Hawaiian Electric

Integrated Grid Planning

Forecast Assumptions Working Group

January 29, 2020

Meeting agenda

8:30
- Welcome
- Objectives & Agenda
- Process recap

8:50
Distributed Energy Resources

10:20
Break (10 mins)

10:30
Electrification of Transportation

11:30
Energy Efficiency Potential Study

12:15
Working lunch (20 mins)

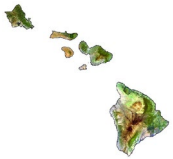
12:35
Sensitivities and Scenarios

1:05
Resource Costs

1:35
What's next

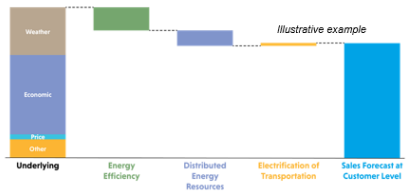
Pau

Process recap



Overview

Who are our customers?
What are we forecasting?
High level “how”



Gather assumptions

Economic outlook
Behind the meter technologies
Electricity price
Weather…

It takes a village

Present methods

To derive the “layers”
Shaping the forecast
Other utilities

ercot
SMUD
Portland General Electric
NVEnergy
Hawaiian Electric

Review assumptions and forecasts

Present assumptions and forecasts
Gather feedback
Refine assumptions
Sensitivities
Update as needed

Resource Cost Forecast
Fuel Price Forecast
Load Forecast
Sensitivities

Objectives for today

1

Distributed Energy Resources, Electrification of Transportation and Energy Efficiency

- Present updated assumptions and preliminary forecasts
- Propose sensitivities to address uncertainty
- Gather feedback

2

Resource costs used for planning

- Present forecasts and solicit feedback

Distributed Energy Resources

Inputs to DER Forecast

Economic Assumptions

- PV and battery installed costs
- Incentives
- Electricity price
- Program structure
- Panel degradation, maintenance and replacement

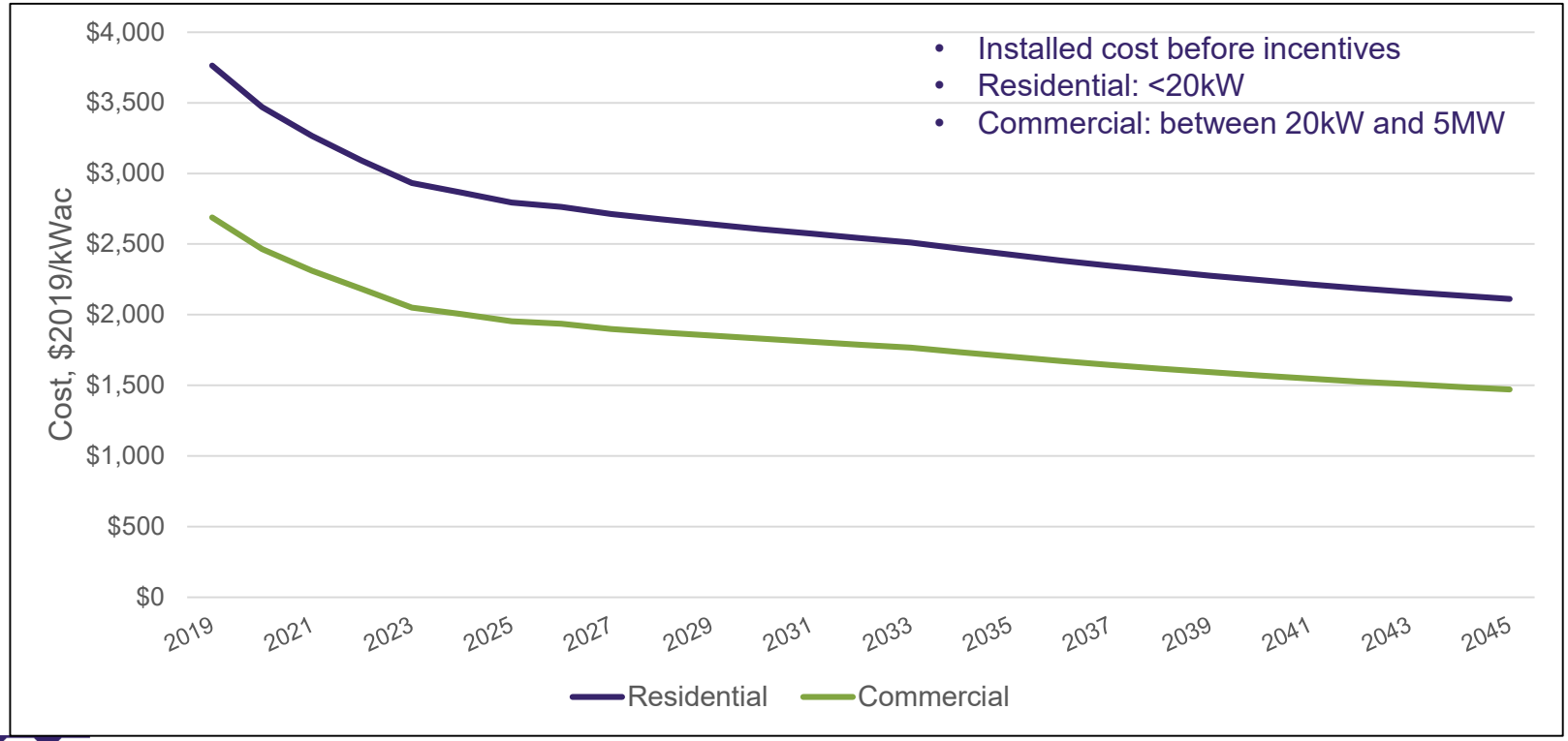
Addressable Market

- Residential customers
- Commercial customers

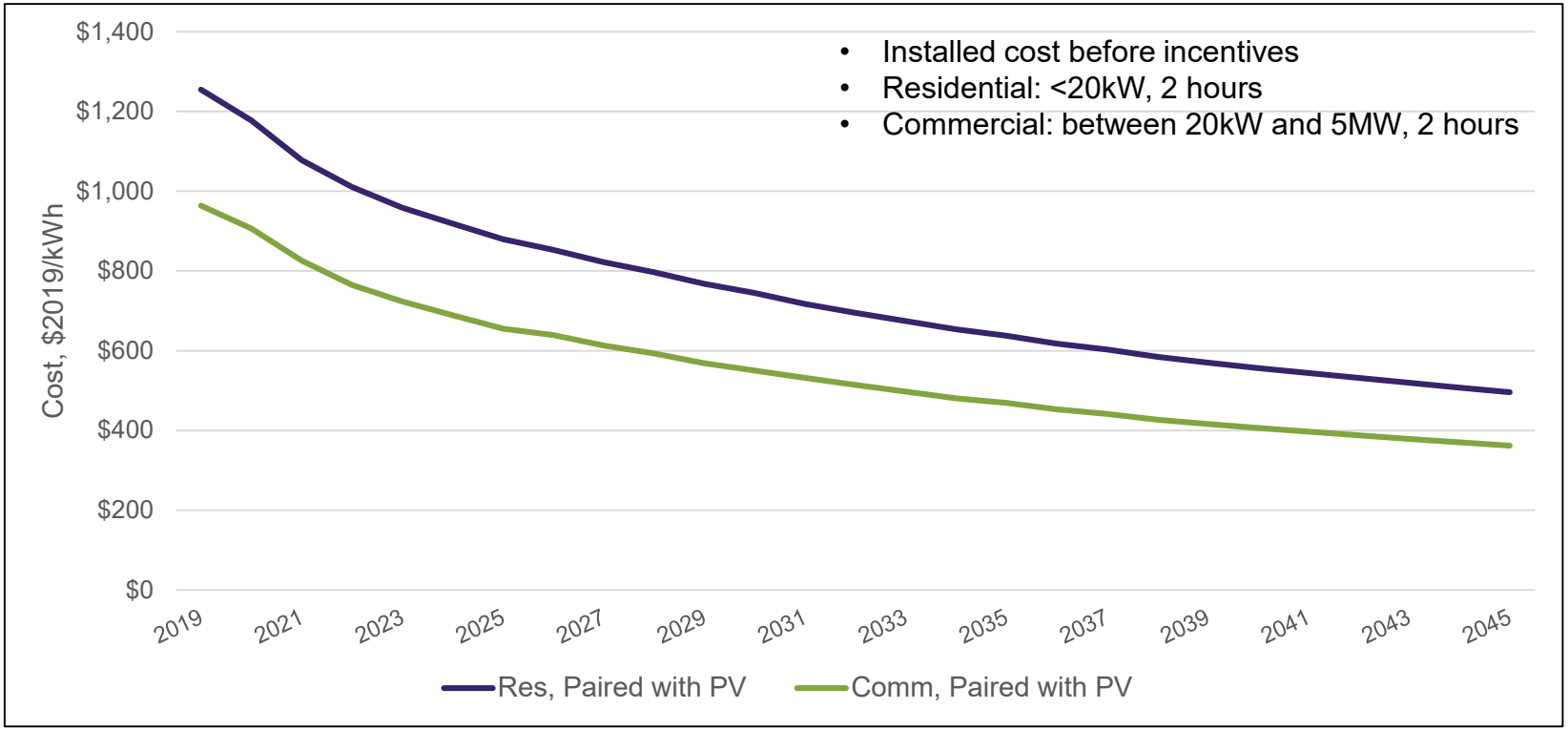
Solar resource assumptions

- Unitized generation profiles
- Capacity factors

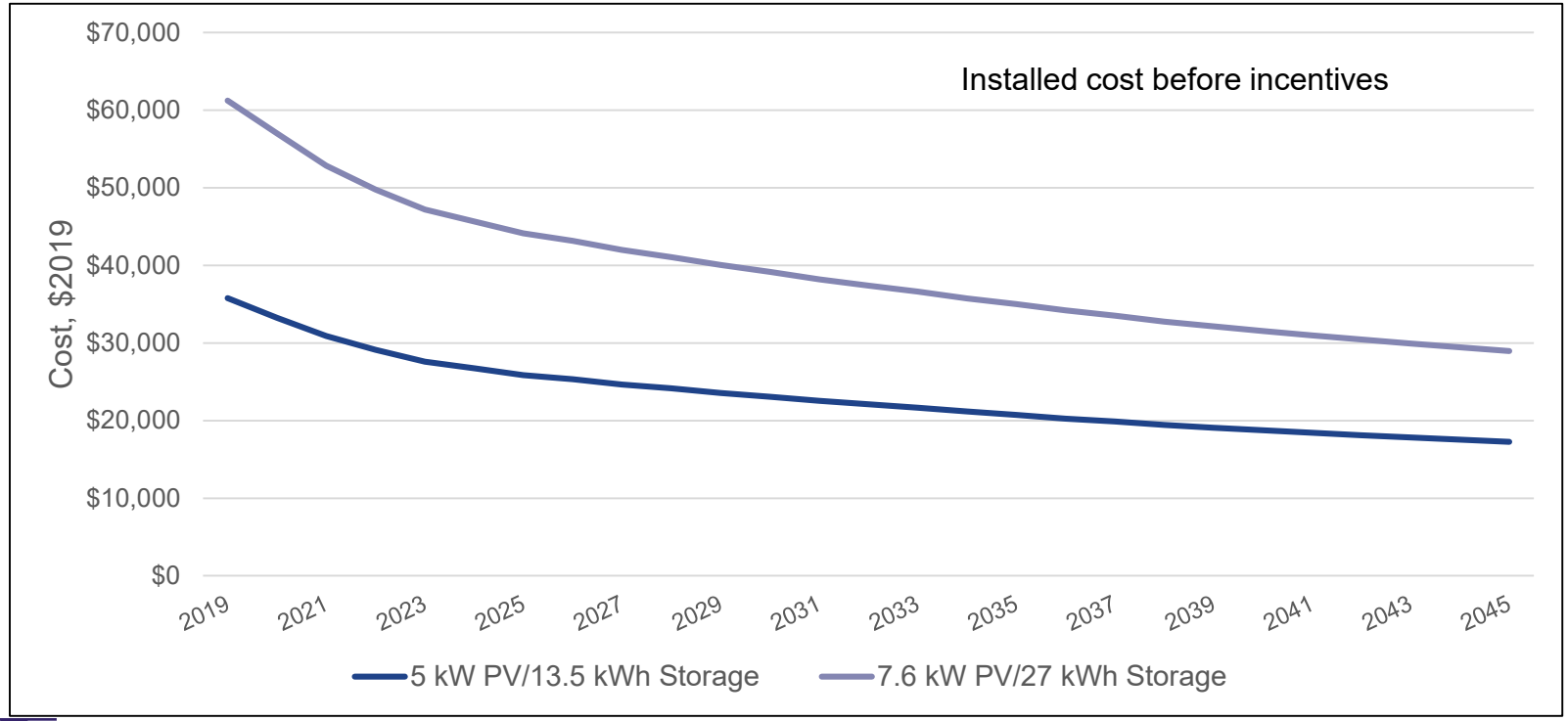
Solar PV Cost Projections, Real Dollars



Storage Cost Projections, Real Dollars



Examples of Residential PV+Storage System Costs, Real Dollars



Incentives

- Federal tax credits

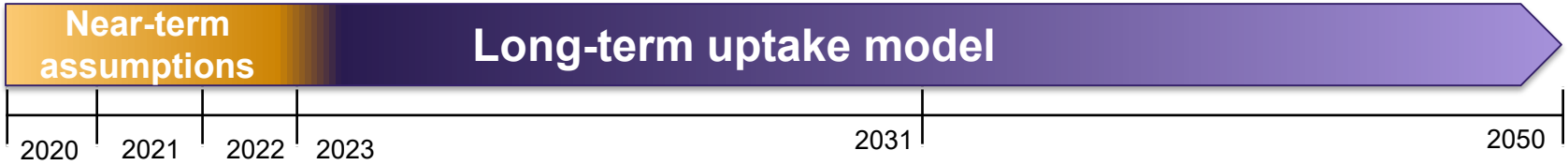
	2019	2020	2021	2022 - forward
Residential	30%	26%	22%	0%
Commercial	30%	26%	22%	10%

