WELCOME AND OPENING REMARKS
Housekeeping

- Restrooms – Code: 3698
- Emergency exits
- Parking validation
Recap of Previous Meeting

- Identify threat impacts to grid and key customers
- Develop inputs to Integrated Grid Planning
- Identify grid resilience planning criteria

PURPOSE

- Utilities moving toward acquiring clean energy
- Resilience criteria may include recovery time for key customers and other customers
- Consider rain bombs as another serious threat

LESSONS LEARNED

1. Raise awareness
2. Define resilience
3. Define priorities
4. Identify potential impacts
5. Identify/assess options
6. Put it all together

PROCESS OVERVIEW

- Mapping of customers to threats and grid
- Assumptions regarding threat impacts and outages
- Inputs to IGP: objectives, assumptions, threat scenarios, resilience criteria, and solution options

Topics Covered
OVERVIEW AND PLAN FOR THE DAY
IGP RWG Process Overview

1. Raise awareness
2. Define resilience
3. Define priorities
4. Identify/map potential impacts
5. Identify/assess/discuss options
6. Put it all together
7. Review final report outline

Today
Meeting Objectives

1. Review and comment on draft outline of RWG report
   - Definition of resilience
   - Resilience threats and impacts to grid and customers
   - Key customer/sector capabilities and needs

2. Review and comment on Integrated Grid Planning inputs
   - Resilience objectives and measurement criteria
   - Assumptions and threat scenarios
   - Resilience strategies
Handouts

- Agenda/Chatham House Rules
- Schedule of Resilience Working Group meetings
- Topical outline of final report
- List of organizations and individuals on RWG for inclusion in final report
RESILIENCE WORKING GROUP OVERVIEW
Overview of Integrated Planning

Customer Needs
- Policy Goals (e.g., renewables, resilience, etc.)
- Forecasts (Assumptions, Sensitivities & Scenarios)
- Other Planning Inputs

We are here

Identify System Needs
- Generation, Transmission, and Distributed Planning

2045 Long-Term Planning
Resource and T&D Needs & Long-term Considerations

5-year Resource Solution Sourcing
- Resource Procurement (Grid Scale, Aggregated DER/DR)
- DER and DR Programs
- Tariffs
- Utility Resource Development

T&D Needs (Resource)

T&D Needs Planning
- (Non-Resource)

T&D Solution Sourcing
- Targeted DER Programs
- NWA Competitive Bid
- Grid Modernization
- Traditional Grid Solution estimate

Solution/Bid Evaluation & 5 yr. IGP Plan
- Grid Resources
- Grid Services
- NWA

Regulatory Approval
Seek PUC approval of IGP 5 yr. plan & related applications

Stakeholder Engagement
Stakeholder Engagement in Integrated Planning

- Affordability
  - Standard Contract
  - Competitive Procurement

- Reliability
  - Forecasts and Assumptions
  - Distribution Planning

- Energy Choices
  - Resilience
  - Grid Services
  - Solution Evaluation and Optimization

Working Groups: Hawaiian Electric, Maui Electric, Hawai‘i Electric Light
Support the development of resilience planning criteria for Hawaii's power system including resource, transmission and distribution, in relation to potential societal and economic impacts.

- Identify and prioritize resilience threat scenarios and potential grid impacts
- Identify key customer/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 integrated grid planning to address resilience needs
- Recommend additional grid and customer actions to close gaps in capabilities following severe events
Resilience Working Group Meetings

- **July 22, 2019**
  - Introduce Resilience Working Group topics and get initial input/thoughts

- **August 29, 2019**
  - Review needs and existing capabilities of critical infrastructure/customer segments under a severe hurricane scenario
  - Get preliminary consensus on resilience process

- **September 17, 2019**
  - Define severe event priorities
  - Identify/map potential impacts of all hazards
  - Identify/assess/discuss mitigation options

- **October 28, 2019**
  - Mapping of threats, vulnerabilities, key customer needs and capabilities as compared to grid
  - Review planning criteria/scenarios

- **November 22, 2019**
  - Review outline of final report

- **December 16, 2019**
  - Review final written report
  - 4 week RWG review and comment period through January 10
  - Consensus/acceptance by RWG
  - Consider minority views
Defining Resilience

