consensus forecasts found in *Blue Chip Economic Indicators*. Macroeconomic Advisers by IHS Markit of St. Louis, Missouri produces this forecast detail based on a simulation of its econometric model of the U.S. economy.

Should you have questions about the contents, or methods used to produce ***Blue Chip Economic Indicators****, please contact Joseph Aguinaldo at (212) 986-9300 or email him at: bluechip@haver.com.*

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December 28, 2021

The Honorable Chair and Members
of the Hawaiʻi Public Utilities Commission
Kekuanaoʻa Building, First Floor
465 South King Street
Honolulu, Hawaiʻi 96813

Dear Commissioners:

Subject: Resilience Investments by Hawaiʻi's Electric Utilities

I am submitting this letter to strongly urge the Hawaiʻi Public Utilities Commission to encourage and support necessary and important investments made by Hawaiʻi's electric utilities, Kauaʻi Island Utility Cooperative and Hawaiian Electric, in the resilience of their electric grids.

Two of my primary roles as the Adjutant General for the State of Hawaiʻi are serving as the director of the Hawaiʻi Emergency Management Agency (HI-EMA) and the director of the Hawaiʻi Office of Homeland Security. I am extremely concerned that a major natural, or human caused disaster would result in long-term power outages and consequent death and human suffering.

Investments to improve resilience in the electric utilities' generation, transmission and distribution systems against the effects more extreme weather events caused by climate change as well as increased cyber threats will support the reliable provision of electric service to the State of Hawaiʻi, critical infrastructure providers, and the first responders who will be a key part of any rescue and recovery response resulting from a major disaster in Hawaiʻi.

As HI-EMA Director, I am responsible for coordinating emergency and disaster response and recovery for all of Hawaiʻi. This includes coordinating with county emergency management agencies and other public and private organizations dealing with emergency management; performing emergency management functions within the state; coordinating all resource support to the counties; ensuring coordination of emergency management plans across the state and with state, federal and other organizations; and coordinating emergency and disaster response and recovery activities.

I have seen firsthand, during my 38 years of disaster response experience, the impact to the community and economy following a major disaster. In 1992, I was a part of the initial

National Guard deployment in response to Hurricane Iniki that resulted in widespread damage of several Critical Infrastructure and Key Resources sectors, especially power. Scientists predict that natural disasters will occur with increasing frequency and intensity. The early December "Kona Low" flooding and subsequent power outages reveals the susceptibility of Hawaii's power systems and underscore the importance of making the investments necessary to ensure a resilient electric system. Additionally, recent cyber-attacks against Healthcare, Transportation, and Water Critical Infrastructure sectors demonstrate the importance of strong and resilient Cyber Security.

Based on my experience, loss of reliable electricity in critical sectors (hospitals, first responders, emergency management, telecommunications, water, and food supplies), results in significant impacts. These impacts include severe disruption to mission critical services, impacts to life and health of the public, damage to infrastructure and property, environmental impacts, and immense cost and economic implications. Several critical infrastructure and key resources providers possess backup power capabilities; however, backup generator power is not sufficient to sustain "normal" operations and are reliant on fuel resupply.

My recommendation is to support investment efforts of the state's electric utilities that align to Emergency Management/Homeland Security priorities of Prevention, Protection, Mitigation, Response, and Recovery. Aligning to these goals will allow Hawai'i's electric utilities the ability to maintain electric service or restore that service as quickly as possible once disruptions occur. One key contribution to that ability will be the sensible hardening of generation, transmission, and distribution facilities critical to the provision of electric service such that essential services can survive during and after severe events.

Time is of the essence for investments to build a more resilient grid. I truly believe that if investments are not made now, future costs will be exponentially higher following a major disaster.

Please encourage and support the state's electric utilities' future efforts to make Hawai'i's grids more resilient.

Sincerely,

Kenneth S. Hara
Major General
Hawaii National Guard
Adjutant General

CC: Luke Meyers, HI-EMA Administrator

Verizon Wireless
255 Kahelu Ave
Mililani, HI 96789

Corey Shaffer
Sr. Manager – Network Operations

June 10, 2022

The Honorable Chair and Members
of the Hawai'i Public Utilities Commission
Kekuanao'a Building, First Floor
465 South King Street
Honolulu, Hawai'i 96813

Dear Commissioners:

Subject: Hawaiian Electric Companies' Resilience Investments

I strongly support the Hawaiian Electric Companies' necessary and important investments in the resilience of the electric grid. These investments will support the reliable provision of electric service to the State of Hawaii, critical infrastructure providers such as Verizon, and the first responders who will be a key part of any rescue and recovery response resulting from a major weather emergency or other natural disaster in Hawaii.

As the Senior Manager for Network Assurance in Hawaii, I can state unequivocally that a functioning communications infrastructure (wired and cellular communications and internet service) is crucial to support mission critical functions as well as enable communication within communities both during and after a disaster. Verizon has hundreds of cell sites in Hawaii that require power to operate and virtually all are powered by the Hawaiian Electric Companies. Moreover, fiberoptic cables run along Hawaiian Electric's pole lines, and these fibers provide connectivity to over 95% of Verizon's wireless network. Many people do not realize that this wired communication infrastructure is *required* to support our modern wireless communications networks.

As discussed in the Resilience Working Group ("RWG") of the Integrated Grid Planning ("IGP") proceeding, of which I am a member, Verizon's main concern is ensuring that poles serving our critical infrastructure and poles carrying our fiberoptic lines are resilient. Hardening of transmission and distribution poles serving critical cell sites as well as lines carrying critical fiberoptic lines would greatly enhance the resilience of the communications system and overall community resilience.

Based on my experience, loss of electricity in critical sectors including telecommunications, whether utility-supplied power or customer-owned backup power, could have severe impacts. These impacts include severe disruption to mission critical services, impacts to life and health of the public, damage to infrastructure and property, environmental impacts, and immense cost and economic implications.

While certain infrastructure providers, including Verizon, have limited backup power capabilities, this is not sufficient to carry on anything close to "normal" operations and will not last, in part due to fuel supply issues if outages extend beyond a few days. A vital part of both a sustained response as well as recovery operations and mission assurance will be to have Hawaiian Electric able to maintain electric service or restore that service as quickly as possible once disruptions occur. And a key

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255 Kahelu Ave
Mililani, HI 96789

Corey Shaffer
Sr. Manager – Network Operations

contributor to that ability will be the sensible hardening of transmission and distribution facilities critical to the provision of electric service such that essential services including communications can survive during and after severe events.

The next major natural disaster could hit Hawaii at any time, and we must all work to make sure we are as prepared as we can be when it does. Time is of the essence for these investments in a more resilient grid and we as a community cannot afford to delay action or fail to make decisions due to overthinking or overanalyzing potential solutions.

I encourage and support the Hawaiian Electric Companies' efforts to make our grids more resilient.

Sincerely,

Corey B. Shaffer
Senior Manager
Network Operations
Verizon Hawaii

verizon

GOVERNMENT AND CUSTOMER STAKEHOLDERS RECOGNIZE THE IMPORTANCE OF A RESILIENT ELECTRIC GRID

A. Introduction

The Commission as well as Federal, State, and County governments, and Hawaiʻi's communities, have all identified the resilience of the electric system and the ability of the utility to continue to provide reliable power during emergencies as a critical matter for attention. Climate change has only exacerbated concerns and intensified focus on the issue of a resilient power system and its ability to recover from natural disasters and other emergencies.