- State tax credits

	2019	2020	2021	2022	2023	2024	2025	2026	2027-forward
Tax Credit Rate	35%	35%	25%	25%	25%	20%	20%	20%	15%

  - Cap on residential PV-only systems: $5,000 in all years
  - Cap on residential PV+storage systems: $5,000 in 2019-2020, $10,000 in 2021-forward
- Grid services/demand response
  - Base assumption: no grid services incentive factored into adoption decision
  - Future consideration: capacity incentives for grid services participants

Oahu



Near-term is informed by experts and recent activity

- NEM complete

- CGS fully subscribed, but not built out
- GSP and ISE not fully subscribed
- SIA projects thru 2022

- NMP installations continue thru 2031 with current pace increasing by 10% in 2021 and 2022

- Uptake model accounts for adoption of all future programs and all rate schedules

Hawaii

Near-term is informed by experts and recent activity

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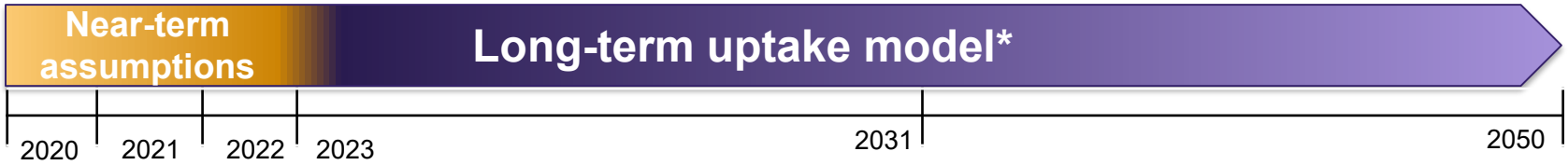
- CGS and GSP complete
- ISE complete
- SIA projects thru 2022
- NMP installations continue thru 2031 with current pace increasing by 10% in 2021 and 2022
- Uptake model accounts for adoption of all future programs in R, G and J rates
- *Manual forecast for P rate

Maui



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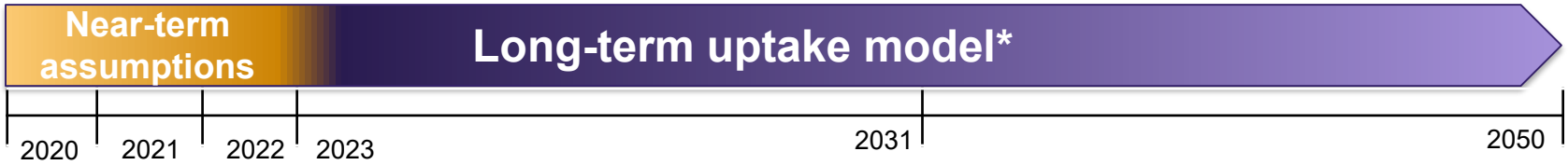
Lanai



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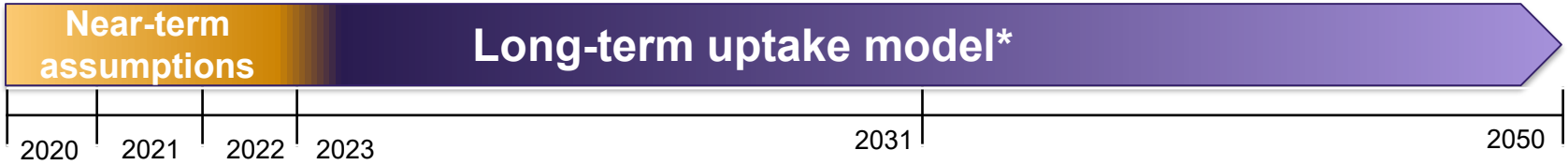
- Uptake model accounts for adoption of all future programs in R
- * G and J rates forecasted in historical proportion to R

Molokai



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Future Program Structures

Standard DER Tariff	• Time-variant compensation for export aligned with system needs • Controllable by utility for system stability emergency
Standard Interconnection Agreement (SIA)	• Primarily utilized by large commercial customers with load exceeding potential on-site PV generation
Future Consideration	• Advanced Rate Design

Addressable Market for Behind-the-Meter DER

- Residential Rate Class
  - Single family and multi-family with maximum of 4 units
  - Owner-occupied
  - Consumption high enough to utilize at least a 3kW PV system

Island	Percent of R Customers
Oahu	37%
Hawaii	40%
Maui	43%
Lanai	24%
Molokai	30%

Addressable Market for Behind-the-Meter DER

- Commercial Rate Classes
  - Private and public ownership
  - Exclude structures with >6 stories
  - Small and medium commercial consumption above threshold

Island	Percent of G Customers	Percent of J Customers	Percent of P Customers
Oahu	37%	53%	78%
Hawaii	35%	68%	44%
Maui	41%	63%	68%

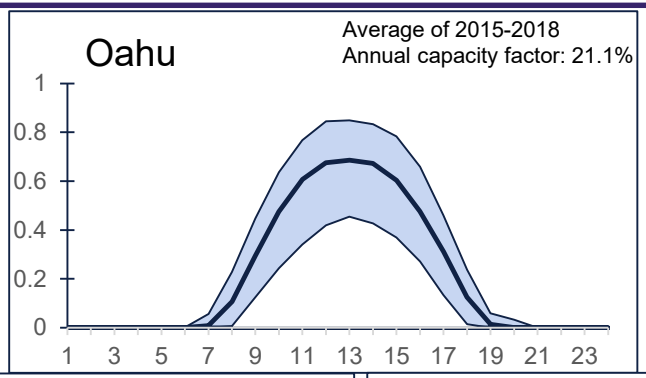
Panel Degradation and Replacement

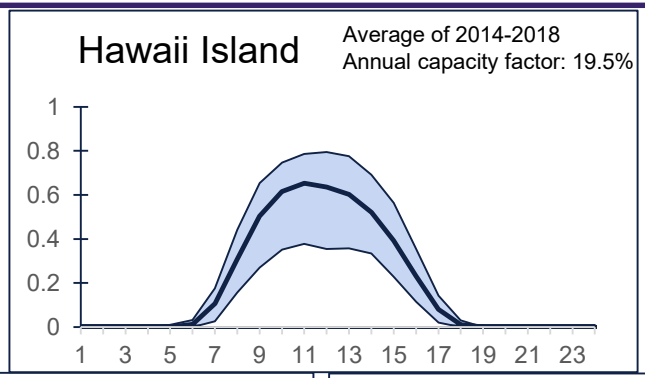
- PV system
  - Output degrades at rate of 0.5% per year
  - No removal or replacement
- Battery replacement after 15 years in service

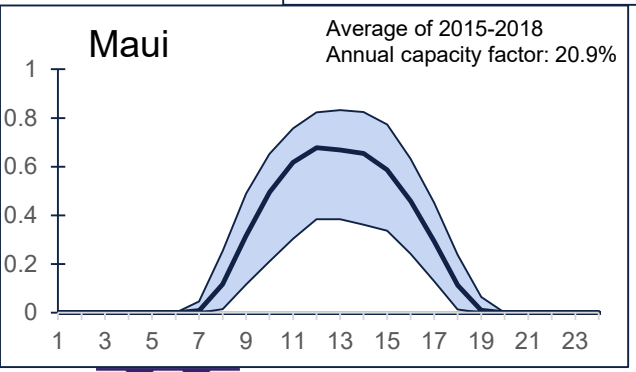
PV Paired with Battery Assumptions

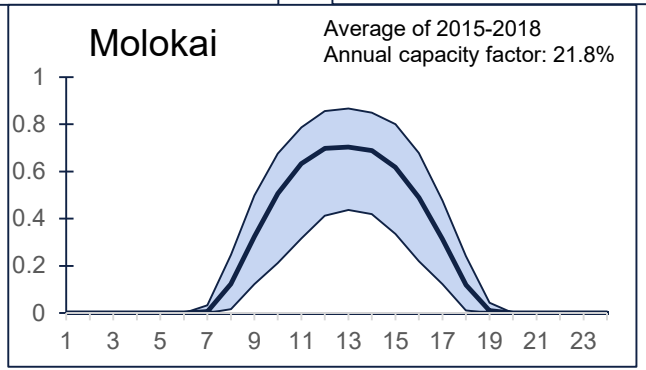
- In the near-term, proportion of systems paired with batteries are based on recent application data
- All residential and small commercial have batteries under future programs
- A portion of medium commercial customers have batteries
- For large commercial, include known projects

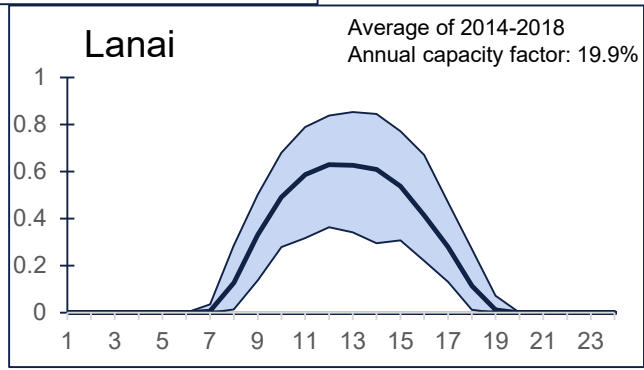
Solar Resource Unitized Profiles (kWh/kW)