“Resilience is the ability of a system or its components to adapt to changing conditions and withstand and rapidly recover from disruptions.” – PUC Staff, PBR Docket

Key elements

- Ability to minimize impacts of severe events
- Ability to sustain mission critical functions under severe conditions
- Ability to rapidly recover from a severe event
- Ability to learn from severe events and continuously adapt
Discussion Questions
Role of RWG and Definition of Resilience

1. Is the Integrated Planning Process sufficiently understood, particularly stakeholder and RWG roles?

2. Are the goals and objectives of the Resilience Working Group understood and acceptable to the RWG?

3. Are there any concerns with the final report review and acceptance process or outline of the final report?

4. Are the definition of grid resilience and description of the elements of resilience acceptable to the group?
RESILIENCE THREAT SCENARIOS
Historical Perspective: Severe Events Affect Hawai‘i

- **Hurricanes** (more than 3 dozen threats since 2000)
  - Iniki – Category 4 hit Kaua‘i September 11, 1992
  - Iwa – Category 1 hit Oahu and Kaua‘i November 23, 1982

- **Flash floods/rain bombs**
  - April 2018 areas over 50 inches of rain in 24 hours (2nd most in U.S. history after Harvey)
  - March 2006 – 30 days of torrential rain

- **Tsunamis**
  - April 1, 1946, 7.8 earthquake off Aleutian Islands caused tsunami max 55 feet runup
  - 5/22/60 Valdivia 9.5 earthquake in Chile caused tsunami in Hawai‘i
  - 3/11/11 state emergency for tsunami

- **Earthquakes**
  - 4/2/1868 7.9 magnitude on Hawai‘i Island
  - 10/15/06 6.7 magnitude on Hawai‘i Island

- **Volcano**
  - Kilauea erupting since 1983
RWG Ranking of Threat Scenarios – Top 5 by Island

Sample vote for Oahu

<table>
<thead>
<tr>
<th>Threat Scenario</th>
<th>Oahu</th>
<th>Hawai‘i</th>
<th>Maui</th>
<th>Lana‘i</th>
<th>Moloka‘i</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hurricane</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Tsunami</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Flooding</td>
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<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Cyber attack</td>
<td>X</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>High winds</td>
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<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Fuel supply</td>
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<td>Earthquake</td>
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<td>Physical attack</td>
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<tr>
<td>Demand (system issues and threats)</td>
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<tr>
<td>Resources (eclipse/strike)</td>
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<td>Wild fire</td>
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<tr>
<td>Greenhouse Gas Emissions</td>
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<tr>
<td>Landslide</td>
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<tr>
<td>Volcanic activity</td>
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<tr>
<td>Lightning</td>
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</table>

MeetingSift Results for Island of Oahu
Total Points Based on Votes for Each Rank

Legend:
- Ranked 1st
- Ranked 2nd
- Ranked 3rd
- Ranked 4th
- Ranked 5th
## Severe Events Considered and Prioritized by RWG

<table>
<thead>
<tr>
<th>Natural</th>
<th>C</th>
<th>P</th>
<th>Technological</th>
<th>C</th>
<th>P</th>
<th>Attack</th>
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<th>P</th>
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<td>Dam failure</td>
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<td>Physical (shooter)</td>
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<td>Industrial Acc</td>
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<td>Levee failure</td>
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<td>Pipeline</td>
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<td>Terrorist nuke</td>
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<td>High wind</td>
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<td>X</td>
<td>Radiological</td>
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<td>Fuel supply</td>
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<tr>
<td>Landslides</td>
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<td>Demand/resources</td>
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<td>C - Considered</td>
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<tr>
<td>Lightning</td>
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<td>P - Prioritized</td>
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**Notes:**
- **C** indicates considered.
- **P** indicates prioritized.
- **X** indicates present in the table.
### September Meeting

#### Threat Scenarios

<table>
<thead>
<tr>
<th>Threat</th>
<th>Includes</th>
<th>Oahu</th>
<th>Hawai‘i</th>
<th>Maui</th>
<th>Moloka‘i</th>
<th>Lana‘i</th>
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<td>X</td>
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<tr>
<td>Fuel Disruption</td>
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<td>X</td>
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<td>X</td>
</tr>
<tr>
<td>Wild Fire</td>
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<tr>
<td>Cyber Attack</td>
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<tr>
<td>Physical Attack</td>
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<tr>
<td>Volcano</td>
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### October Meeting