This Application requests recovery for key resilience project investments which the IGP RWG and the Companies have identified as the immediate no-regrets projects and programs that are necessary to begin the critical process of hardening the electrical system against severe events such as major storms, hurricanes, flood events, and wildfires on Oʻahu, Maui County, and Hawaiʻi Island.

B. The Commission Recognizes the Importance of a Resilient Grid

1. Integrated Grid Planning and the Resilience Working Group

The Commission has recognized the need for a resilient electric grid due to the State of Hawaiʻi's isolated island location, vulnerability to natural hazards, and history of disasters. This is evidenced in Order No. 34696 of the IGP docket in which the Commission reiterated the Department of Business and Economic Development's recommendation that future planning processes should be refined "to ensure resulting plans are resilient to uncertainty".[1]

[1] Order No. 34696 at 16, issued on July 14, 2017, in Docket No. 2014-0183.

Recognizing the need for a resilient grid, the Companies included resilience as part of the IGP process. Notably, an RWG was formed to advise the broader IGP process. The RWG's members represent a broad range of state and national agencies, commercial and industrial customers, and not-for-profit interest groups. The goal of the RWG is to support the development of resilience planning inputs for Hawai'i's power system including resource, transmission, and distribution assets, in relation to potential societal and economic impacts of potential severe events.

As described more fully in the RWG Report [2], the goals of the RWG are to:

- Identify and prioritize resilience threat scenarios and potential grid impacts;
- Identify key customer and infrastructure sector capabilities and needs following a severe event and loss of power;
- Identify gaps and priorities in grid and customer capabilities following a severe event and loss of power;
- Provide recommendations and inputs for the IGP to address resilience needs; and
- Recommend additional grid and customer actions to close gaps in capabilities following severe events.

Each of these goals and the RWG's specific work are described more fully below in Section V and in Exhibit B (*Resilience Working Group Report for Integrated Grid Planning*) to this Application.

In particular, the RWG identified the following objectives for key customers/sectors during a severe emergency:

[2] *See*, *Resilience Working Group Report for Integrated Grid Planning* ("RWG Report") at 16, dated April 29, 2020, which is being submitted as Exhibit B in this Application.

- Maintain critical functions and services
- Limit fatalities and human suffering
- Limit infrastructure damage
- Limit property damage
- Limit cost and economic impacts
- Limit environmental impacts

The RWG developed a framework for prioritizing customers and infrastructure sectors from a perspective of importance to supporting (1) national security and/or public safety and health and (2) power system recovery. It was clear during the severe event scenarios discussed during breakout sessions that loss of electricity in critical customer and infrastructure sectors, whether utility-supplied power or customer-owned backup power, could have severe impacts. These impacts include severe disruption to mission critical services, impacts to life and health of the public, damage to infrastructure and property, environmental impacts, and immense cost and economic implications.

2. Performance Based Regulation ("PBR")

In the Performance-Based Regulation proceeding (Docket No. 2018-0088), the Commission Staff called attention to the importance of monitoring the resilience of Hawai‘i's electric system. The Staff's proposal in the proceeding defined resilience as, "the ability of a system or its components to adapt to changing conditions, as well as withstand and rapidly recover from disruptions."[3] The Staff Proposal further stated that resilience is increasing in importance for Hawai‘i given its geographic isolation, the increasing threat of natural disasters

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[3] Staff Proposal, Appendix A at 5.

and climate change, as well as many other risk factors such as cybersecurity attacks and aging infrastructure. D&O No. 37507 continued to identify Resilience as an emergent and prioritized outcome that is ripe for discussion and development of Reported Metrics to be included in the PBR Framework's initial portfolio. More recently, in the Commission's D&O No. 38429 on June 17, 2022, the Commission expressed that it is "concerned about the impacts of outages during [major event days] to customers, who may experience significant interruptions during these major events." This Project is intended to improve system performance and recovery during and after extreme events.

In the April 26, 2022 PBR Panel Hearing, Commission Chair Jay Griffin referenced the December 6, 2021 Kona Low event, which brought high winds and heavy rainfall and caused long-duration customer interruptions on O'ahu, Hawai'i Island, and Maui, as an event that attests to the need for greater focus and accountability for system resilience:

> When we talk about . . . increasing frequency and intensity of these storms in the future, I think the public expects us to be creating a system that will be more resilient to [extreme weather] . . . This was an extreme event and we're expecting more of those . . . We've got to do better . . . We need to have answers we can take back to the public [regarding] how we're responding to these events.[4]

The Companies agree. A focused effort on resilience improvement is imperative to meet the challenges of a changing climate and increasingly volatile threats to the Companies' isolated power system. This Application articulates a set of immediate actions, based on industry best practice and stakeholder input, to enhance the resilience of the Companies' transmission and distribution system for today and into the future.

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[4] PBR Hearing Day 1, April 26, 2022, at 02:29:10 - 02:36:52. See https://youtu.be/4ysLdVLJr4.

C. Federal, State, County and Community Resilience Focus

As a result of climate change, Hawaiʻi and other locations around the world are becoming increasingly vulnerable to severe weather events. In 2017, the U.S. experienced 16 separate weather-related disasters which resulted in over $306 billion in damage.[5] Entire communities were devastated, with families losing loved ones, as well as their homes and livelihoods. The people of Puerto Rico are still recovering more than a year after Hurricane Maria struck. In 2018, catastrophic flooding occurred on Kauaʻi and parts of Oʻahu, while Hawaiʻi Island dealt with the destructive powers of Kīlauea's eruptions and lava flows. That same year, Hurricane Lane and Tropical Storm Olivia brought high winds and heavy rains across the entire State of Hawaiʻi. These events, some of which are discussed in more detail below, highlight the extreme vulnerability of the electric grid and other critical infrastructure, such as roadways and harbors. They also underscore the vital need to be prepared and to strengthen the resilience of communities throughout the state.

1. Federal Focus on Resilience

> "*Our power systems weren't built to withstand extreme weather events. Without major investments to reinforce, modernize and clean our grid, the question will not be whether it fails, but when.*"
>
> *"When these climate disasters hit the power system, they disrupt businesses, put a massive strain on state and local government budgets, and harm the health and wealth of American families nationwide."*

Jennifer M. Granholm, 16th United States Secretary of Energy[6]

The importance of a reliable electric grid to sustain communications and commerce, in particular through internet functionality and powering a decarbonized transportation system, is

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[5] *See,* https://www.noaa.gov/news/2017-was-3rd-warmest-year-on-record-for-us

[6] "Extreme weather keeps knocking out America's power. Here's what we must do." (CNN, September 17, 2021).

more critical today than ever. This has already been well documented. However, with the adverse effects of climate change increasing the severity and frequency of natural disasters, it is becoming increasingly more important. The U.S. Department of Energy, Department of Homeland Security, Federal Emergency Management Agency, and Federal Energy Regulatory Commission have all engaged extensively on this issue through their various agencies.