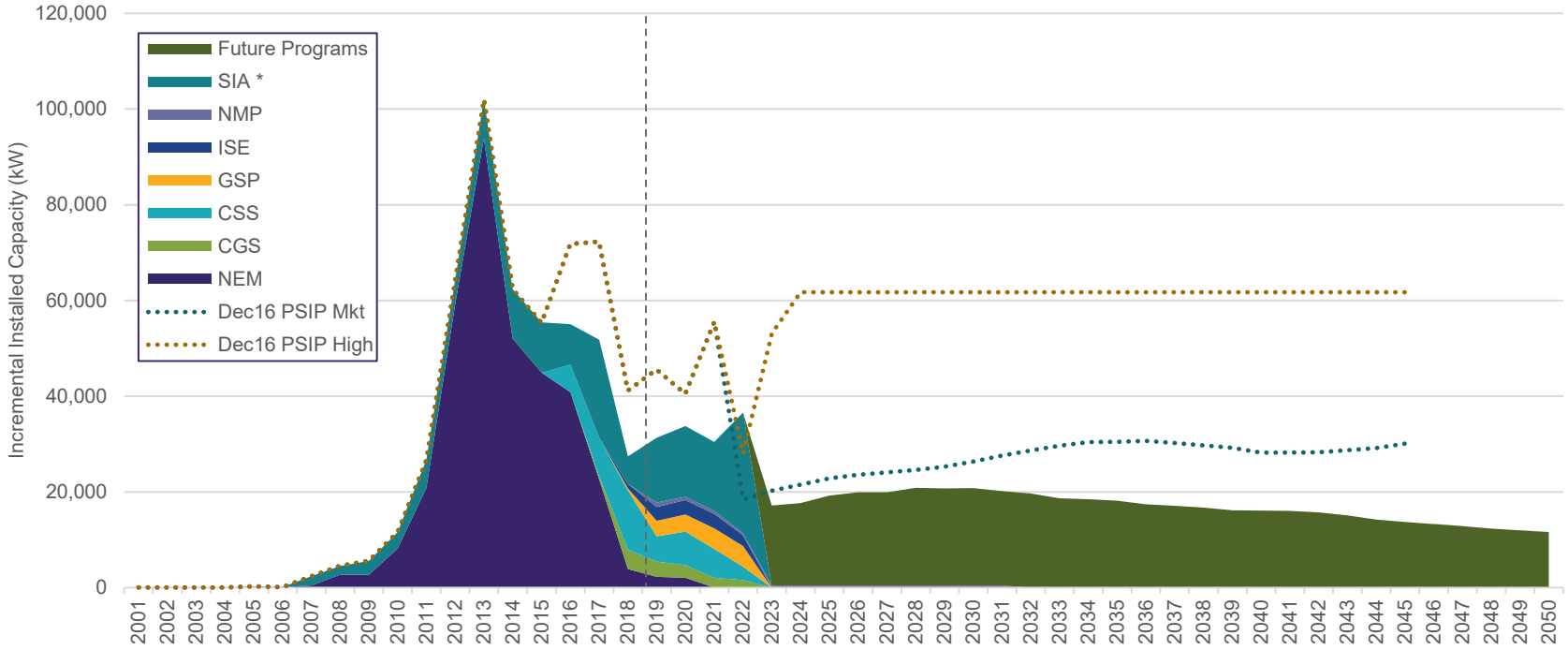




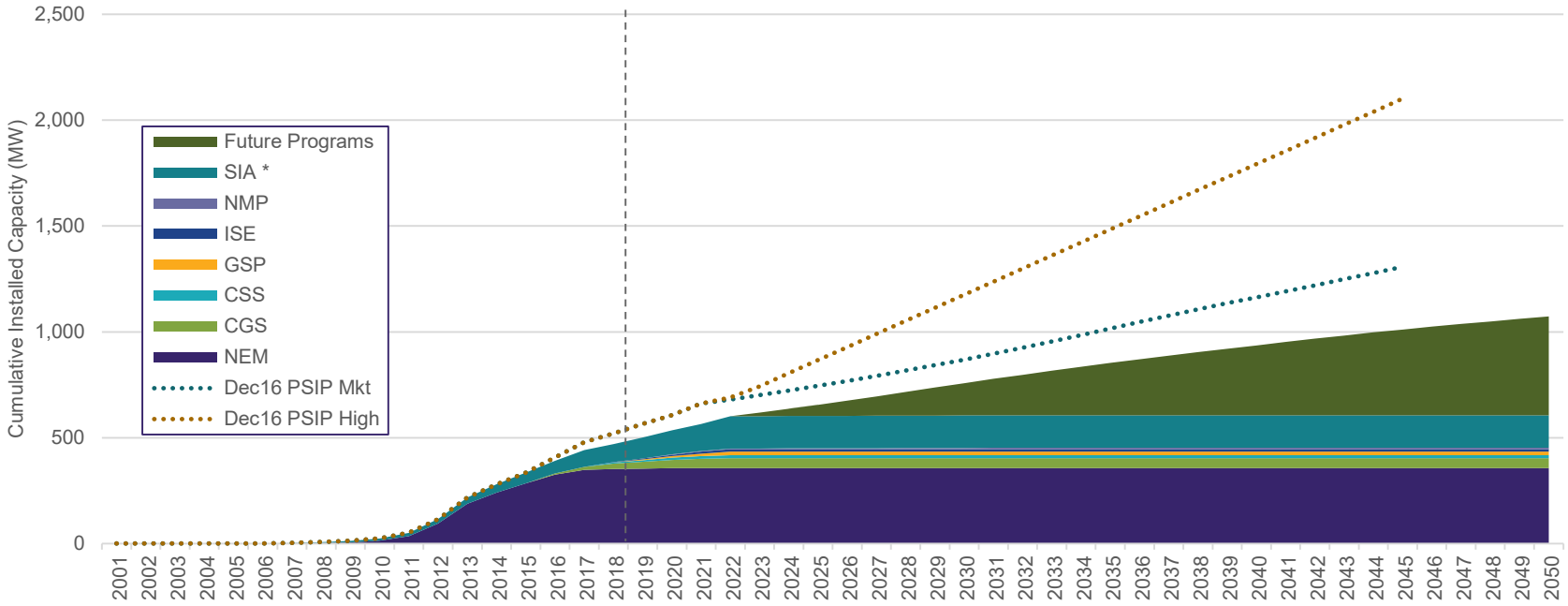
Hour Ending

DER Forecast Developed by Island for Each Program

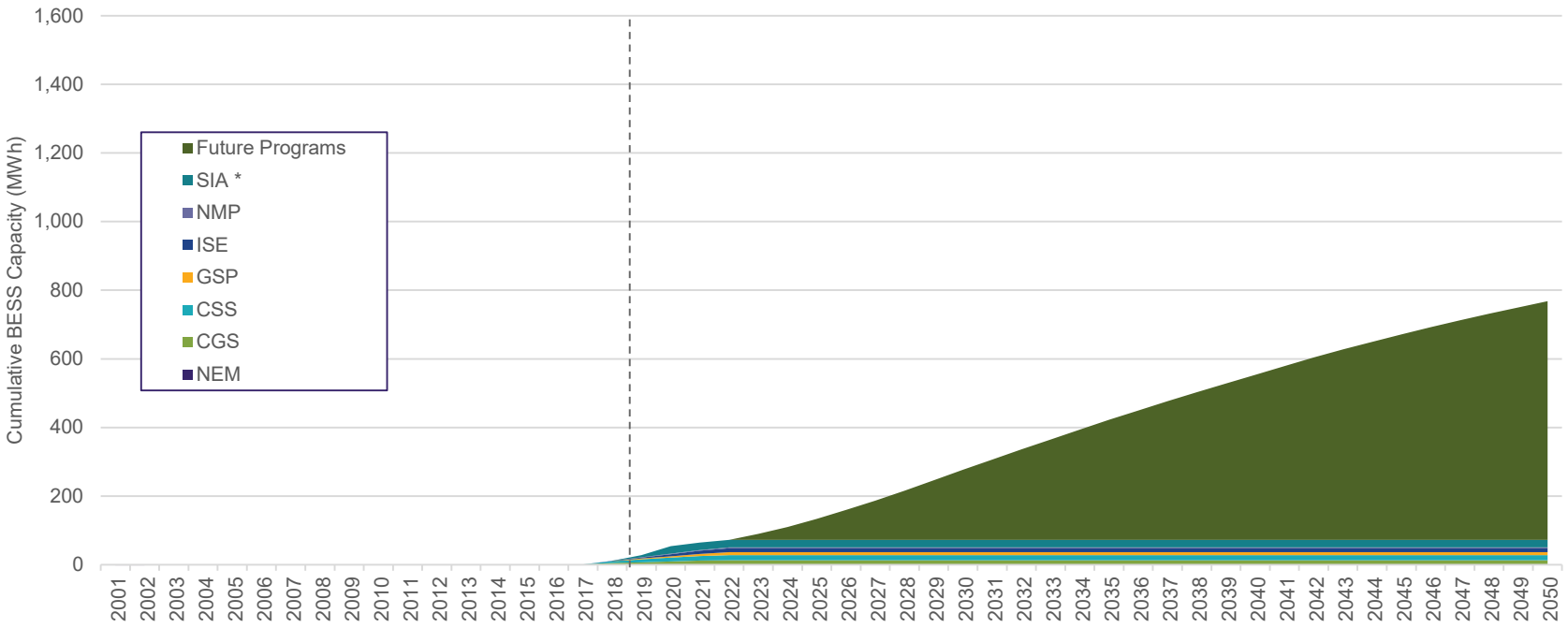
Oahu Incremental



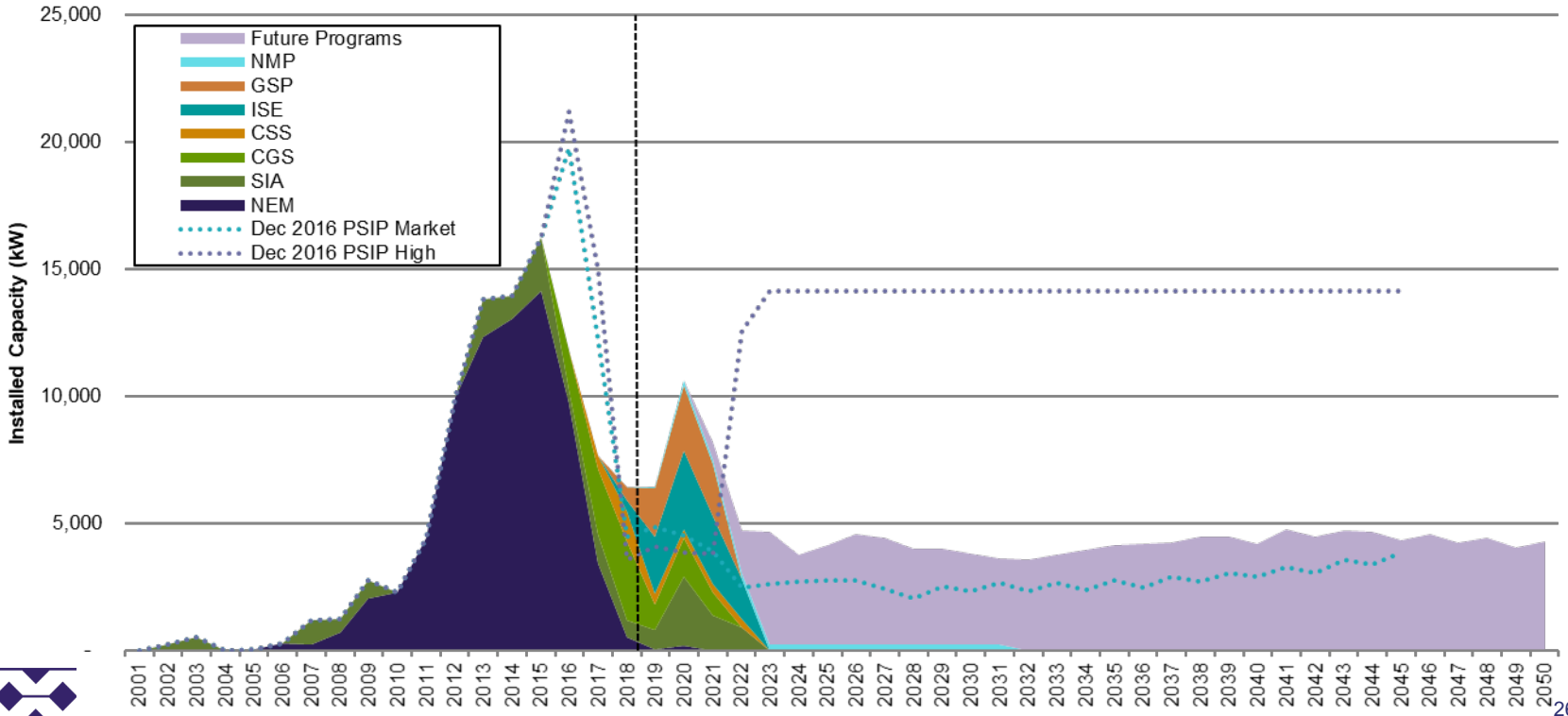
Oahu Cumulative



Oahu BESS Cumulative



Hawaii Island Incremental



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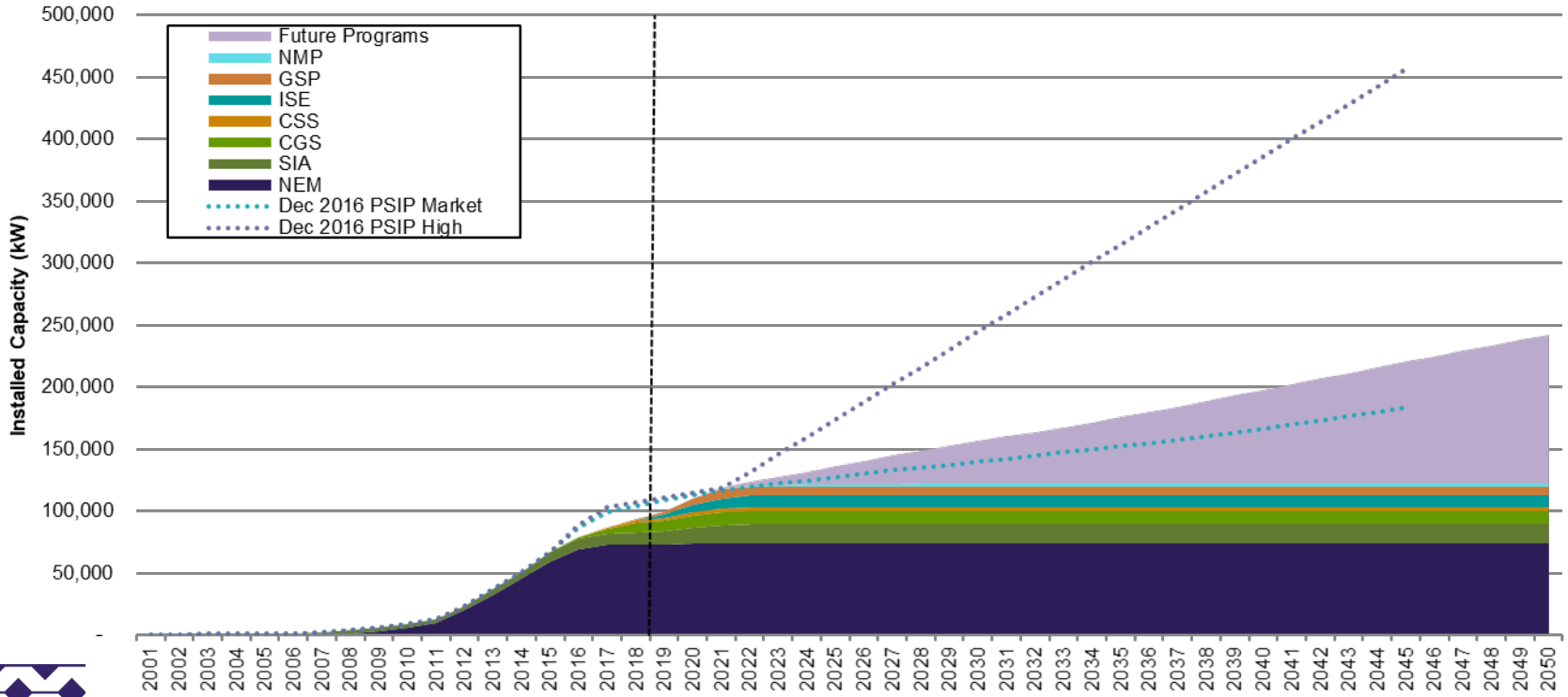