#### Threat Scenarios

<table>
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<th>Includes</th>
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<th>Hawai‘i</th>
<th>Maui County</th>
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</thead>
<tbody>
<tr>
<td>Hurricane</td>
<td>Flood, Wind</td>
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<tr>
<td>Tsunami</td>
<td>Earthquake</td>
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<tr>
<td>Wild Fire</td>
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<tr>
<td>Physical Attack</td>
<td>Cyber Attack</td>
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<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Volcano</td>
<td></td>
<td></td>
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<td>X</td>
</tr>
</tbody>
</table>

- 12 threat scenarios for study, 4 per county
- Moderate + severe conditions for each; volcano requires 1 scenario (23 total)
- High impact scenarios capturing damage to electric and key customer infrastructure
- Fuel supply is an issue for all scenarios with extended outage times
- Combined cyber and physical security into one hybrid threat
Hurricane Hazard Impact Areas
(All Locations on all Islands)

- Depending on path of hurricane, all islands and locations can be subject to damaging wind, rain and coastal and inland flooding
- Sample impacts
  - Category 2: 96-110 mph wind; 6-8’ surge; power lines/poles damaged
  - Category 4: 130-156 mph wind; 13-18’ surge; most trees broken or toppled; damage to majority of power lines and poles; some damage to substations and power plants
Coastal Flooding Impact Areas

- Severe coastal flooding in Oahu along south and north
- Flooding of key customers and backup generators in coastal areas
- Flooding of utility distribution substations and lines in coastal areas
- More limited coastal flood impacts in Hawai’i and Maui County
Threat Scenario: Hurricane, Wind, Flood
O‘ahu, Hawai‘i Island, and Maui County

- **Moderate**
  - Category 2
  - 96-110 mph winds
  - 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 3-4 days
  - Fuel supply available within 3-4 days

- **Severe**
  - Category 4
  - 130-156 mph winds
  - 20’ storm surge
  - Coastal infrastructure destroyed
  - Damage to transmission lines, poles and towers due to wind, falling trees/branches, and flying debris
  - 25-30% of transmission lines have sustained outage and restored over four months
  - 50-75% of distribution lines out of service and restored over four months
  - Fuel resupply available after four weeks
Earthquake Impact Areas

- Highest risk for Hawai‘i Island
- Major fault lines on east portion of island near Hilo and critical infrastructure
- Seismic damage is a risk but much lower impacts on remaining islands
Tsunami Impact Areas

- Tsunami infrastructure risk highest in Oahu
- Significant damage to utility and customer infrastructure along coastal areas
- Some coastal infrastructure damage expected in Maui
Threat Scenario: Tsunami and Earthquake
O‘ahu, Hawai‘i Island, and Maui County

- **Moderate**
  - 6.5 earthquake on Hawai‘i island
  - Infrastructure damage on eastern and southern portions of island including Hilo
  - Transmission and distribution lines and poles damaged
  - Restoration times 1 day to two weeks

- **Severe**
  - 8.5 earthquake near East Aleutian Islands
  - 50+ foot runup moving as far inland as 0.75 mile affecting all islands
  - Coastal distribution substations and feeders restored over one week to six months

11/19/2019
Wildfires can damage power lines and poles in fire-prone areas.

Impact risks are high in Oahu, Maui, Hawaii Island, and Molokai.
Threat Scenario: Wild Fire
Oʻahu and Maui County

- **Moderate**
  - Massive wildfire on western slopes of Oahu damage all northern transmission corridor circuits
  - 25% of poles and towers sustain permanent damage
  - One line restored after 8 weeks; remaining lines restored over four months

- **Severe**
  - Severe wildfire destroys Maalaea power plant switchyard and power lines emanating from station
  - Reconstruction and repairs completed in six months
Threat Scenario: Physical/Cyber Attack
O‘ahu, Hawai‘i Island, and Maui County

- Moderate
  - Most critical substation sustains physical damage from high powered rifles and several explosive devices
  - Half of transformers at substation can be repaired within two weeks
  - Half of transformers at substation are permanently damaged and require 12-18 months for permanent replacement
  - Lines and switchgear can be repaired in two to six weeks