More immediately for Hawaiʻi, the Department of Defense, which would be a critical resource in natural disaster response and recovery as well as its primary mission of national defense, relies upon a reliable and resilient electrical grid for both its military and civilian operations. Notably, the United States Indo-Pacific Command (USINDOPACOM), which is based on Oʻahu, is the nation's oldest and largest combatant command. USINDOPACOM includes 380,000 Soldiers, Sailors, Marines, Airmen, Guardians, Coast Guardsmen and Department of Defense civilians and is responsible for all U.S. military activities in the Indo-Pacific, covering 36 nations, 14 time zones, and more than 50 percent of the world's population.[7] INDOPACOM is the only command served by a single electric utility and therefore, it is critical to the mission of INDOPACOM that Hawaiian Electric have the resilience to provide reliable power to the U.S. military as well as civilian operations. This is critical for both national security and global defense initiatives, as well as the military's ability to assist in recovery missions for the State.

2. The State of Hawaiʻi has Prioritized Resilience

The Hawaiʻi Emergency Management Agency ("HI-EMA"), has noted in presentations that Hawaiʻi has been facing a near-constant stream of disaster-related events and that Hurricane

[7] *See,* https://www.pacom.mil/About-USINDOPACOM/USPACOM-Area-of-Responsibility/

Lane presented a potential worst-case scenario.[8] Typhoon Yutu, which struck Saipan in 2018 resulted in no access to food, water, communication, or port and airport facilities; all resources needed to be brought in by helicopter. In contrast to Saipan (which has a population of approximately 30,000 people), Hawai‘i has a population of more than one million people, which presents a significant issue for recovery. These events also underscored the vital need to be prepared and to strengthen the resilience of communities throughout the state.

3. The City and County of Honolulu has Prioritized Resilience

The former Executive Director and Chief Resilience Officer with the City & County of Honolulu Office of Climate Change, Sustainability & Resiliency has stated that resilience can be defined as the capacity to survive, adapt, and thrive no matter what kind of chronic stresses and active shocks are experienced. Based on ongoing outreach conducted by that office, the top potential shocks and stresses in Hawai‘i have been identified to include hurricanes, tsunamis, flooding, cost of living, and aging infrastructure. Given the observed and anticipated effects of climate change, these potential stresses and shocks are growing both in intensity and frequency. The resulting effects will be at a scale that requires extensive alignment and collaboration between the public, private and non-profit sectors.

Recent disasters in Puerto Rico and Saipan provide insight into the particular vulnerability of island communities and the need for shared preparation and response. The Office of Climate Change, Sustainability & Resiliency is working on an O‘ahu Resilience Strategy for the City and County of Honolulu that addresses issues including long-term affordability, disaster preparedness, climate change mitigation and adaptation, and social

[8] Hurricane Lane neared Hawai‘i as a Category 5 hurricane then weakened to a tropical storm. Even as a tropical storm the state experienced extremely heavy rainfall, flooding and road closures. However, the State, and in particular O‘ahu, is believed to have escaped a worst case scenario.

cohesion. Discussions with communities can help inform the Resiliency Strategy, and the need to build partnerships based on shared values. Leveraging these partnerships will be key to building resilience through actions that enable the community to best respond to shocks and stresses (and ideally, in advance of future events).[9]

4. Communities such as Koʻolaupoko have Prioritized Resilience

Koʻolaupoko, which encompasses Waimānalo, Kailua, Kāneʻohe, and the area from Heʻeia to Kualoa, is one of the most vulnerable communities on Oʻahu from a critical infrastructure lens. *Strengthening Koʻolaupoko: A Community Resilience Initiative* is a collaboration with leadership in the Koʻolaupoko community and is focused on minimizing vulnerability and ensuring a safe recovery in the aftermath of a major hurricane, which could involve prolonged disruptions of electricity, communications, transportation, and more. The forum brings together Koʻolaupoko community leadership with critical infrastructure owners, emergency management, and response agencies to share concerns, discuss potential options and solutions while focusing attention on hurricane preparedness topics. Specifically, the forum is intended to raise awareness of the risks and with community input, explore ways to strengthen the resilience of the Koʻolaupoko community through short-and long-term actions. By raising awareness of vulnerabilities, priorities, and expectations of the Koʻolaupoko region, the intent is to begin closing the gap between community preparedness and disaster response by government agencies and critical infrastructure owners for a well-coordinated recovery.

[9] *See*, *Multi-Hazard Pre-Disaster Mitigation Plan for the City & County of Honolulu*: https://resilientoahu.org/hazard-mitigation-plan

II. RECENT CASE STUDIES SUPPORTING RESILIENCE INVESTMENTS

As noted above, a catastrophic hurricane will lead to major disruptions in the production, transmission, and distribution of electricity in Hawaiʻi. This section presents some recent case studies of hurricanes and other major storms affecting power systems to illustrate both the damage that hurricanes can inflict on electric system infrastructure, as well as how targeted resilience investments can serve to mitigate the level of damage.

The first two specifically look at hurricanes impacting island systems (Maria in Puerto Rico and Iniki in Kauaʻi). The third examines Hurricane Sandy, which struck unhardened but robust power systems in the Northeast. The fourth examines how aggressive hardening efforts in Florida significantly limited transmission and distribution system damage and markedly reduced restoration times. And last, Hurricane Lane is examined both in terms of the actual damage that occurred and the much more extensive impact that might have occurred had it not veered away from the Hawaiian Islands.

A. Puerto Rico – Hurricane Maria

Hurricane Maria formed in September 2017 and strengthened to a powerful Category 5 Hurricane. Maria made landfall in Puerto Rico on September 20 as a strong Category 4 storm bringing a large storm surge, very heavy rains, and strong wind gusts. Maria was the strongest hurricane to impact Puerto Rico in nearly 90 years.

The hurricane caused extensive damage to the island's electric system, resulting in a complete blackout and leaving all 3.4 million residents without electricity. Restoration took many months:

Sep. 20, 2017: 100% of customers without power

Sep. 26, 2017: 95% of customers without power

Oct. 6, 2017:	89% of customers without power
Oct. 20, 2017:	88% of customers without power
Dec. 20, 2017:	45% of customers without power
Jan. 31, 2018:	13% of customers without power

Complete restoration of electric service took almost one year, with restoration costs exceeding $3 billion.[10]

B. <u>Kaua'i – Hurricane Iniki</u>

Hurricane Iniki originated off the African coast on August 18, 1992. Iniki gradually intensified as its track shifted to the north. The storm moved around the western edge of the subtropical ridge. Typically, the subtropical ridge keeps storms away from the Hawaiian Islands. On September 9, Iniki strengthened into a hurricane, and the next day it passed about 300 miles (480 km) south of the southernmost point of the Big Island. The hurricane slowed and curved toward the north while continuing to intensify to Category 4. Its eye made landfall on the southern coast of Kaua'i near Waimea with winds of 140 mph, making it the strongest hurricane on record to strike Hawai'i. Iniki caused six deaths and approximately $3.1 billion in damage, making it the costliest natural disaster on record in the state.

The high winds of Iniki resulted in the destruction of 27% of the island's transmission poles, 37% of its distribution poles, and 35% of overhead distribution wires. This damage resulted in a complete island blackout. After four weeks, 80% of customers were still without power, with some areas not being restored for up to four months.