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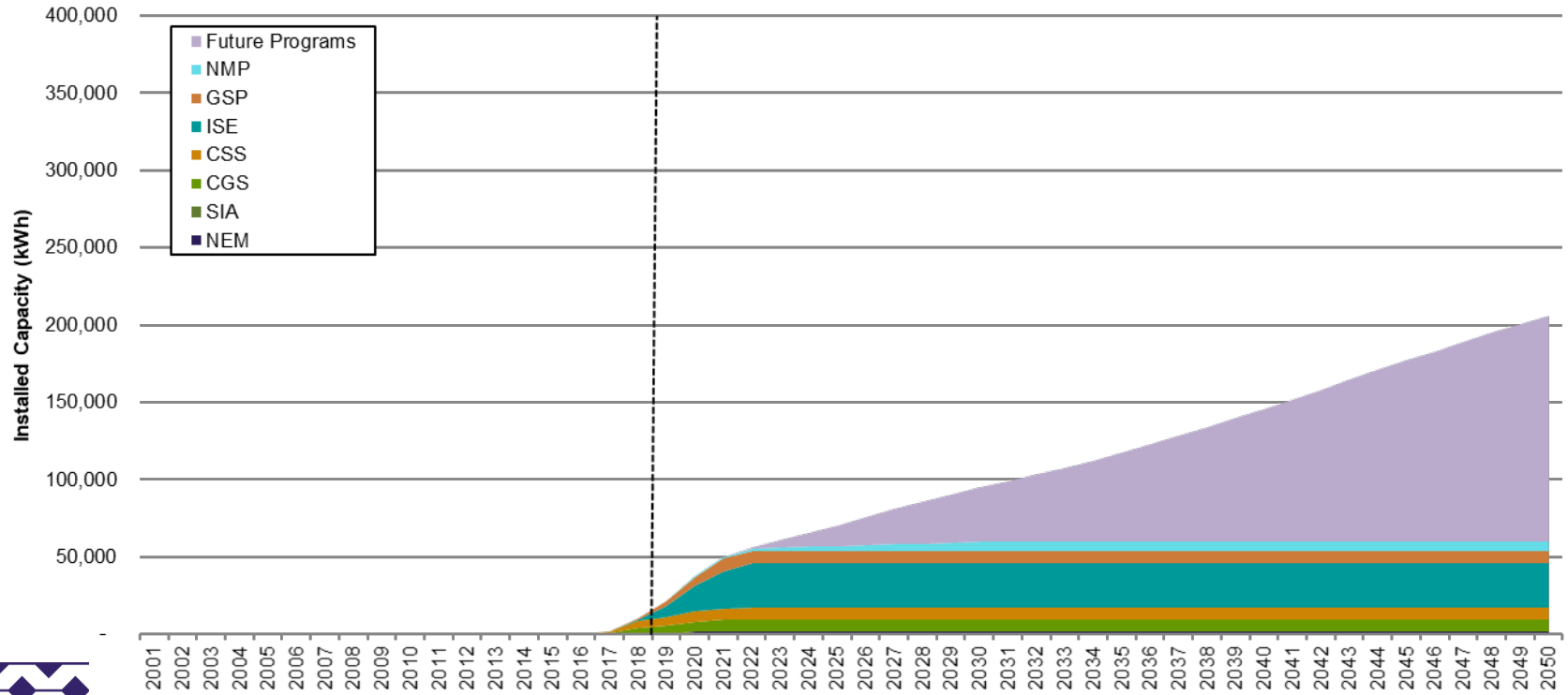
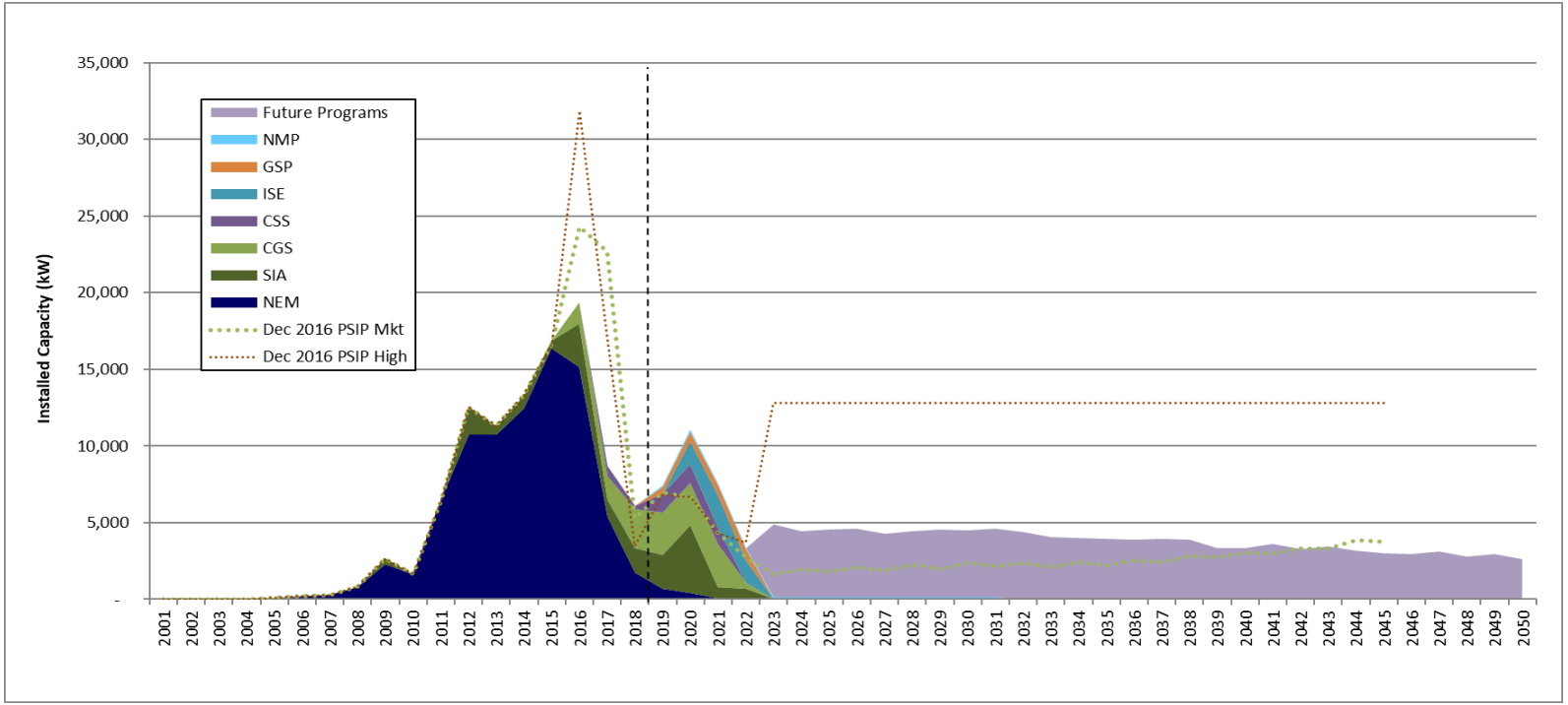


Maui Incremental



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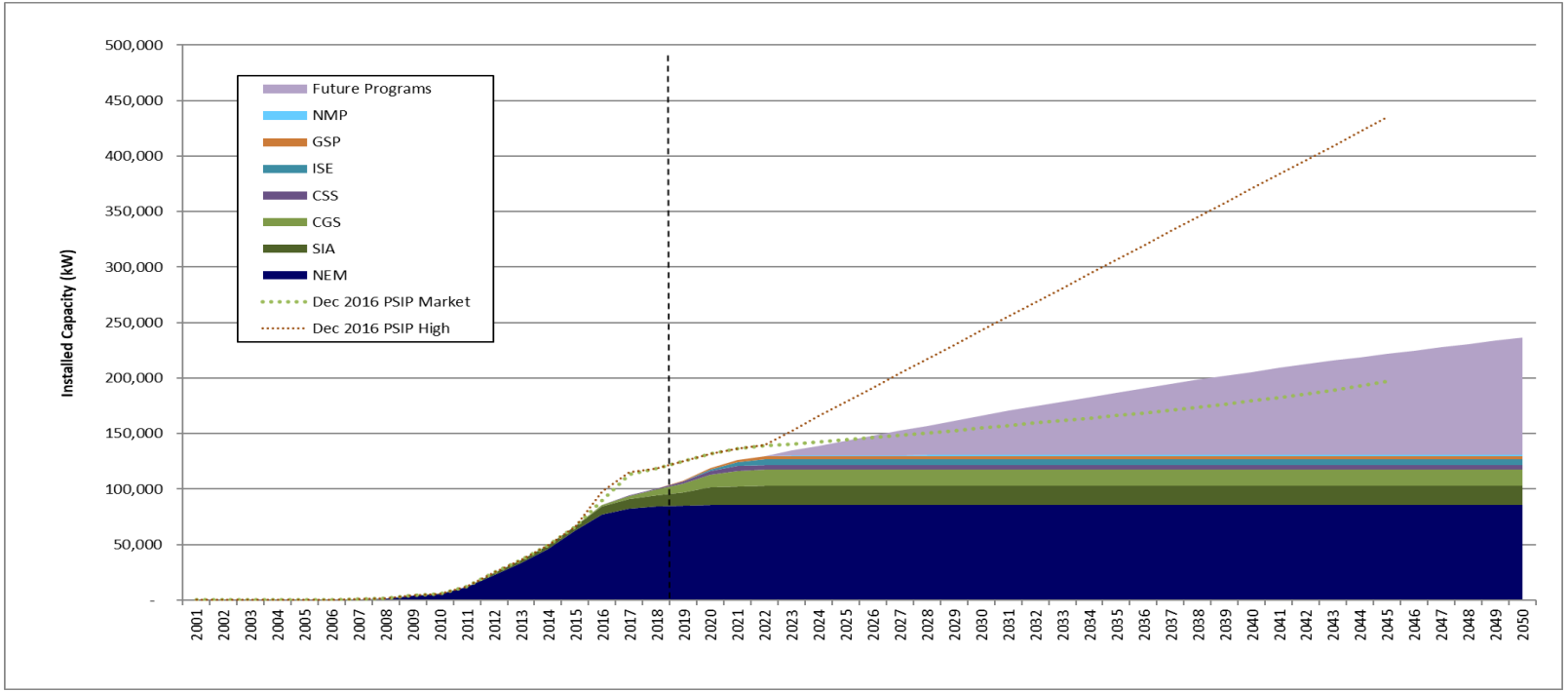

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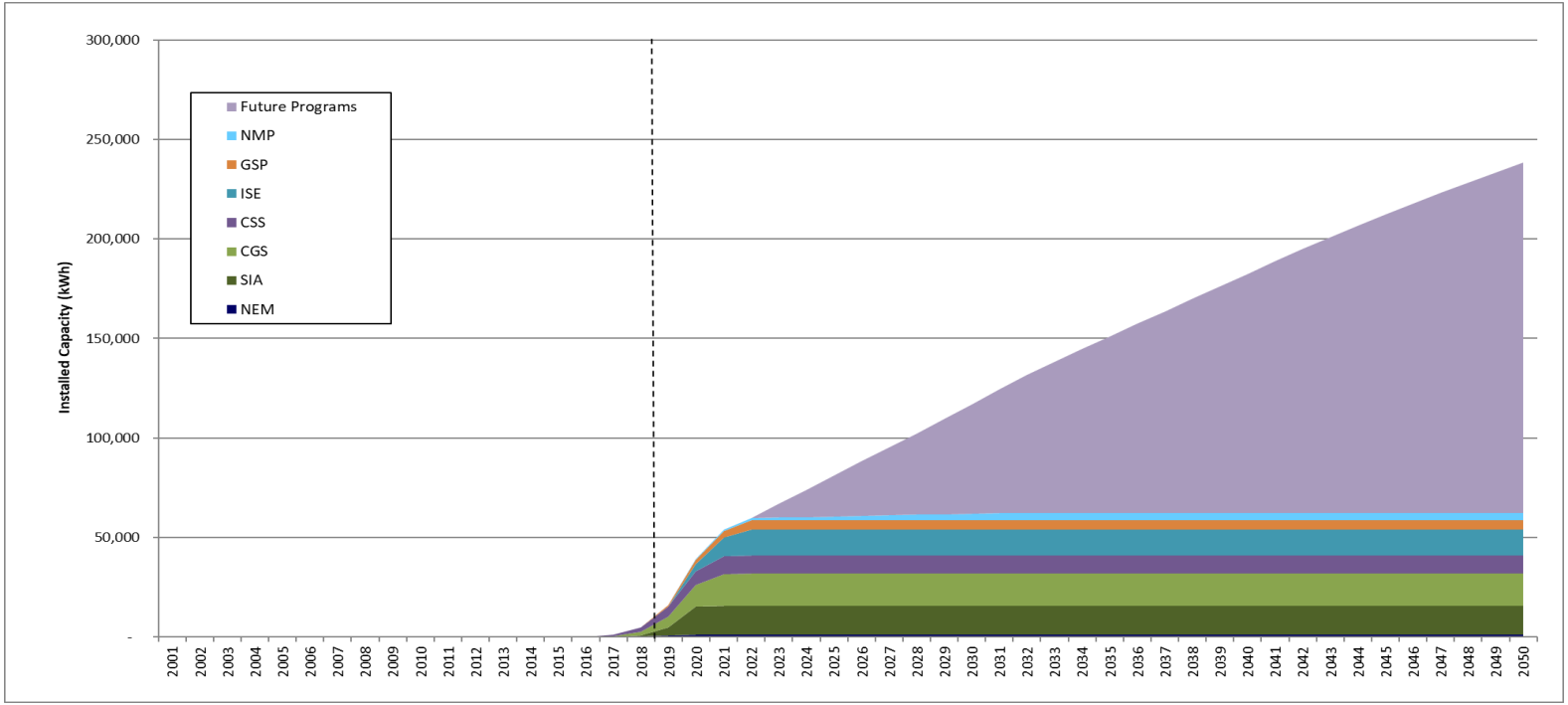

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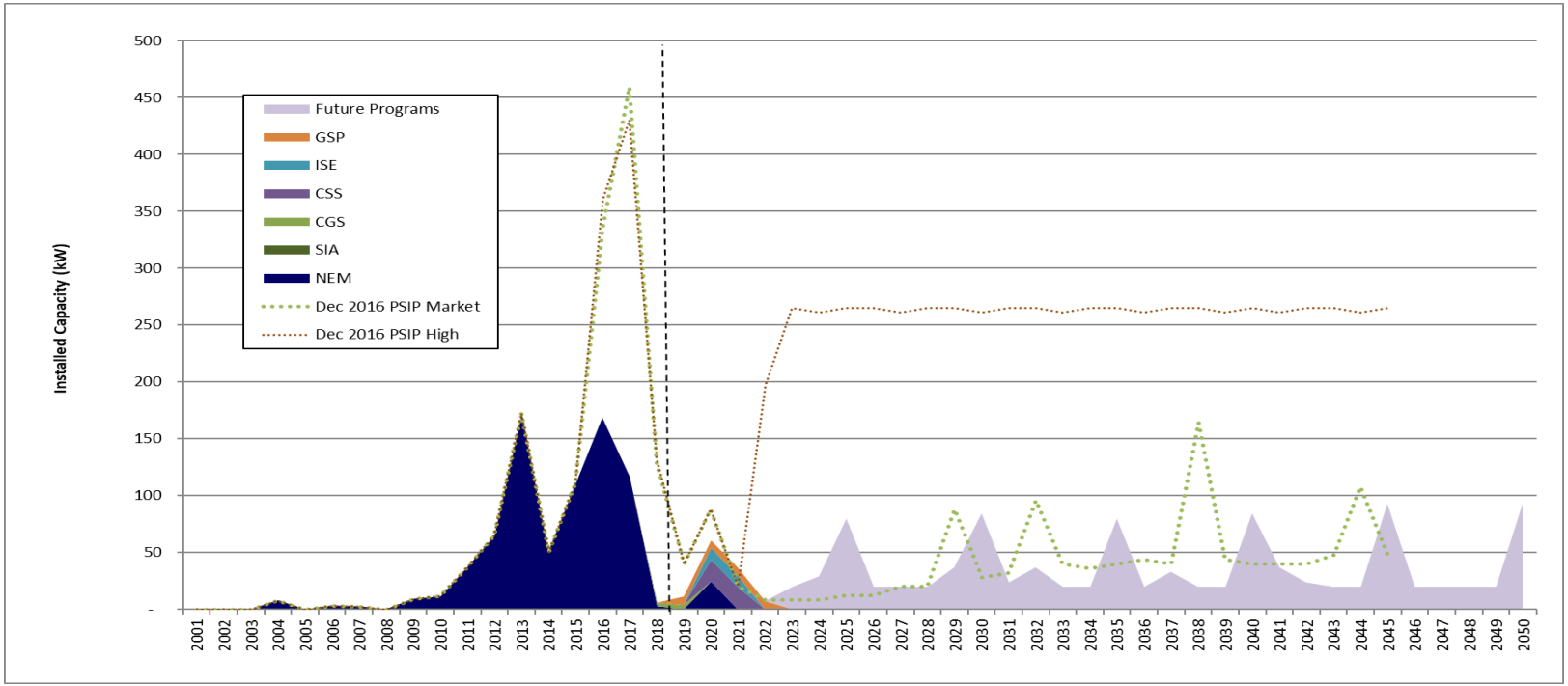