- Severe
  - Two most critical substations sustain physical damage from high powered rifles and several explosive devices
  - Half of transformers at those two stations can be repaired within two weeks
  - Half of transformers at the two stations are permanently damaged and require 12-18 months for permanent replacement
  - Lines and switchgear repaired in two to six weeks
  - Cyber attack disables control center situational awareness and primary voice communications for 24 hours
Threat Scenario: Volcano
Hawai‘i Island

- Severe
  - Mauna Loa 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
  - 27% of generation is located hazard zone and could be affected for years
  - Worker access limited due to conditions for one month
Discussion Questions
Selection of Threat Scenarios for IGP

1. Are the 12 threat scenarios (4 per county) a good set of events to challenge the grid and key customers?

2. Do the descriptions of the potential impacts of the severe events appear to reasonably describe future expectations?

3. Are the scenarios described sufficient and reasonable for evaluating grid resilience performance for the future?

4. What other comments do you have on what you heard?
KEY CUSTOMER PRIORITIES AND NEEDS
Criteria for Identifying Customers/Sectors

**Tier 1**
- Essential for national security and/or public safety and health
- Essential for power system restoration
- Power should be restored within minutes up to several hours (by utility or backup resource)

**Tier 2**
- Important for national security, public safety and health, and other essential services
- Supports power system restoration
- Power should be restored within hours up to several days (by utility or backup resource)

**Tier 3**
- Remaining customers

- **Resilience objectives**
  - Maintain critical functions
  - Limit fatalities and human suffering
  - Limit infrastructure damage
  - Limit property damage
  - Limit cost/economic impacts
  - Limit environmental impacts
### Suggested Priorities for Customers/Sectors

<table>
<thead>
<tr>
<th>Tier 1</th>
<th>Tier 2</th>
<th>Tier 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Military</td>
<td>• Transportation</td>
<td>• Remaining customers</td>
</tr>
<tr>
<td>• Telecommunications</td>
<td>• Hospitality</td>
<td></td>
</tr>
<tr>
<td>• Hospitals and critical healthcare</td>
<td>• Banking and finance</td>
<td></td>
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<tr>
<td>• Water and wastewater</td>
<td></td>
<td></td>
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<tr>
<td>• Emergency management and first responders</td>
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</tr>
</tbody>
</table>
Even the most capable sectors are limited to 1 week or less without refueling
Sector Interdependencies

Electricity
- All sectors need power restored as soon as possible

Telecommunications
- All sectors need cell, landline, and data communications as soon as possible

Transportation
- Road access is critical to most other sectors
- Airports and ports critical for fuel and supplies for recovery

Water and wastewater
- All sectors require water and wastewater support

Banking and finance
- Required to pay employees and critical supplies

Emergency management, hospital, hospitality
- All sectors need housing facilities and healthcare
O‘ahu Island Critical Facilities

- Concentrated in Honolulu and south shore
- Others distributed in central and shore areas
- Generation southwest with resources at Schofield and Honolulu
- Renewables distributed across island
- Transmission backbone west to east along south
Hawaiʻi Island Critical Facilities

- Concentrated in Hilo and Keahole
- Transmission ring with connectors across
- Power plants at Hilo and Keahole
- Renewables distributed in south and across island
Maui Island Critical Facilities

- Generation at Maalaea and Kahului
- Critical customers in Kahului area and resorts along west coast
Lana‘i Island Critical Facilities

- Central generation with radial distribution
- Limited critical customer sites
Moloka‘i Island Critical Facilities

- Central generation with radial distribution
- Limited critical customer sites

MAP REMOVED FOR CONFIDENTIALITY
Critical Customer/Sector Opportunities to Improve Resilience under Scenarios Identified

- Backup power supply at all critical sites
- Regular testing and operation of backup units
- Consider increasing fuel storage for backup units
- Consider alternative technologies for the most critical sites, including microgrid, renewable and storage, grid-forming inverters, other clean fuel black start units
Discussion Questions
Key Customer/Sector Priorities and Capabilities