[10] *See,* https://news.wttw.com/2021/10/23/electrical-outrage-thousands-puerto-rico-left-dark; https://www.theverge.com/2017/9/25/16362410/hurricane-maria-puerto-rico-power-outages-electrical-grid-destroyed; https://www.vox.com/identities/2018/8/15/17692414/puerto-rico-power-electricity-restored-hurricane-maria

The massive destruction of property and infrastructure resulted in a rise in unemployment. Unemployment was around 3% in 1990 and 6.8% just before the hurricane. Immediately after the hurricane, unemployment on Kaua'i shot up to 19.1%, with at least 10 percentage points of unemployment directly attributed to the hurricane. It took Kaua'i seven years for its labor market to recover to its previous pre-Iniki unemployment rate. Economists believe that Kaua'i experienced a permanent loss of about 3,000 private sector jobs. Immediately after the hurricane, tourist arrivals to Kaua'i dropped by 70%. Kaua'i's tourism-based economy took a long time to recover as tourism infrastructure and tourist levels in Kaua'i did not reach their pre-Iniki levels until eight years after the disaster. The disaster resulted in an out-migration of Kaua'i residents from which the island's population has never fully recovered. The island 'permanently' lost about 10% of its population.[11]

C. <u>New York - Superstorm Sandy</u>

Hurricane Sandy (sometimes referred to as Superstorm Sandy) was the deadliest, the most destructive, and the strongest hurricane of the 2012 Atlantic hurricane season. The storm inflicted nearly $70 billion (2012 USD) in damage and killed 233 people across eight countries from the Caribbean to Canada. Sandy was a Category 3 storm at its peak intensity and had Category 1 hurricane wind speeds when it struck the coast of the northeastern United States. After making its way up from the Caribbean, Sandy made landfall early on October 29, 2012 in New Jersey, just to the northeast of Atlantic City.

Sandy caused massive power outages in the northeast for approximately 2.2 million customers, which resulted in estimated losses in economic activity between $30 billion and $50

[11] *See,* https://www.cnn.com/2018/08/23/us/hawaii-hurricane-iniki-1992-wxc/index.html; https://www.accuweather.com/en/weather-news/25-years-later-hurricane-iniki-still-one-of-hawaiis-most-devastating-storms/357419

billion. Two of the largest affected utilities were Consolidated Edison ("ConEd") and Long Island Power Authority ("LIPA"). Massive flooding forced ConEd to de-energize all of its underground system serving Manhattan, and LIPA had to de-energize 15 substations due to flooding. In all, about 2.2 million customers were interrupted by Sandy on October 29, 2012. As of the morning of November 2, 2012, more than 1.3 million customers were still without power. Restoration to most customers did not occur until the weekend of November 10 and 11, 2012, over 12 days later, with restoration to the remaining customers occurring over several more weeks.[12]

D. Florida – Before and After Hardening

Florida was impacted by five major hurricanes in 2004 and 2005. As a result, the Florida Public Service Commission ("FPSC") issued an order requiring all electric utilities to submit storm hardening plans, with updates to these plans being submitted every three years. There were no major storm landfalls in Florida until the four hurricanes in 2016 and 2017, which provided the first opportunity to gather performance data.

On October 3, 2017, the FPSC opened a docket to review the effectiveness of 12 years of storm hardening. Results of this review were documented in the report *Review of Florida's Electric Utility Hurricane Preparedness and Restoration Actions (2018)*.[13] Some of the key findings include:

- Florida's aggressive storm hardening programs for the T&D system are working.

[12] *See,* https://www.nationalgeographic.com/environment/article/hurricane-sandy; https://www.worldvision.org/disaster-relief-news-stories/2012-hurricane-sandy-facts; https://www.cnn.com/2013/07/13/world/americas/hurricane-sandy-fast-facts/index.html

[13] *Review of Florida's Electric Utility Hurricane Preparedness and Restoration Actions,* July 2018, Florida Public Service Commission

- Hardened overhead distribution facilities performed better than non-hardened facilities.
- Very few transmission structure failures were reported.
- Underground facilities performed much better compared to overhead facilities.
- The primary causes of power outages came from outside the utilities' rights of way including falling trees, displaced vegetation, and other debris.
- The length of outages was reduced markedly from the 2004-2005 storm season.
- Customers expect that resilience and restoration times will continually improve.

From 2006 through 2017, Florida Power & Light ("FPL") spent approximately $4 billion on storm hardening efforts (referred to as its "Storm Secure" initiative). This corresponds to about $714 per customer over 12 years, or on average, about $76 per customer per year.

FPL provided the commission a comparison of storm performance for Hurricane Wilma and Hurricane Irene. Wilma struck in 2005, prior to storm hardening efforts, as a strong Category 3 hurricane which affected the majority of the FPL service territory. Irma struck in 2017 as a weak Category 4 hurricane which also affected the majority of the FPL service territory. Therefore, these two storms are appropriate to use to determine the effectiveness of 12 years of system hardening on the FPL system. A comparison of the impact of Wilma and Irma on the FPL system is shown in Table 1.

Table 1: FPL Restoration Comparison of Wilma (2005) vs. Irma (2017)

	Wilma (2005)	**Irma (2017)**
Customer Outages	3.2M	4.4M
Staging Sites	20	29
% Restored / Days	50% / 5	50% / 1
Total Length of Restoration (Days)	18	10
Average Days to Restore	5.4	2.1

As can be seen from Table 1, customer restoration occurred much quicker after Irma when compared to Wilma. After Irma, it took five days to restore 50% of customers whereas it only took one day after Irma to restore 50% of customers. During Wilma, extensive damage occurred to the bulk power system, which delayed the restoration of many customers. During Irma, the hardened bulk power system incurred far less damage, resulting in large numbers of customers being restored very quickly. The total length of time to full restoration was also much shorter after Irma when compared to Wilma. Total length of restoration for Wilma was 18 days as compared to 10 days for Irma, despite more customer outages occurring during Irma. This is largely due to less damage occurring on the hardened distribution system. The average number of days to restore customers was also reduced by more than half, from 5.4 days after Wilma to 2.1 days after Irma.

A failure rate of transmission and distribution structures is shown in Table 2 for both hardened and unhardened structures.

Table 2: FPL Failure Rates for Hurricane Irma (2017)

	Hardened Overhead Total	Hardened Overhead Replaced/Repaired	Non-Hardened Overhead Total	Non-Hardened Overhead Replaced/Repaired
Transmission Structures	60,694	0 (0%)	5,991	5 (0.08%)
Distribution Poles	124,518	26 (0.02%)	1,063,684	2,834 (0.27%)

As can be seen in Table 2, hardening transmission structures was very effective, with no hardened transmission structrures failing during Irma (transmission structures were hardened to NESC extreme wind criteria). Since most of the tramsmission structures had been hardened by the time Irma struck, there were only 5,991 unhardened transmission structures left and five of those failed. This small number (in absolute terms) is a large factor as to why 50% of interrupted customers were able to be restored within one day.

Equally important is the reduction in failure rates of hardened distrubution poles. Of the 124,515 hardened distribution poles, only 26 failed (0.02%). This is in stark contrast to the 2,834 unhardened distribution poles that failed (0.27%). For a comparison, approximately 10,000 distribution poles failed during Wilma, as compared to about 2,900 during Irma. This dramatic reduction is a result of FPL targeting the weakest distribution poles for hardening and is a large factor in why TLR was only 10 days for Irma.

As can be seen from the FPL comparison of Wilma in 2005 to Irma in 2017, hardening efforts resulted in significant benefits and support the FPUC's conclusions that "Florida's aggressive storm hardening programs are working," and that "[t]he length of outages was reduced markedly from the 2004-2005 storm season."