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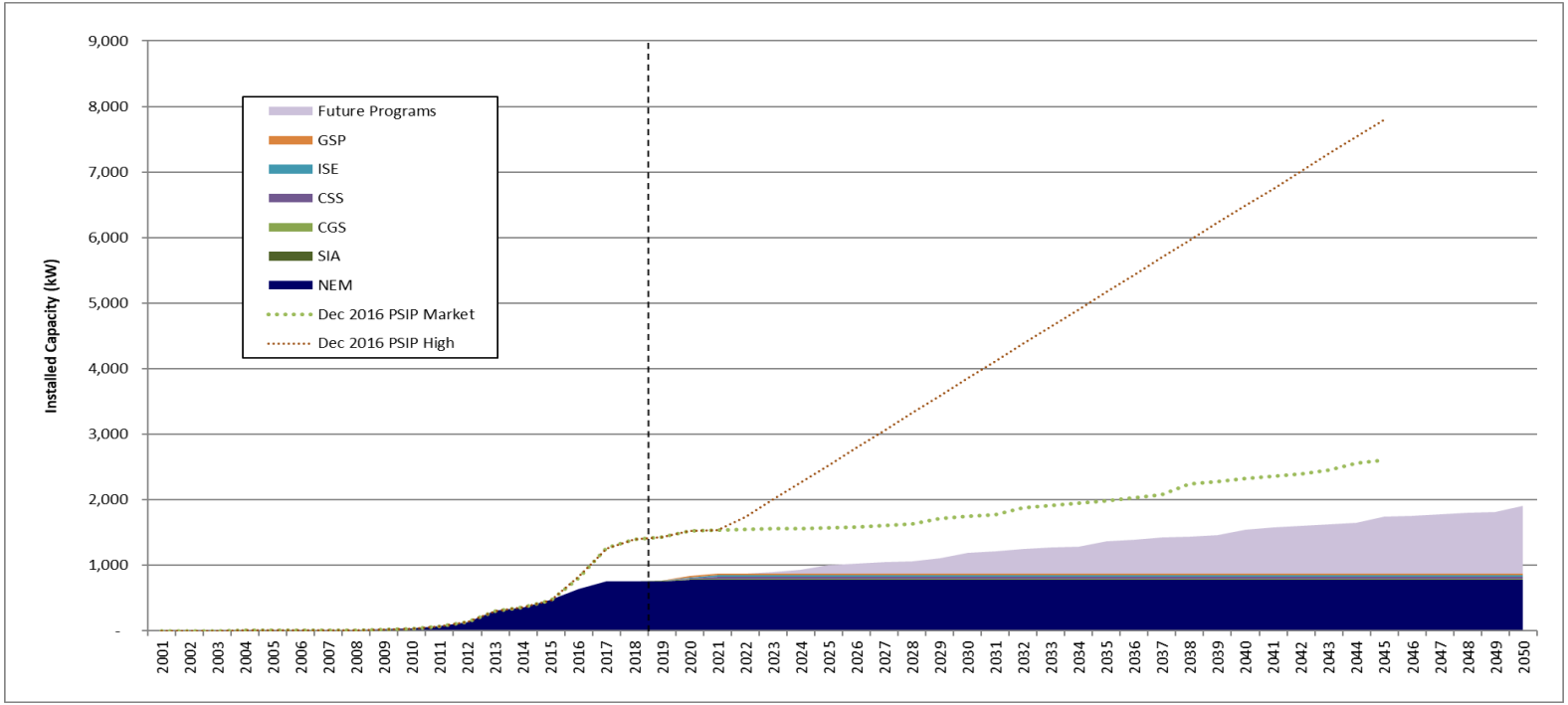

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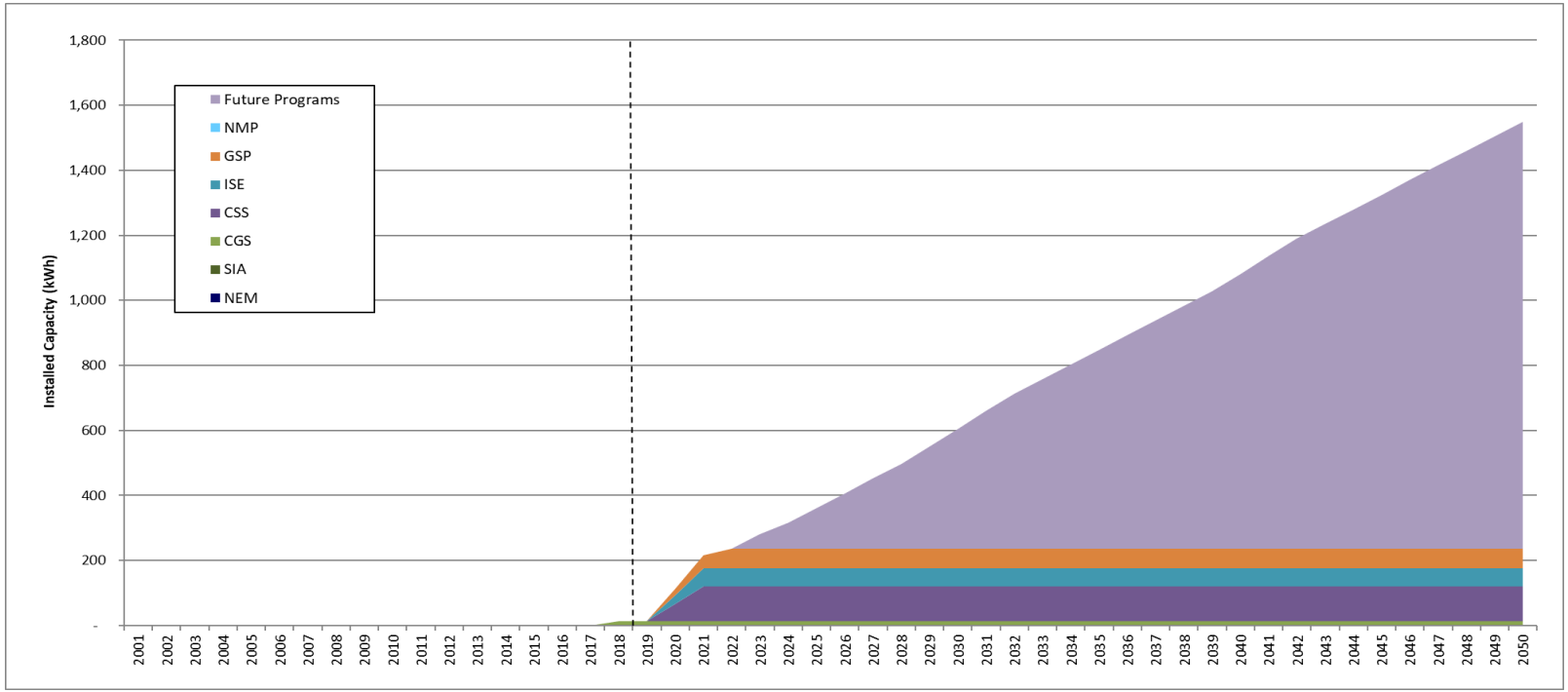
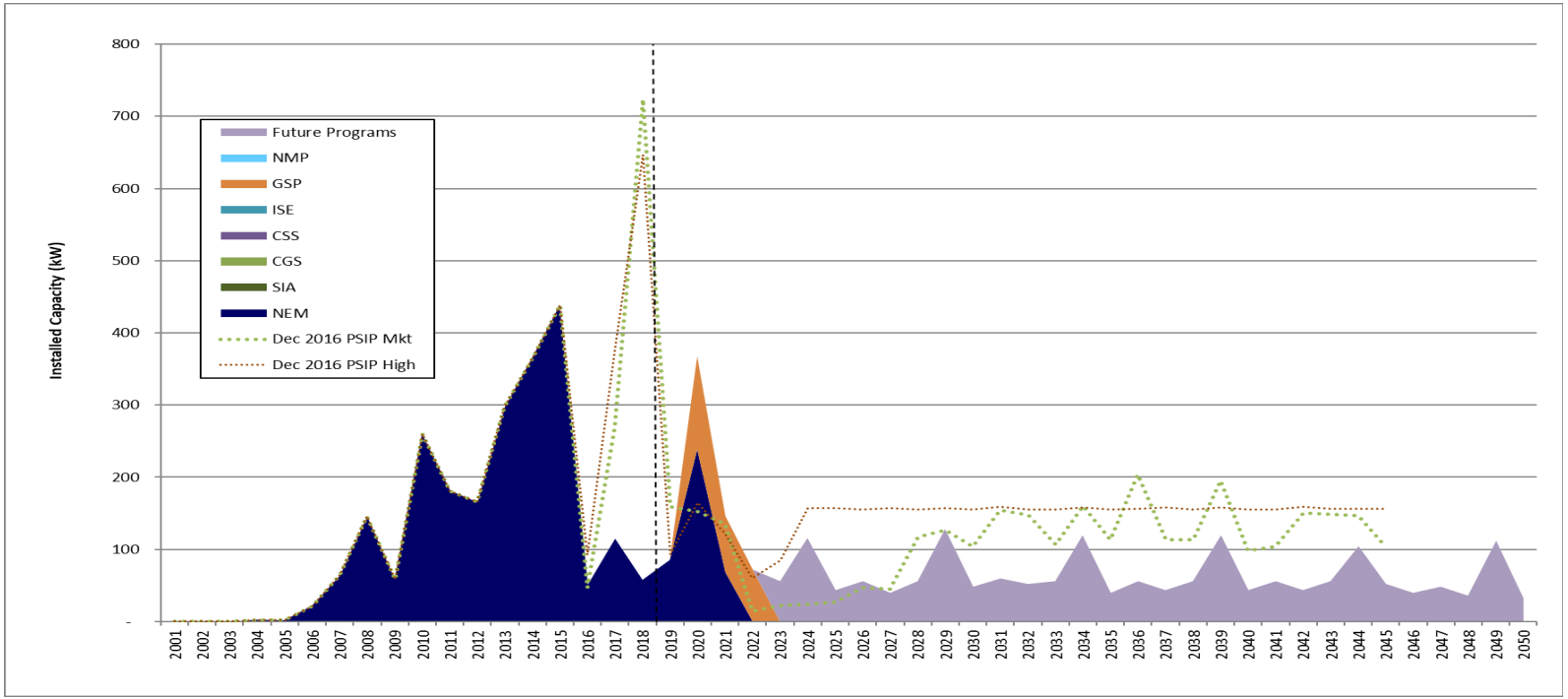
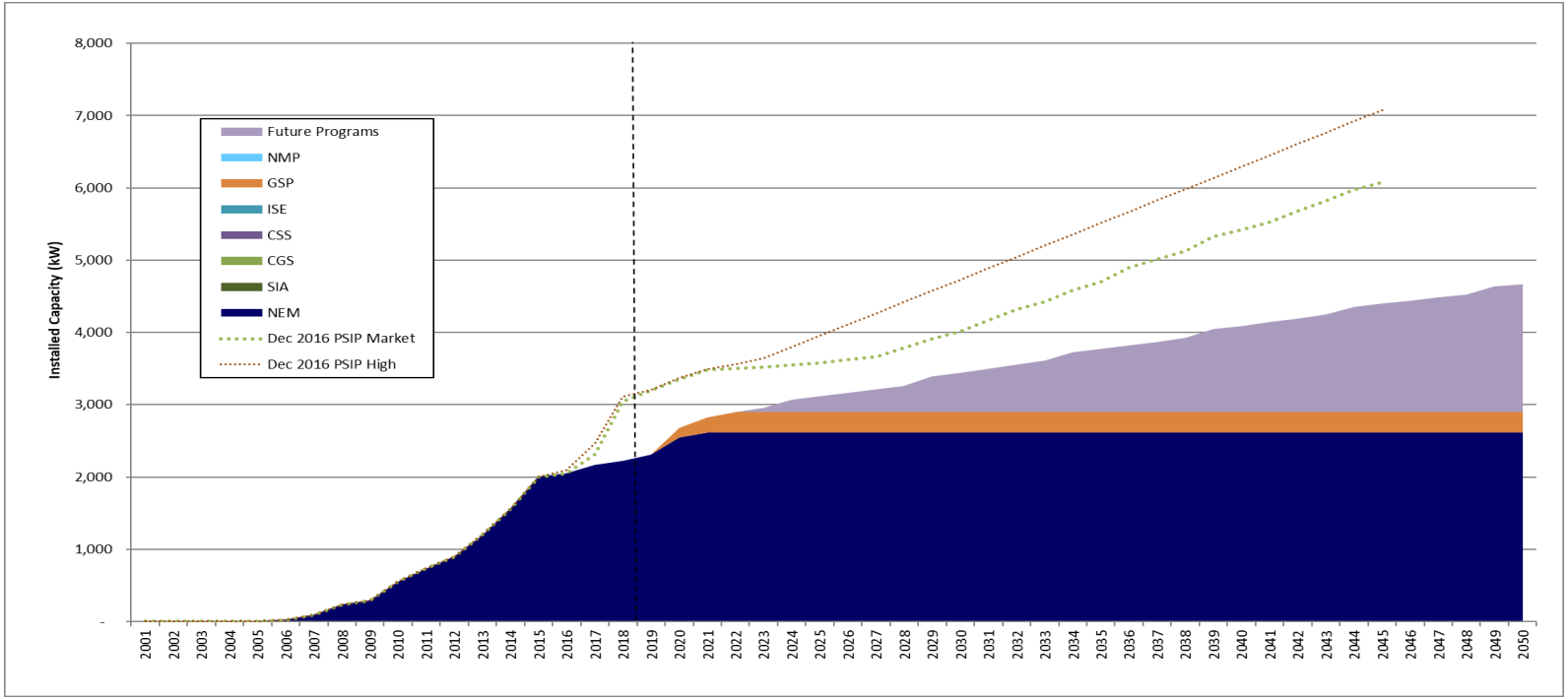