1. Are the tiers an acceptable approach to prioritizing key customers, and are sectors shown in the correct tier?

2. Are resilience capabilities, including backup power supply and fuel resupply, described adequately?

3. Are the sector interdependencies described sufficiently? What else should be identified?

4. What actions should critical customers focus on to improve resilience under cited threats and extended power outages?
GRID OPPORTUNITIES
TO IMPROVE RESILIENCE
Characteristics and Vulnerabilities of Existing Electricity Infrastructure – O‘ahu

MAP REMOVED FOR CONFIDENTIALITY

**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
Characteristics and Vulnerabilities of Existing Electricity Infrastructure – Hawai‘i Island

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

### Major Vulnerabilities
- Load center at Kahului
- One major generating plant
- Wildfire hazards
- Coastal flooding
- Spares, supplies and road access
Characteristics and Vulnerabilities of Existing Electricity Infrastructure – Moloka‘i

**Characteristics**
- Directly connected to radial distribution feeds to customers
- Limited refueling capability during emergency

**Major Vulnerabilities**
- One generating plant
- Wildfire hazards
- Coastal flooding
- Spares, supplies and road access
Characteristics and Vulnerabilities of Existing Electricity Infrastructure – Lana‘i

MAP REMOVED FOR CONFIDENTIALITY

**Characteristics**
- Directly connected to radial distribution feeds to customers
- Limited refueling capability during emergency

**Major Vulnerabilities**
- One generating plant
- Wildfire hazards
- Coastal flooding
- Spares, supplies and road access
Potential Options for Long-Term Plan
Some Worst Case Scenarios May Have Weeks to Months for Full Restoration

**Generation**
- Fuel supply
- Harbor and port facilities
- Decentralized resources
- Microgrids

**Transmission**
- Spare material and supplies
- Access to difficult sites
- Availability of helicopter support
- Resources – personnel, equipment, tools

**Distribution**
- Spare material and supplies
- Access (road clearing)
- Resources – personnel, equipment and supplies
<table>
<thead>
<tr>
<th>Potential Grid Mitigation Strategies</th>
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</table>

### Grid planning
- Transmission reinforcements, alternative paths
- Mix and location of generation
- Distributed energy resources
- Microgrids for key loads (connected to grid normally – available for self-supply in emergency)

### System hardening
- Design standards
- Increased wind withstand ratings
- Elevate flood prone substations
- Upgrade structures; construction methods and materials
- Underground cabling
- Maintenance schedules and resources/spares

### Emergency preparations
- Fuel assurance and increased storage
- Alternative port and delivery options for emergencies
- Increased amounts of critical supplies
Discussion Questions
Grid Resilience Options

1. Do the grid resilience options described seem reasonable?

2. What additional options should be considered?
LUNCH BREAK AND JUPITER DEMO
RESILIENCE INPUTS TO INTEGRATED PLANNING PROCESS
Overview of HECO’s Integrated Planning Process

We are here

1. Identify System Needs
   - Generation, Transmission, and Distributed Planning

2. 2045 Long-Term Planning
   - Resource and T&D Needs & Long-term Considerations

3. 5-year Resource Solution Sourcing
   - Resource Procurement (Grid Scale, Aggregated DER/DR)
   - DER and DR Programs
   - Tariffs
   - Utility Resource Development

4. Solution/Bid Evaluation & 5 yr. IGP Plan
   - Grid Resources
   - Grid Services
   - NWA

5. T&D Needs Sourcing
   - Targeted DER Programs
   - NWA Competitive Bid
   - Grid Modernization
   - Traditional Grid Solution estimate

6. T&D Needs Planning
   - (Non-Resource)

Stakeholder Engagement

- Customer Needs
  - Policy Goals (e.g., renewables, resilience, etc.)
  - Forecasts (Assumptions, Sensitivities & Scenarios)
  - Other Planning Inputs

- Regulatory Approval
  - Seek PUC approval of IGP 5 yr. plan & related applications

- 18 months

Hawaiian Electric
Maul Electric
Hawai‘i Electric Light

11/19/2019
Objectives - What Do Customers Want?