E. Hurricane Lane

Hurricane Lane was a powerful hurricane that brought torrential rainfall and strong winds to Hawai'i during late August 2018. The storm was the wettest on record in Hawai'i, with peak rainfall accumulations of 58 inches along the eastern slopes of Mauna Loa. Lane reached a peak strength of Category 5 on August 22, 2018 when it was to the south of Hawai'i. Thereafter, the hurricane turned north and slowed. During this period, torrential rains battered much of the Hawaiian Islands. Across Hawai'i Island, 159 utility structures were damaged or destroyed. Strong winds downed trees and power lines on Maui, and brush fires ignited on both Maui and O'ahu. In September 2018, President Donald Trump declared much of Hawai'i a disaster area. The track of Lane and its strength along its track is shown in Figure 1. This shows that, although Lane resulted in much of Hawai'i being declared a disaster area, the situation could have been dramatically worse if it had continued north instead of turning west. If Lane had continued North, O‘ahu would have suffered a direct strike of a Category 1 or 2 hurricane, potentially to the heart of the State’s commercial, business and population districts. If this had occurred, the unhardened electric system on O‘ahu would have incurred extensive damage and may have resulted in a situation similar to Iniki on Kaua‘i in 1992, which resulted a restoration process that lasted for four months.[14]

Figure 1: The Track of Hurricane Lane

III. IMMEDIATE NEED TO ADDRESS SEVERE WEATHER AND CLIMATE CHANGE RISKS TO HAWAI‘I

The Hawaiian Islands are already at risk for a host of major natural events that could result in extensive damage to its electric infrastructure. As discussed above, examples include hurricanes, earthquakes, tsunamis, and wildfires. Some of these natural events, such as

[14] *See,* https://www.nhc.noaa.gov/data/tcr/EP142018_Lane.pdf; https://www.cnn.com/2018/08/28/us/hawaii-tropical-storm-lane-flooding-wxc/index.html

hurricanes, are anticipated to become more frequent and/or more severe as climate change results in higher global temperatures.

As has been demonstrated in Florida, hardening the system takes time, but can result in significant benefits when a natural disaster occurs. It is therefore prudent to begin hardening initiatives now so that as much system hardening as possible can be completed as early as possible – hopefully before the next natural disaster occurs and before climate change further increases the risk.

A. **Hawaiian Electric Companies' Ongoing Resilience Efforts**

A hurricane of any size and category may pose a threat to the local infrastructure, environment, and economy and adversely impact the daily lives of the residents of Hawai‘i. These impacts are further compounded by the geographic isolation of Hawai‘i; the vulnerability of Hawai‘i's critical infrastructure; and the time requirements for transporting and delivering additional resources, assets, and capabilities to affected communities during a response. A response to catastrophic impacts caused by a hurricane in Hawai‘i will require a coordinated, joint effort involving county and state agencies, the Federal Government, Non-Governmental Organizations ("NGO"), and private sector organizations.

A catastrophic hurricane will produce statewide power outages and disrupt all energy systems, resources, and markets. The power generation and distribution systems in Hawai‘i are subject to widespread outages before, during, and after a catastrophic hurricane. Transmission and distribution lines are subject to damage from wind and flying debris. In particular, older transmission lines are not designed for winds associated with a significant hurricane. Substations and transformers are also subject to flying debris, and in addition, are susceptible to flooding.

After seasons of deadly and destructive hurricanes in the continental United States, and an increasing number of close calls in Hawai‘i, resilience planning is taking on new urgency. The Companies' efforts to strengthen electric grids and expand storm recovery planning go on year-round in preparation for hurricane season. The Companies work with HI-EMA and county-level emergency planning and response agencies in developing disaster plans and practicing responses. They have strong relationships with other local utilities, companies and contractors that would be crucial to help speed recovery. They are also doing more engagement with communities to ensure that families, businesses, and neighborhoods are doing more to prepare themselves, and that they know what to expect. The Companies recognize that Hawai‘i's island communities can't wait around to be "rescued;" rather, our communities must be resourceful and put plans in place to take care of ourselves and neighbors for some time on our own. This is the work that the Companies want to expand and ramp-up through this Application.

B. Anticipated Climate Change Risks to Hawai‘i

The primary climate change risks for electric infrastructure in Hawai‘i are (1) an increase in flooding due to sea level rise; and (2) an increase in the frequency and severity of tropical cyclones (referred to as hurricanes).

Sea level rise will increase the frequency and severity of coastal flooding. This is true for flooding due to tsunamis and hurricanes and is also true for heavy rain events due to the decreased ability of the watershed to percolate the rainfall. The risk of increased flooding is primarily along coastal areas and in major watershed areas.

According to the National Oceanic and Atmospheric Administration (NOAA), hurricane rainfall rates are projected to increase in the future due to anthropogenic warming and the accompanying increase in atmospheric moisture content. Modeling studies project an increase on the order of 10-15% in atmospheric moisture. Hurricane intensities are projected to increase on average, with models projecting strength increases ranging from 1-10% for an assumed 2-degree Celsius temperature increase due to global warming. The number of hurricanes that reach very intense (Category 4 and 5) levels is also projected to increase due to rising global temperatures.[15]

C. <u>**Lessons Learned from Puerto Rico After Hurricane Maria**</u>

Maria made landfall on Puerto Rico on September 20, 2017 as a strong Category 4 storm bringing a large storm surge, very heavy rains, and strong wind gusts. The hurricane caused extensive damage to the island's electric system, resulting in a complete blackout leaving all 3.4 million residents without electricity.

The damage that Maria caused to the electric infrastructure is a warning to all island utilities with unhardened systems. After one month, 88% of customers were still without power. Complete restoration of electric service took almost one year, with restoration costs exceeding $3 billion. Since the utility serving Puerto Rico (PREPA) has about 1.5 million customers, this restoration cost alone corresponds to about $2,000 per customer.

In the aftermath, Puerto Rico developed a plan to create a more robust grid architecture that incorporated aspects of the fractal grid concept. In a fractal grid, any part of the overall power system will be capable of performing all the functions of the full grid today. With fractal design, parts of the grid can safely isolate from the rest of the power system when it is optimal to do so (e.g., in response to local weather conditions, changes in fuel costs, etc.) but return to the broader system when conditions change.[16] That is, to enable the grid to decompose into

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[15] *See,* https://www.gfdl.noaa.gov/global-warming-and-hurricanes/

[16] T. Heidel and C. Miller, Agile Fractal Systems: Reenvisioning Power System Architecture - Frontiers of Engineering, 2017

segments that allow connected energy resources to supply connected loads, whether as part of a transmission segment, substation, or distribution segment. In large events, such as hurricanes, the concept starts the fractal decomposition from the transmission system, down to distribution, then to the edge, preserving those segments that are undamaged and capable of connecting sufficient energy supply to connected loads. The idea is to create segmentations at the largest size possible so the greatest number of customers can remain with power. This becomes particularly critical with vehicle electrification, especially when considering increased reliance on electric vehicles for evacuation in the future.