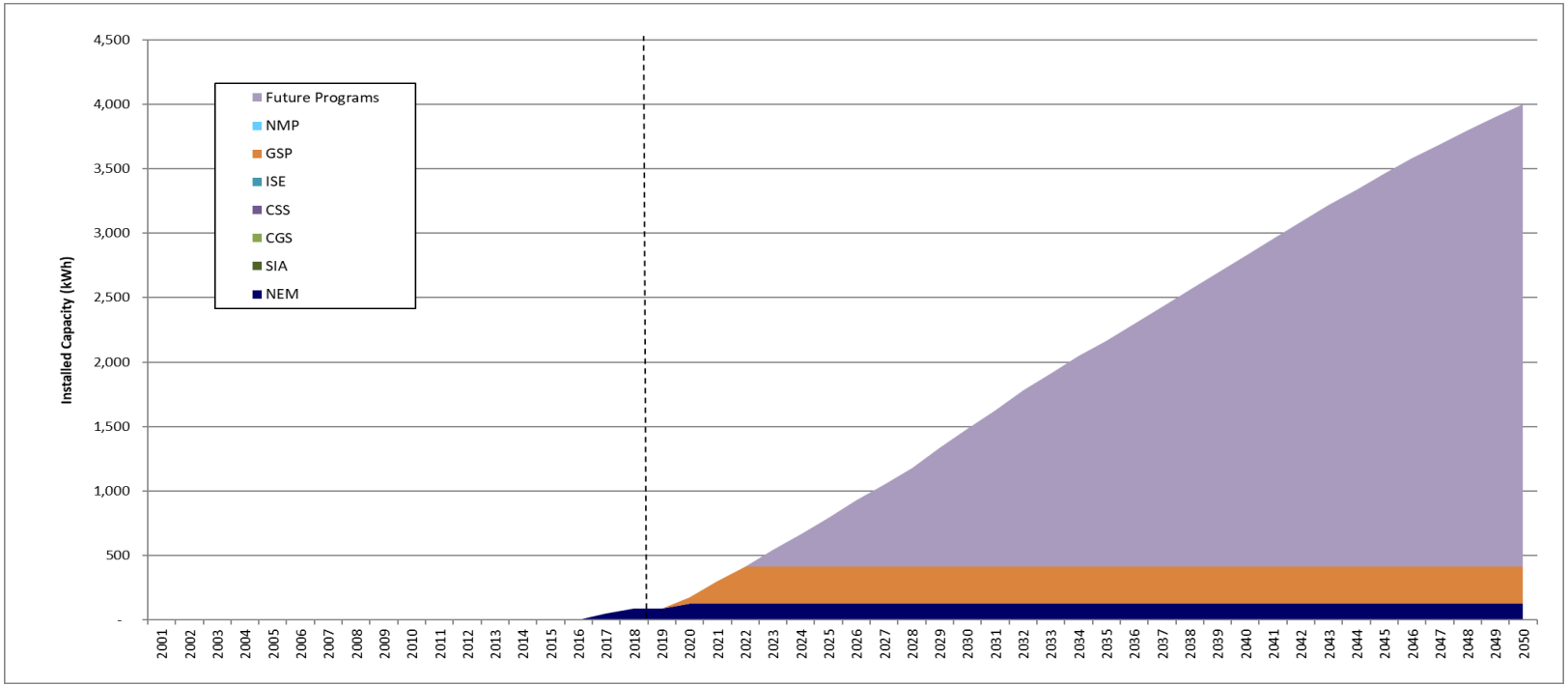
Molokai Incremental



Molokai Cumulative



Molokai BESS Cumulative



Electrification of Transportation (“EoT”)

Light Duty Electric Vehicles (“LD EVs”)

Light Duty Vehicle Forecast

EV Saturation & EV Count Forecast

Daily Vehicle Miles Traveled & kWh per Vehicle

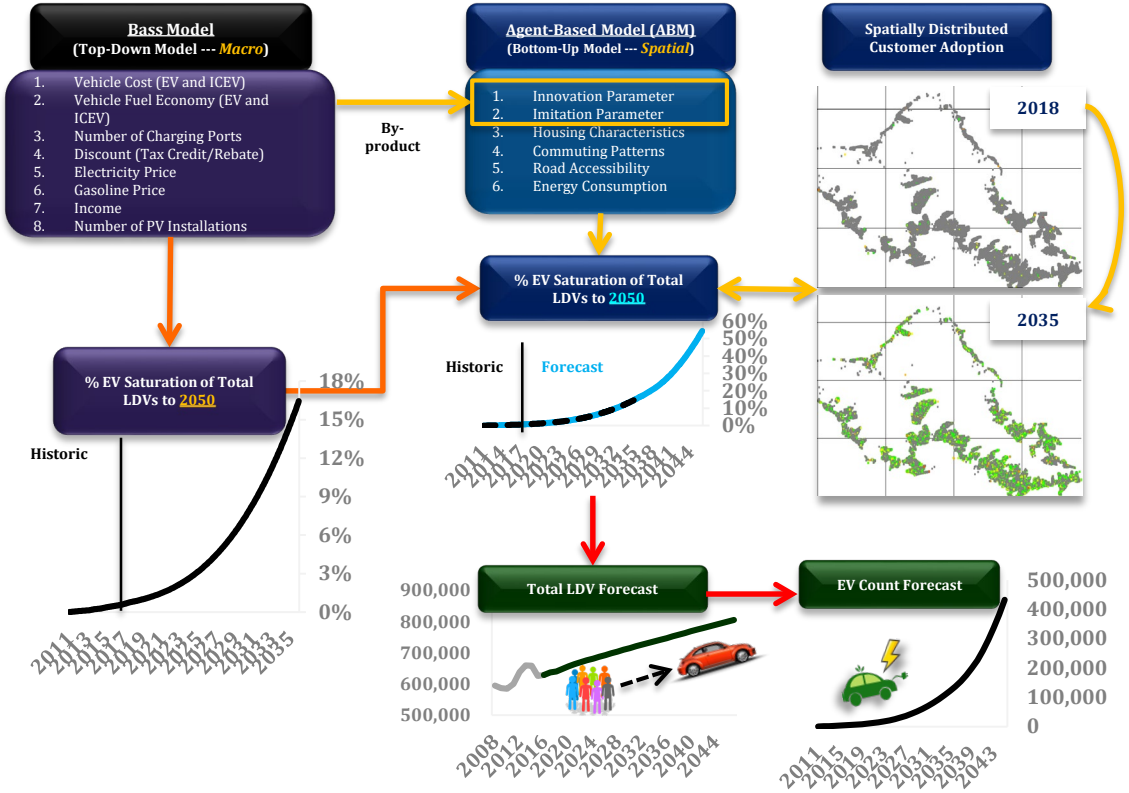
Charging Profiles

Total Energy Sales

LD EV Agenda

- **Light Duty Vehicle Forecast**
- EV Saturation & EV Count Forecast
- Daily Vehicle Miles Traveled & kWh per Vehicle
- Charging Profiles
- Total Energy Sales

Electric Vehicle Forecast Roadmap



Light Duty Vehicle (LDV) Forecast

Model Input Updates

Actual EV counts from DBEDT	Incorporated new UHERO population forecast

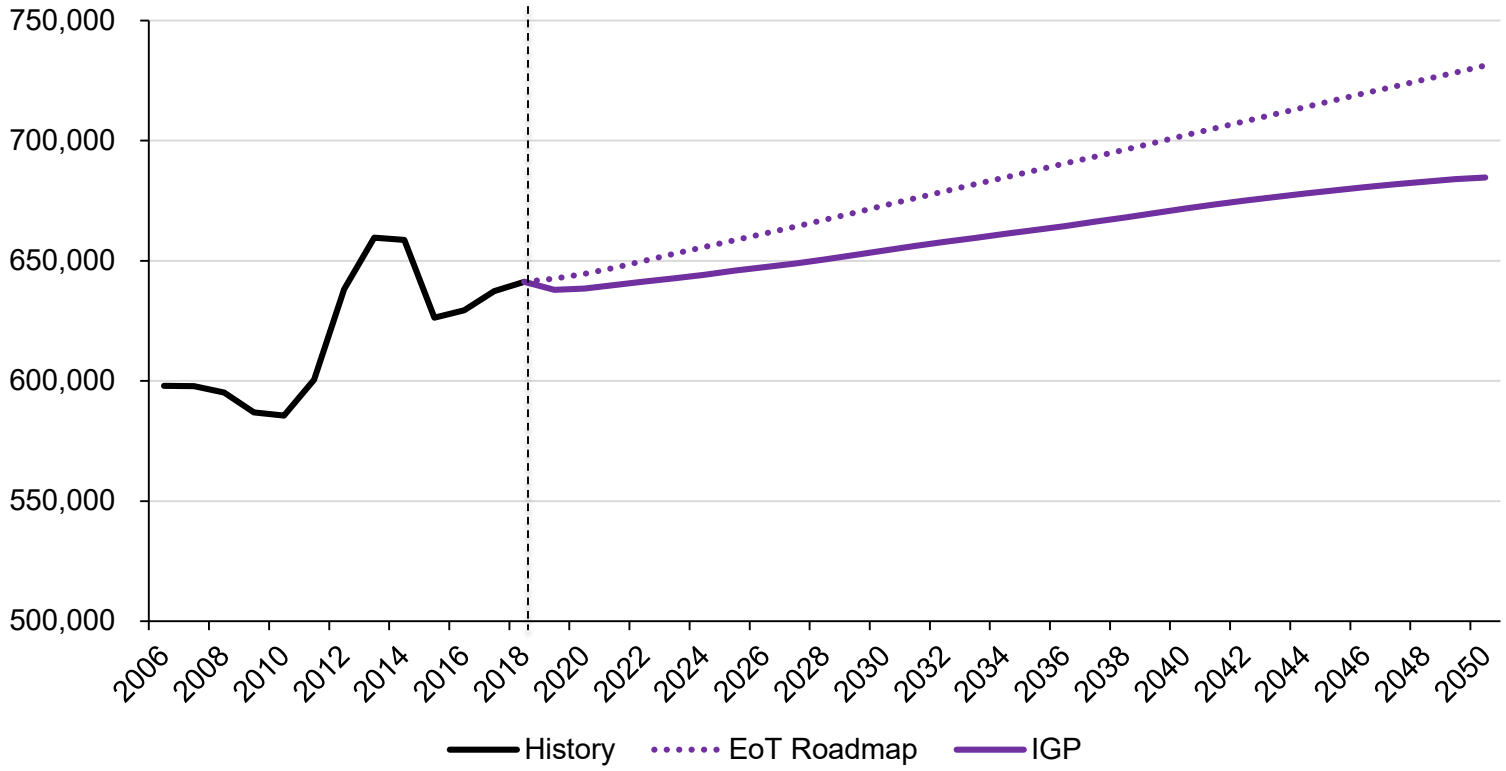
Model Impact

Econometric models with various drivers including population, jobs, GDP growth, CPI & car loan rates	Final model utilized population and jobs