- Affordability
- Resiliency
- Renewable Energy
- Stability
- Reliability
- Economic Development
- Sustainability

Inputs, analysis, results

Best meets objectives
### Policy Goals
(Renewable, Resilience, etc.)
- Meeting renewable and carbon goals
- Tier 1 backup power available to maintain until restoration occurs under all scenarios
- Tier 2 power returned within days until restoration occurs under all scenarios

### Forecasts
(Assumptions and forecasts)
- 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

### Other Planning Inputs
- Days supply of power for each Tier 1 and 2 customer
- 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
Resilience index measures how well a resilient grid performs under proposed severe threat scenarios. It is used to make comparisons among various strategies and options. The index is not a utility target or requirement – simply a measuring device to compare how well different solutions perform under severe circumstances.

- Resilience Index (Sample Index Weighting Shown)
  - Percent of Tier 1 customer sites that lose offsite power day or less (25%)
  - Percent of Tier 2 customer sites that lose offsite power 3 days or less (15%)
  - Percent of Tier 3 customers that lose offsite power 14 days or less (10%)
  - Percent of Tier 1 customer sites restored within 3 days (25%)
  - Percent of Tier 2 customer sites restored within 7 days (15%)
  - Percent of tier 3 customers restored within 28 days (10%)
- Cost
Overview of HECO’s Integrated Planning Process

Identify System Needs (Generation, Transmission and Distribution Planning)

- Need strategies to bridge the gaps between customer needs and system vulnerabilities
- Need to test gaps under a wide range of circumstances
  - Typical future uncertainties
  - Atypical events (12 scenarios depicted in the critical resilience events)
- Need to identify the solutions that will
  - Reduce the outage risk of an event
  - Reduce the magnitude of impact
  - Reduce restoration and recovery time
  - Reduce the cost (cost to system vs expected cost of outage)
Overview of HECO’s Integrated Planning Process

- Strategies: Centralized vs Decentralized/Distributed
- Options:
  - Black start resources
  - Spare equipment for restoration/crews
  - Hardening of grid (reinforcement above ground, moving resources underground)
  - Micro or mini grids for customers or groups of customers to separate from grid when needed
  - More fuel and water storage at critical sites
  - More local generation near critical loads
  - Better communication networks, sensors etc.
  - Traditional GT&D resources
  - Non Wire Alternatives (e.g. storage, DER)
Potential Options for Long-Term Plan

**Generation**
- Fuel supply
- Harbor and port facilities
- Decentralized resources
- Microgrids

**Transmission**
- ROW easements and vegetation management
- Spare material and supplies
- Access to difficult sites
- Availability of helicopter support
- Resources – personnel, equipment, tools

**Distribution**
- Spare material and supplies
- Access (road clearing)
- Resources – personnel, equipment and supplies
Potential Grid Mitigation Strategies

**Grid planning**
- Transmission reinforcements, alternative paths
- Mix and location of generation
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**System hardening**
- Design standards
- Increased wind withstand ratings
- Elevate flood prone substations
- Upgrade structures; construction methods and materials
- Underground cabling
- Maintenance schedules and resources/spares

**Emergency preparations**
- Fuel assurance and increased storage
- Alternative port and delivery options for emergencies
- Increased amounts of critical supplies
- Restorations plans, training and drills
## Sample Score Card Summary of Portfolio Options

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Affordability</th>
<th>Resilience</th>
<th>Sustainability</th>
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<tbody>
<tr>
<td></td>
<td>2020-2030 Cost NPV ($Mil)</td>
<td>2020-2040 Levelized Cost (2019 $/MWh)</td>
<td>Cost Rating Score</td>
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<tr>
<td>Status Quo</td>
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Discussion Questions
Inputs to Integrated Planning Process

1. Are the resilience objectives appropriate for input to the Integrated Grid Planning Process?

2. Are the grid planning solutions suggested reasonable and preferred? What other solutions would you offer?

3. Are there any suggested planning solutions that customers feel are not acceptable?

4. Are the grid resilience criteria and scorecard acceptable? What improvements would you suggest?
NEXT STEPS AND CLOSING REMARKS
Next Steps

- Meeting presentation and summary will be made available on the IGP website
  

- Plans for posting and review of draft report
IGP RWG Process Overview (Update)

July 22
- Raise awareness

Define resilience

Define priorities

Identify/map potential impacts

Identify/assess/discuss options

Put it all together

September 17

October 28

November 22

December 16

July 22

September 17

October 28

November 22

December 16

11/19/2019
Mahalo!