The Puerto Rico strategy and investment plan recognizes that developing such a fractal grid begins with hardening the transmission and distribution system and incorporating grid modernization capability as distributed energy producing resources and microgrids are developed over time. Transmission resilience addresses the needs of the largest number of customers, given the majority of energy resources are transmission connected, as in Hawaiʻi. Additionally, the architecture considered substation and distribution hardening, flexibility, and operational systems (e.g., ADMS) required to enable mini-grids,[17] community microgrids,[18] and customer microgrids.[19] Combined, these synergistic, architecturally strategic investments at each tier: transmission, substation/distribution, and customer, provide for a holistic resilient system today and into the future.[20]

[17] For the purpose of this Application, mini-grids are largely self-sufficient electric islands that generally operate over larger areas than microgrids, including at the transmission level.
[18] Community microgrids include multi-customer microgrids operating on utility-owned distribution or sub-transmission infrastructure. This would include hybrid microgrids of the type defined in the Microgrid Services Docket No. 2018-0163
[19] Customer microgrids include single-customer or multi-customer (e.g., campus-style) microgrids operating on non-utility infrastructure.
[20] DOE, Energy Resilience Solutions for the Puerto Rico Grid, 2018. Available at: https://www.energy.gov/sites/prod/files/2018/06/f53/DOE%20Report_Energy%20Resilience%20Solutions%20for%20the%20PR%20Grid%20Final%20June%202018.pdf

D. Economic Loss Risks

Electrical outages caused by natural disasters and other catastrophic events can have devastating economic impacts. As a very general matter, these impacts could be measured in terms of Gross Domestic Product ("GDP"). 2019 GDP for the State of Hawai'i counties are shown in Table 3.[21]

Table 3: 2019 GDP for Hawai'i Counties

County	GDP ($M)	GDP Per Day ($M)
Hawai'i	8,221	22.5
Honolulu	61,094	167.4
Kaua'i	3,829	10.5
Maui + Kalawao	9,329	25.6

Honolulu County has an average economic activity amounting to $167 million per day. This economic activity level will be severely impacted by an extreme event, potentially resulting in hundreds of millions of dollars in reduced GDP output. While economic loss would be due to a variety of factors, electric service loss would be a significant contributor. Without electric service, the economic output of most facilities may be zero. For a single severe event (e.g., a Category 3 hurricane), it was estimated that faster electric service restoration would result in avoided GDP loss exceeding the cost of the hardening investments proposed in this Application (see Section 7.3 of Exhibit C (*Project Business Case*)). That is, avoided GDP loss alone may exceed the incremental electric bill payments required for the Project.

Although reducing risk of GDP loss is typically the largest monetary benefit of system hardening, there are also benefits in reducing economic loss risk to residential customers. These

[21] Hawaiian Electric Tariff Rule 16 provides in pertinent part that "The Company will not be liable for interruption or insufficiency of supply or any loss, cost, damage or expense of any nature whatsoever, occasioned thereby if caused by accident, storm, fire, strikes, riots, war or any cause not within the Company's control through the exercise of reasonable diligence and care."

primarily include the "customer cost of an interruption" and avoided food spoilage. The customer cost of an interruption can be estimated using the U.S. Department of Energy ("DOE") Interruption Cost Estimator ("ICE") calculator. For residential Hawaiʻi customers, ICE estimated the customer cost of an interruption to be $4.96 for a 24-hour interruption.[22]

System hardening is also expected to reduce the cost of restoration efforts by reducing the amount of damage incurred in a severe event. For example, FPL estimated that the total restoration benefits of community undergrounding amounted to about 25% of the undergrounding cost. The FPSC agreed with this estimate and now allows FPL to subsidize up to 25% of community undergrounding costs, paid for by the entire rate base.[23] While the system hardening activities proposed in this Application can be expected to reduce total restoration time and costs under severe event scenarios, there is not sufficient data at this time to estimate expected restoration cost reductions over the life of these investments with precision.[24]

IV. ROUTINE ASSET SUSTAINMENT IS INADEQUATE TO ADDRESS SEVERE RESILIENCE THREATS

Asset sustainment is primarily concerned with preventing failures caused by asset deterioration while maximizing the lifetime value of assets. This is accomplished by prudent maintenance to preserve function and extend asset life and replacing aging or deteriorated assets near end-of-life, either with like-kind assets or by upgrading the asset to current standards. The value of asset sustainment to customers is primarily realized in terms of increased blue-sky, day-

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[22] The ICE calculator is available at https://icecalculator.com/home. The website states that the calculator is (1) not statistically-representative for all regions of the U.S., and (2) not appropriate for estimating costs of widespread, long-duration (> 24 hour) interruptions. The ICE calculator is not appropriate for calculating customer costs for multi-day restorations, and it is not used for this purpose in this application. It is used to provide the reader a feel for the typical cost of a 24-hr interruption to a residential customer in Hawaiʻi.

[23] *See,* https://www.orlandosentinel.com/opinion/os-ed-rich-florida-cities-putting-power-lines-underground-20171005-story.html

[24] *See* Section 7 of Exhibit C (*Project Business Case*) for a discussion on Project benefits.

to-day reliability, since allowing assets to deteriorate will eventually result in outages and interruptions to customers. Note that the relationship between asset sustainment and reliability is not direct since not every asset failure immediately results in an outage, and not every outage immediately results in customer interruptions. However, from a systems perspective, effective asset sustainment prevents outages and interruptions caused by asset failures under normal conditions. The overarching goal of asset sustainment, therefore, is to identify and replace assets before they fail due to deterioration/age, but no earlier than needed to maximize the value of the asset.

Routine asset sustainment efforts are inadequate to safeguard the grid against severe resilience threats. Although asset sustainment efforts maintain system integrity and slowly strengthen the grid by replacing and often upgrading assets at end-of-life, these efforts: 1) are not targeted and optimized for resilience improvement, and 2) do not result in assets being upgraded at a pace necessary to yield sufficient resilience benefits. Since two of the primary drivers for asset sustainment are to prolong the life of assets and prevent failures of assets due to deterioration, asset sustainment programs will inherently prioritize replacement and upgrade of assets in poor condition and near end-of-life over assets that are "critical" from a system resilience perspective but are in acceptable condition and have remaining useful life. This demonstrates an inherent difference in objectives and corresponding efforts between asset sustainment and resilience investments. For example, one could imagine a scenario where a marginal capital budget amount could be spent on one of the following two options:

Option 1: 30 distribution poles, located across various circuits, are identified to be deteriorated and require replacement to conform with safety codes and prevent failures, which could pose a safety risk and impact reliability. Each of these poles could be replaced and brought to current design standards.

Option 2: 20 distribution poles are identified on a single circuit serving highly critical community lifeline infrastructure.[25] Each of these poles is in acceptable condition, conforms with safety codes, and has useful life remaining. However, these poles could be upgraded such that the overall circuit is designed to withstand extreme wind loadings in the event of a hurricane.

Based on asset sustainment priorities, Option 1 would be prioritized over Option 2. The poles comprising the circuit in Option 2 may not be replaced until they are near end-of-life given limited capital budgets and competing priorities. When each of the poles on the circuit in Option 2 eventually nears end-of-life, which may take decades, they could be replaced with a stronger pole to upgrade the resilience of the circuit over time given the circuit criticality. This example demonstrates that the grid can be hardened incrementally over time through ongoing, routine asset sustainment programs as assets near end of life, but would not be targeted to address critical vulnerabilities over an accelerated timeframe.