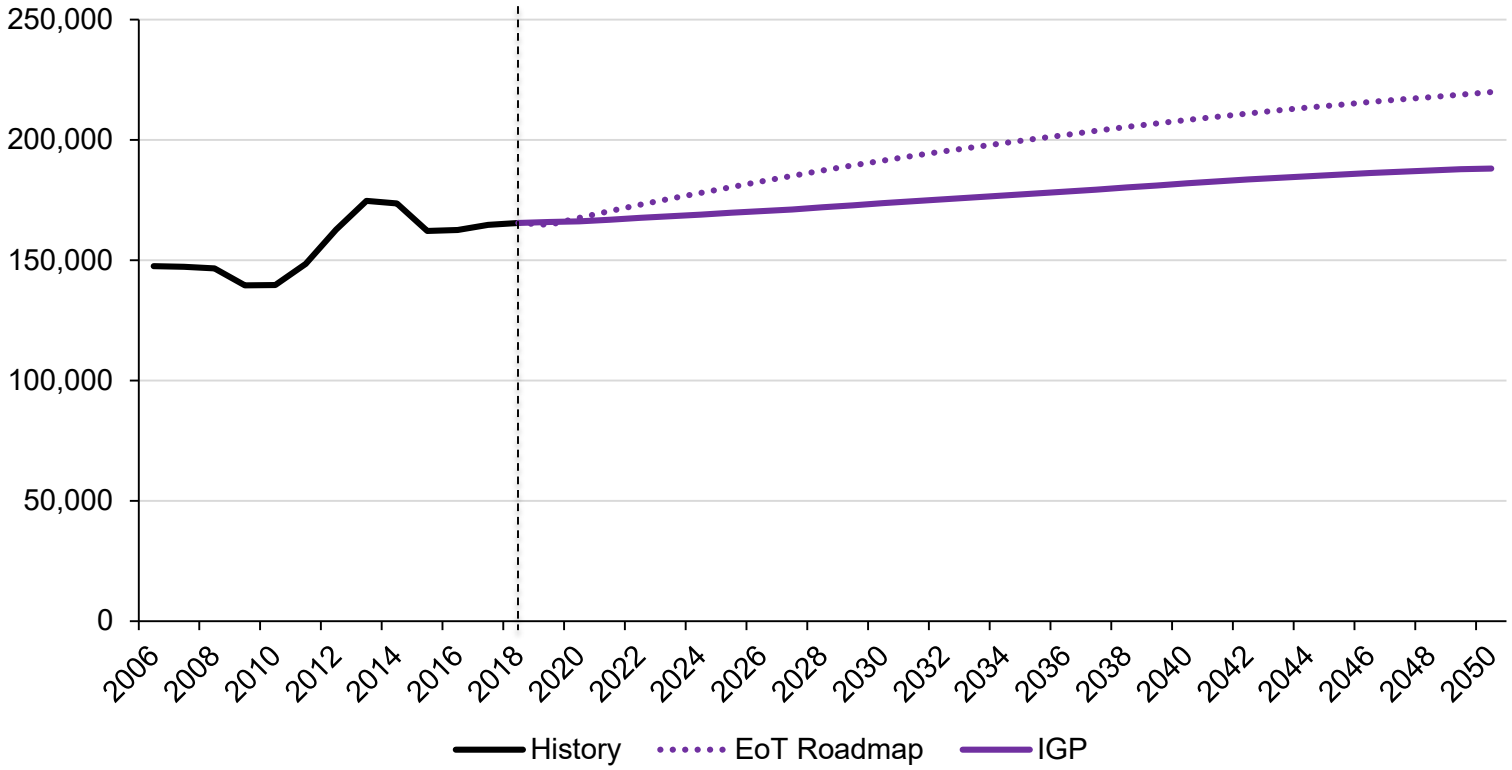
LDV Results

Lower LDV forecast across all islands compared to EoT Roadmap

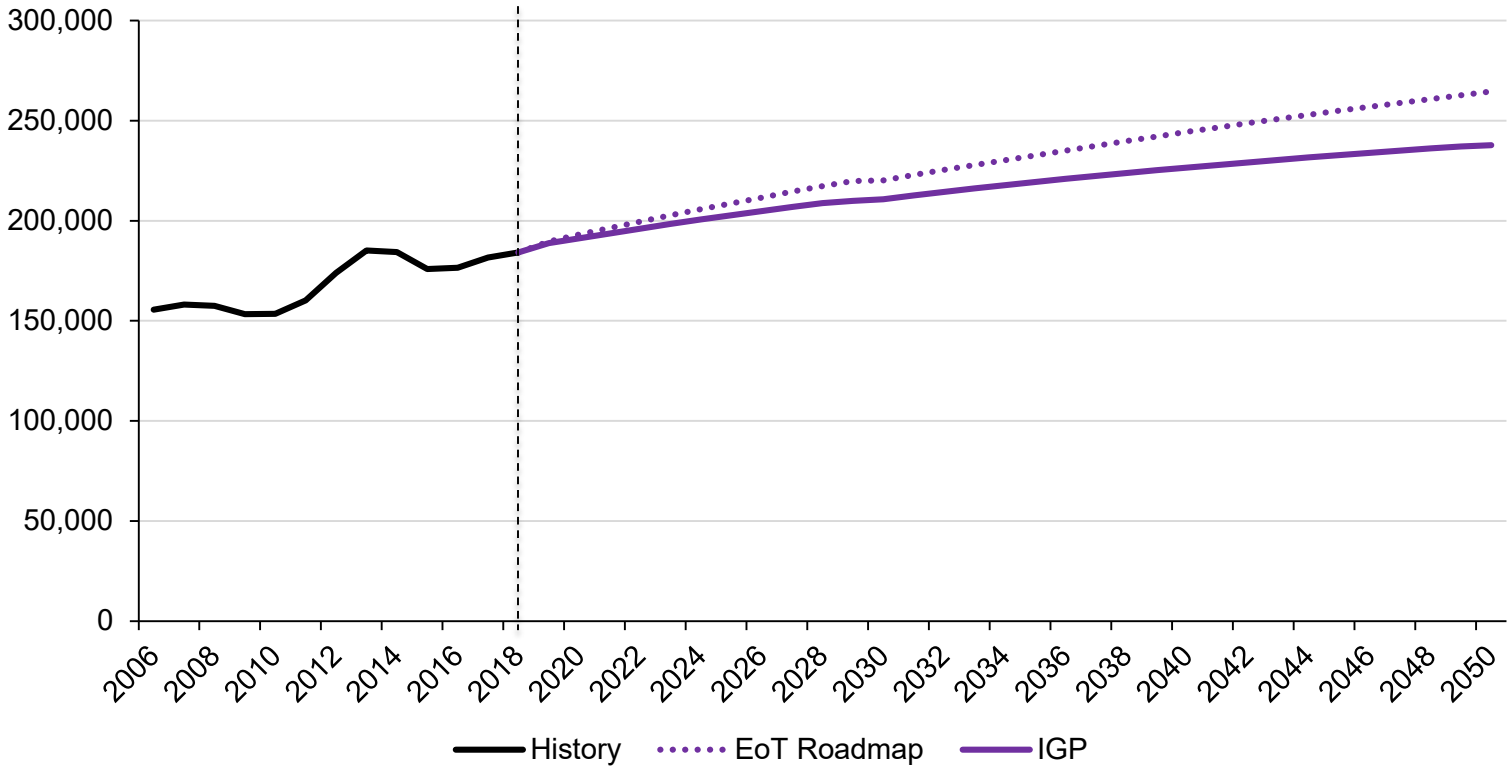
LDV Forecast – Oahu



LDV Forecast – Maui County



LDV Forecast – Hawaii Island



LD EV Agenda

Light Duty Vehicle Forecast

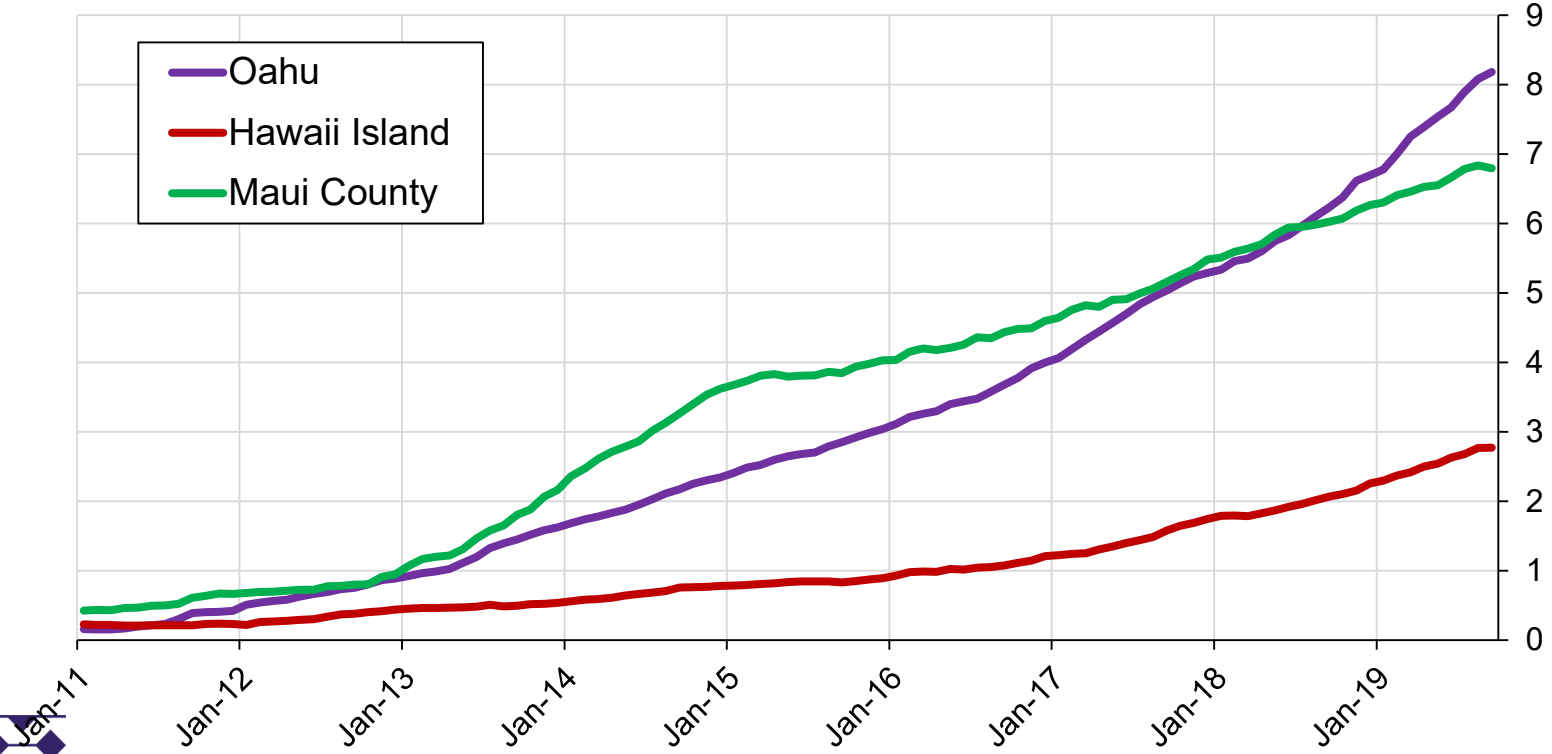
EV Saturation & EV Count Forecast

Daily Vehicle Miles Traveled & kWh per Vehicle