Indeed, as the Consumer Advocate noted in its Comments on the Commission Staff Proposal in Docket No. 2018-0088:

> Resilience investments are not adequately addressed through the ARA, existing PIMs, or proposed PIMs. Further, the economic pressure created by the ARA might encourage utilities to downplay resilience-related investments. The Consumer Advocate believes that the utilities should be making more progress to prepare for the increasing frequency and magnitude of storms that can wreak havoc on the electric utility system and the Hawaii economy.[26]

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[25] *See*, FEMA Community Lifelines, https://www.fema.gov/emergency-managers/practitioners/lifelines
[26] Division of Consumer Advocacy's Comments on Staff Proposal for Development of Priority Performance Mechanisms dated September 17, 2021, filed September 30, 2021, at 10.

Additional resilience-focused investment is needed to strategically strengthen the grid and address vulnerabilities to severe events to limit outages to critical community lifelines, lessen damage to the grid, and reduce restoration times. Resilience-focused investments are concerned with maximizing the ability of the system to withstand and rapidly recover from severe events. In the case of existing assets, this will typically involve identifying and upgrading critical and/or vulnerable assets to withstand extreme conditions. The practical consequence of these distinct prioritization paradigms is that resilience-focused investments will generally target different assets from routine asset sustainment and will typically exceed the design standards applied for routine asset replacement. Resilience enhancements may also involve the installation of new assets, such as intermediate poles to strengthen the overall wind rating of a critical line or devices to provide situational awareness in severe event scenarios – neither of which would be done for asset sustainment purposes.

For example, the proposed Project includes plans to harden critical distribution circuits, such as those serving major hospitals, critical military facilities, first responders, or other critical facilities, to withstand extreme wind events. In doing so, the Companies plan to upgrade assets on lines serving identified critical loads that are not currently rated for extreme winds. Since distribution circuits are not typically designed using extreme wind loading criteria, this will involve replacing or reinforcing existing poles, many of which still have remaining useful life. This work could also involve installing additional intermediate poles to reduce span lengths and increase the overall wind rating of the line. Investments such as these have not been a common historical practice and are not routine. However, they are needed to address the increasing threat of climate change and severe weather events.

V. RWG IDENTIFICATION OF KEY RESILIENCE THREATS AND RECOMMENDED SOLUTIONS

As described more fully in the RWG Report, the goals of the RWG are to:

- Identify and prioritize resilience threat scenarios and potential grid impacts
- Identify key customer and infrastructure sector capabilities and needs following a severe event and loss of power
- Identify gaps and priorities in grid and customer capabilities following a severe event and loss of power
- Provide recommendations and inputs for the IGP to address resilience needs
- Recommend additional grid and customer actions to close gaps in capabilities following severe events

The following is a brief description of the major activities and recommendations of the RWG to date.

A. Identifying Severe Threats

The RWG began by identifying and prioritizing severe threats and understanding their impacts on the grid and customers. They spent several meetings discussing severe event scenarios and conducting tabletop exercises in breakout sessions to discuss the event impacts by island and within their various sectors. The group recognized that severe events have happened in the past and are likely to continue. The group also believes that some severe events will increase in frequency and severity in the future.

The RWG determined by consensus that five types of severe events were most important to consider for achieving a resilient grid in Hawai‘i. They are:

- Hurricanes

- Earthquakes and tsunamis
- Volcanos (Hawai‘i Island)
- Wildfires
- Physical and cyber-attack

The RWG then developed moderate and severe scenarios for each of the above threats along with corresponding impact estimates and assumptions.

This Application focuses primarily on mitigating the effects of hurricanes (including both high winds and flooding), and preventing ignition of, or contribution to, wildfires by the Companies' facilities.

B. **Prioritizing Customer Sectors**

As part of the work of the Resilience Working Group, the working group members assessed the capabilities of key customer and infrastructure sectors to withstand severe events. These customer sectors, such as hospitals and critical healthcare, first responders and emergency management, defense, water and wastewater, transportation, and telecommunications, are not only important to the health and safety of the public during emergencies, but provide fundamental services that enable all other aspects of society to function.[27] When severe events cause disruptions of these services, decisive intervention is required to stabilize the incident. Since all critical customer sectors depend on electricity to function, ensuring reliable and resilient power to these customers is crucial to the resilience of the community.

In discussing the interdependencies among the various key customer and infrastructure sectors, it was recognized that all sectors need power to be restored as soon as possible after a severe event. During the severe event scenario breakout sessions, it was apparent that the loss of

[27] Exhibit B (*Resilience Working Group Report for Integrated Grid Planning*), Exhibit 23, Pages 42-43.

electricity in critical customer and infrastructure sectors could have severe impacts, including severe disruption to mission critical services, impacts to life and health of the public, damage to infrastructure and property, environmental impacts, and immense cost and economic implications.[28] Energy can appropriately be thought of as a lifeline to other community lifelines.

The RWG recognized that the loss of electricity has a different impact to different sectors of the community. A residential customer will be inconvenienced by a power outage. However, the loss of electricity in critical customer and infrastructure sectors could have severe impacts as described above. Therefore, the RWG prioritized customers and infrastructure sectors from a perspective of importance to supporting national security, public safety and health, and power system recovery.[29]

Sectors of customers were placed into three tiers. Tier 1 included critical services such as the military, telecommunications, hospitals, emergency responders, water, and wastewater. These are the customers with the greatest need to be returned to service quickly. Customer sectors in tier 2, such as harbors and airports, hospitality, and financial institutions, could tolerate an outage lasting from several hours to a few days. Remaining customers would be in tier 3 and would be the lowest restoration priority.

The RWG also provided general information on the ability of customer classes to withstand severe events and recognized that there are gaps between customers' ability to withstand an outage and the potential downtime associated with the severe events contemplated by the RWG. While there are actions to take to close these gaps, the RWG acknowledged that it is a shared responsibility of the critical infrastructure sectors and is not the sole responsibility of

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[28] *Id.*
[29] Exhibit B, Exhibit 23, Page 43.

the power companies. As described further in Section XII.B of the Application, this Application proposes utility actions that prioritize these identified critical customer sectors for targeted resilience enhancements.

C. <u>RWG Recommendations</u>

The RWG recognized that there are many options for enhancing grid resilience to the threats identified by the group, and that the focus should be on closing gaps between existing capabilities and needs to withstand and recover from severe events. The final RWG report includes recommendations for 1) the IGP process, 2) key customers and infrastructure partners, and 3) utility actions outside of the IGP process.[30] While a primary purpose of the RWG was to provide general guidance and inputs to the IGP process to address resilience needs, the RWG also recognized that "some grid resilience solutions may not be about the grid at all or may not be developed through an IGP process."[31]

The following are some examples of resilience options the RWG recommended the Companies consider outside of the IGP process:

- Utilities plan for enhanced vegetation management, particularly in critical grid areas susceptible to damage from wind and falling or flying debris
- Utilities continue hardening or reinforcing critical transmission circuits, including upgrading wind criteria and flood mitigation, upgrading structures, and using enhanced construction methods and materials
- Utilities continue planning for expanding underground cables (water resistant) and locating equipment outside flood prone areas

[30] Exhibit B, Pages 67-70.
[31] Exhibit B, Page 55.

- Utilities consider alternative paths for transmission circuits to increase diversity of location and enhance performance during severe events
- Utilities establish one or more priority circuits with enhanced restoration capabilities and greater hardening

The RWG noted that its list of recommendations was "not meant to be a comprehensive list but rather a starting point for further evaluation."[32] In developing its plans for the proposed Project, the Companies incorporated some of the RWG's recommendations in addition to other compatible actions based on industry best-practice and lessons learned from other utilities who have made significant investments in resilience.

[32] Exhibit B, Page 10.

ACCOUNTING TREATMENT DETAILS

The Companies will follow their existing general policies and procedures with respect to accounting for the Project costs.

1. CAPITAL COSTS

Project costs will be capitalized following the Companies' existing practices for capital costs. Costs will be included in construction work in progress and transferred to plant in service upon completion. Depreciation will commence starting the beginning of the calendar year following the date the component is placed in service.

The capital costs are proposed to be recovered through the EPRM guidelines approved at that time, until such costs are reflected in new rates that provide cost recovery of the Project, as discussed in Exhibit E (*Exceptional Project Recovery*).

The capital costs of the Project will be included in plant accounts following the Federal Energy Regulatory Commission ("FERC") Uniform System of Accounts and is consistent with the Companies' Property Unit Catalog.

a. The Critical Transmission Line Hardening assets will be accounted for in FERC plant account 355, "Poles and Fixtures – Transmission Plant" which has an average service life of 58 years.
b. The Critical Customer Circuit Hardening, Critical Pole Hardening & Mitigation, and Distribution Feeder Ties assets will be accounted for in FERC plant account 364, "Poles, Towers and Fixtures – Distribution Plant" which has an average service life of 45 years.
c. The Wildfire Prevention & Mitigation assets will be accounted for in FERC plant account 365, "Overhead Conductors and Devices – Distribution Plant" which has an average service life of 53 years.
d. The Lateral Undergrounding assets will be accounted for in FERC plant accounts 366 "Underground Conduit – Distribution Plant", 367 "Underground Conductors and Devices – Distribution Plant" and 368 "Line Transformers – Distribution Plant" which has average service lives of 60, 55 and 30 years, respectively.
e. The Substation Flood Monitoring assets will be accounted for in FERC plant account 362, "Station Equipment-Substations – Distribution Plant" which has an average service life of 55 years.

As the Companies plan to construct and install the capital for the various initiatives over the course of each year, they propose to include in target revenues the EPRM recovery of actual recorded capital costs incurred during the calendar year for the various initiatives through the annual EPRM filing to be effective January 1 (i.e., the year subsequent to when the costs were incurred) and will be subject to Commission review as part of the Spring Revenue Report filed on or before March 31 of the year following installation.

2. REMAINING PLANT ASSETS

To the extent that any existing plant assets are retired or replaced the Companies plan to reflect this consistent with the normal retirement of other assets, where the book value of such assets are credited to plant in service and a corresponding debit to accumulated depreciation. Such amounts would be considered in the evaluation of accumulated depreciation and depreciation rates for the respective asset class in the subsequent depreciation study following the next depreciation study required to be filed by December 31, 2023.

3. EXPENSES

The Companies will incur incremental expenses for Hazard Tree Removal and Resilience Modeling as discussed in Section XII. Over the course of the program, to the extent that these incremental O&M costs are not recovered in current rates, the Companies request to recover the O&M expenses through the EPRM, until such costs are reflected in new rates that provide cost recovery for the Project, as discussed in Exhibit E (*Exceptional Project Recovery*).

If EPRM recovery is approved, the Companies will defer O&M expenses incurred during a calendar year in a regulatory asset account. In the annual EPRM filing, the Companies will include the prior year actual incurred O&M expenses that were recorded in the regulatory asset account. The costs will be incorporated in target revenues via the annual EPRM revenue adjustment filing as of January 1 (i.e., the year subsequent to when the costs were incurred) and will be subject to Commission review as part of the Spring Revenue Report filed at the end of March. Costs included in the regulatory asset account will be amortized to expense over 12 months starting January 1st of the subsequent year as amounts are accrued to target revenues. This will allow the recognition of target revenues to match the recording of the amortization of the regulatory asset account associated with O&M expenses recovered through the EPRM.

In order to meet the aggressive timelines proposed and due to the critical nature of the work, the Companies will proceed with certain survey activities for the Hazard Tree Removal, as well as, scoping and developing the resilience model beginning in 2022 prior to Commission approval anticipated in 2023. The costs for these activities will be recorded to expense when incurred in 2022. Additional amounts spent in 2023 prior to Commission approval will also be recorded to expense when incurred. Upon Commission approval anticipated in 2023, the Companies propose to record a regulatory asset for the actual expenses incurred in 2022, as well as the actual expenses incurred in 2023 and will request to recover the 2022-2023 pre-approval expenses through an adjustment to target revenues in the annual EPRM revenue adjustment filing effective January 1, 2024. These expenses will be included in the annual MPIR/EPRM filing to be filed on or before February 28, 2024, subject to Commission review as part of the Spring Revenue Report filed on or before March 31, 2024.

VERIFICATION

STATE OF HAWAI‘I)
) SS.
CITY AND COUNTY OF HONOLULU)

JOSEPH P. VIOLA, being first duly sworn, deposes and says: that he is the Senior Vice President, Customer, Legal & Regulatory Affairs of Hawaiian Electric Company, Inc., and Vice President of Hawai‘i Electric Light Company, Inc. and Maui Electric Company, Limited, Applicants in the above proceeding; that he makes this verification for and on behalf of Hawaiian Electric Company, Inc., Hawai‘i Electric Light Company, Inc. and Maui Electric Company, Limited and is authorized so to do; that he has read the foregoing Application and Exhibits, and knows the contents thereof; and that the same are true to the best of his own knowledge and belief.

/s/ Joseph P. Viola
Joseph P. Viola

BEFORE THE PUBLIC UTILITIES COMMISSION

OF THE STATE OF HAWAIʻI

In the Matter of the Application of HAWAIIAN ELECTRIC COMPANY, INC. HAWAIʻI ELECTRIC LIGHT COMPANY, INC. MAUI ELECTRIC COMPANY, LIMITED For Approval to Commit Funds in Excess of $2,500,000 for Climate Adaptation Transmission and Distribution Resilience Program and to Recover Costs through the Exceptional Project Recovery Mechanism.	DOCKET NO.

CERTIFICATE OF SERVICE

I hereby certify that a copy of the foregoing Application, together with this Certificate of Service, was duly served on the following party, by electronic mail service as set forth below:

Dean Nishina
Executive Director
Division of Consumer Advocacy
Department of Commerce and Consumer Affairs
dnishina@dcca.hawaii.gov
consumeradvocate@dcca.hawaii.gov

DATED: Honolulu, Hawaiʻi, June 30, 2022.

/s/ Michael Chu
Michael Chu

HAWAIIAN ELECTRIC COMPANY, INC.

Chu, Michael

From: puc@hawaii.gov
Sent: Thursday, June 30, 2022 2:00 PM
To: Chu, Michael
Subject: Hawaii PUC eFiling Confirmation of Filing

Your eFile document has been filed with the Hawaii Public Utilities commision on 2022 Jun 30 PM 13:58. The mere fact of filing shall not waive any failure to comply with Hawaii Administrative Rules Chapter 6-61, Rules of Practice and Procedure Before the Public Utilities Commission, or any other application requirements. Your confirmation number is MICH22135814071. If you have received this email in error please notify the Hawaii Public Utilities Commission by phone at 808 586-2020 or email at hawaii.puc@hawaii.gov.