Charging Profiles

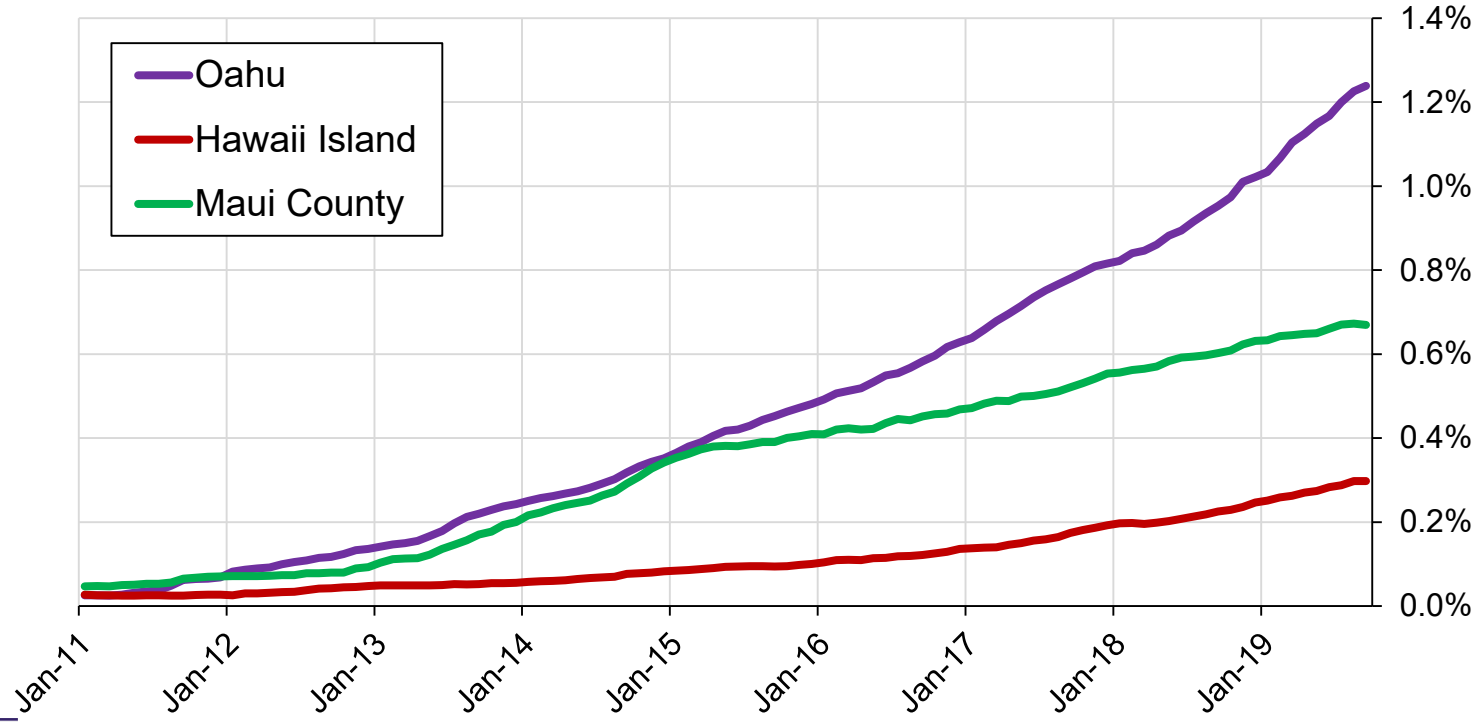
Total Energy Sales

Number of EVs per 1,000 Persons



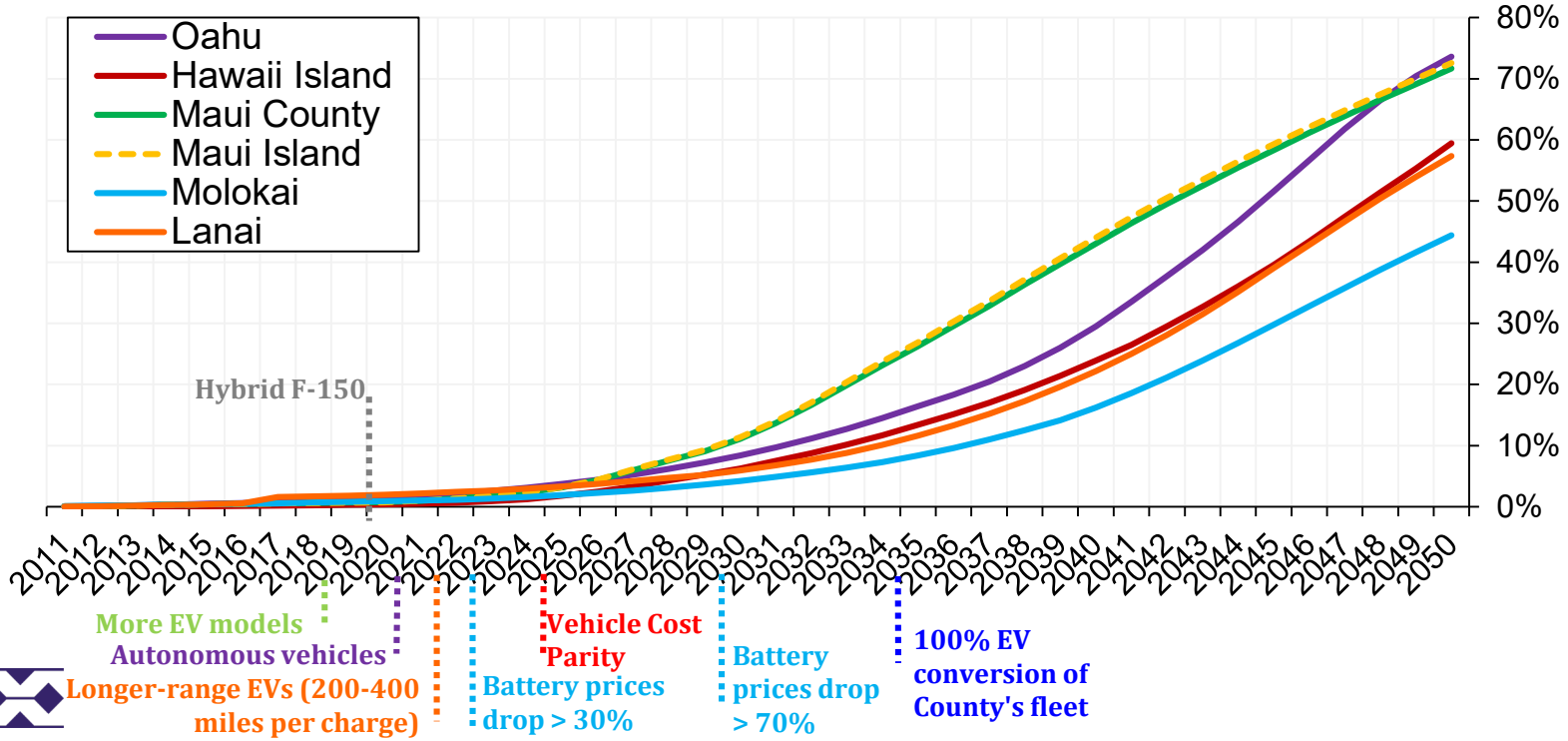
Source: DBEDT

Historical EV Saturation

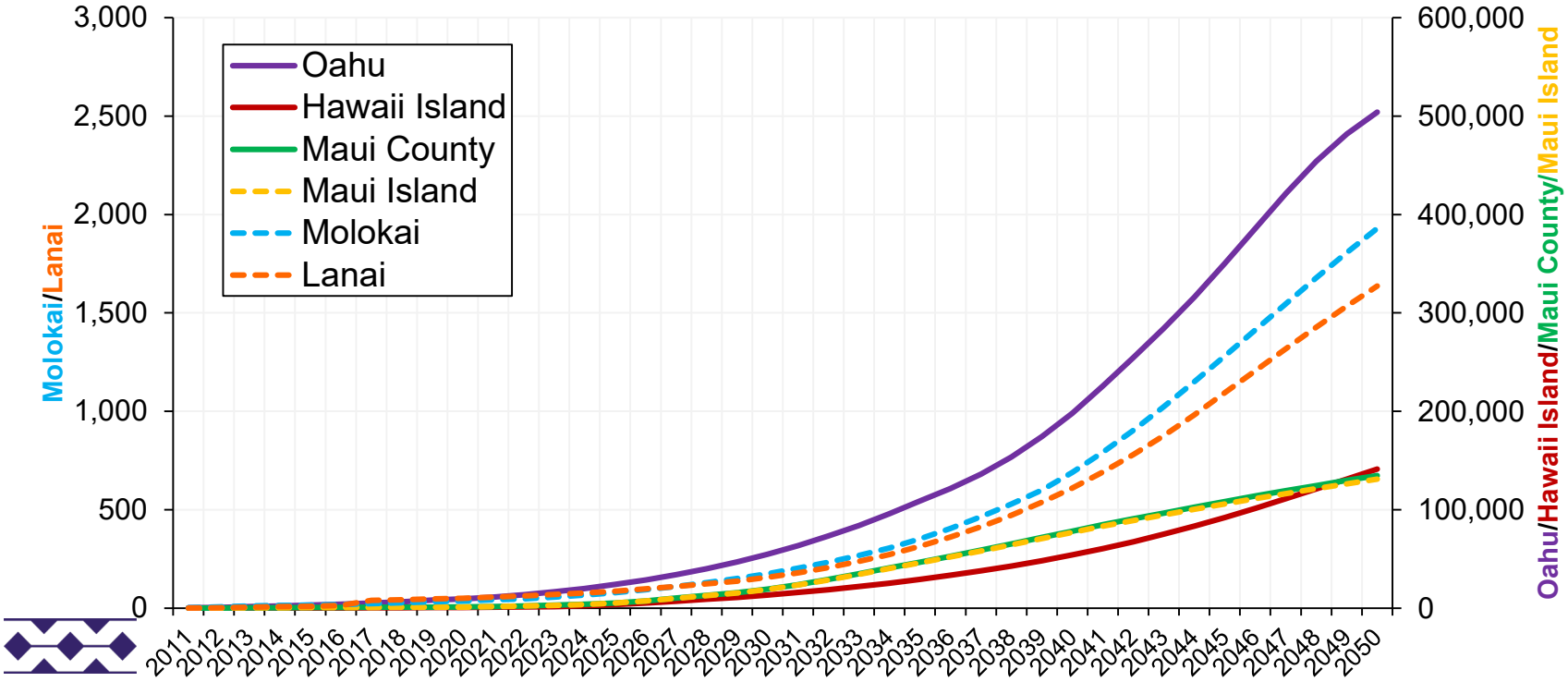


Source: DBEDT

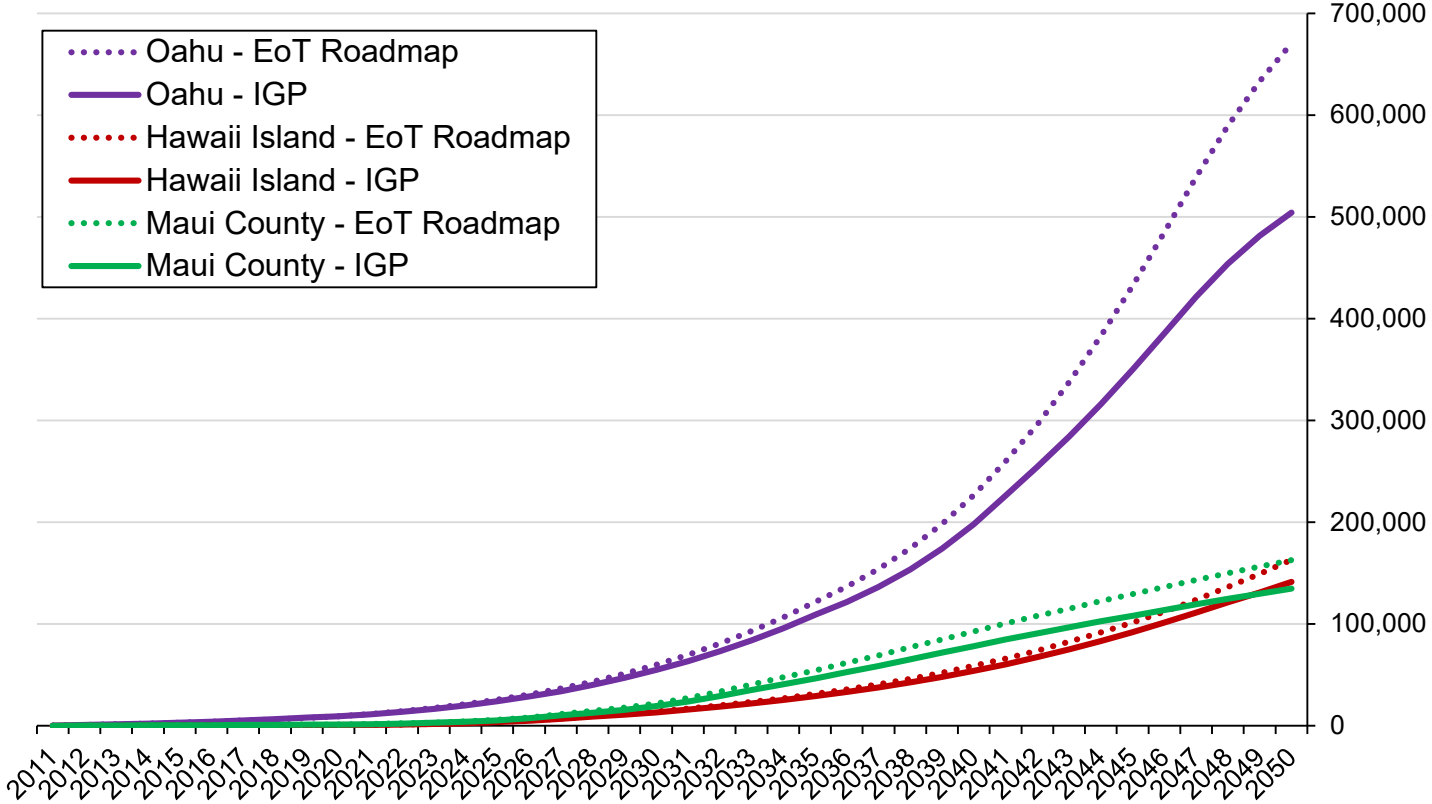
% EV Saturation of Total LDV by Island to 2050



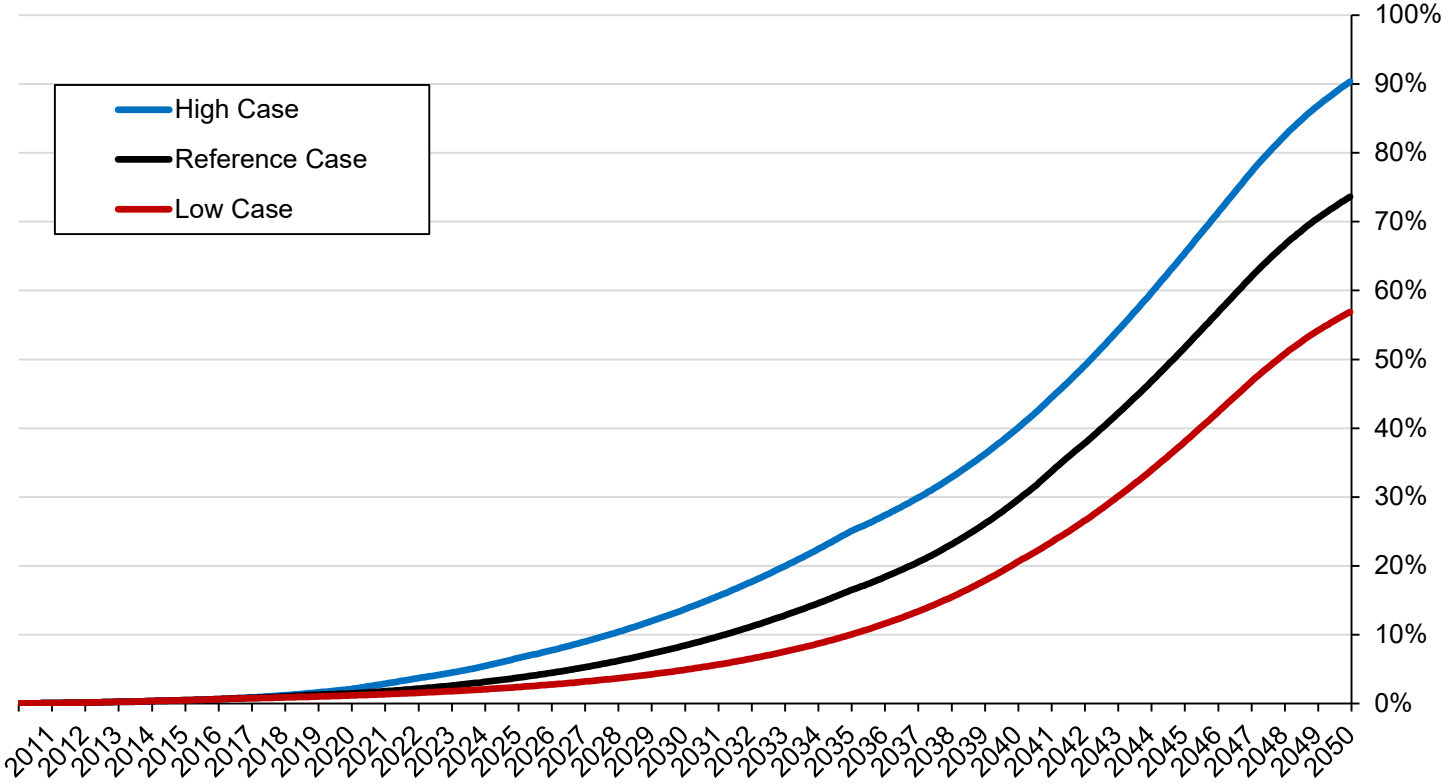
Number of EVs on the Road



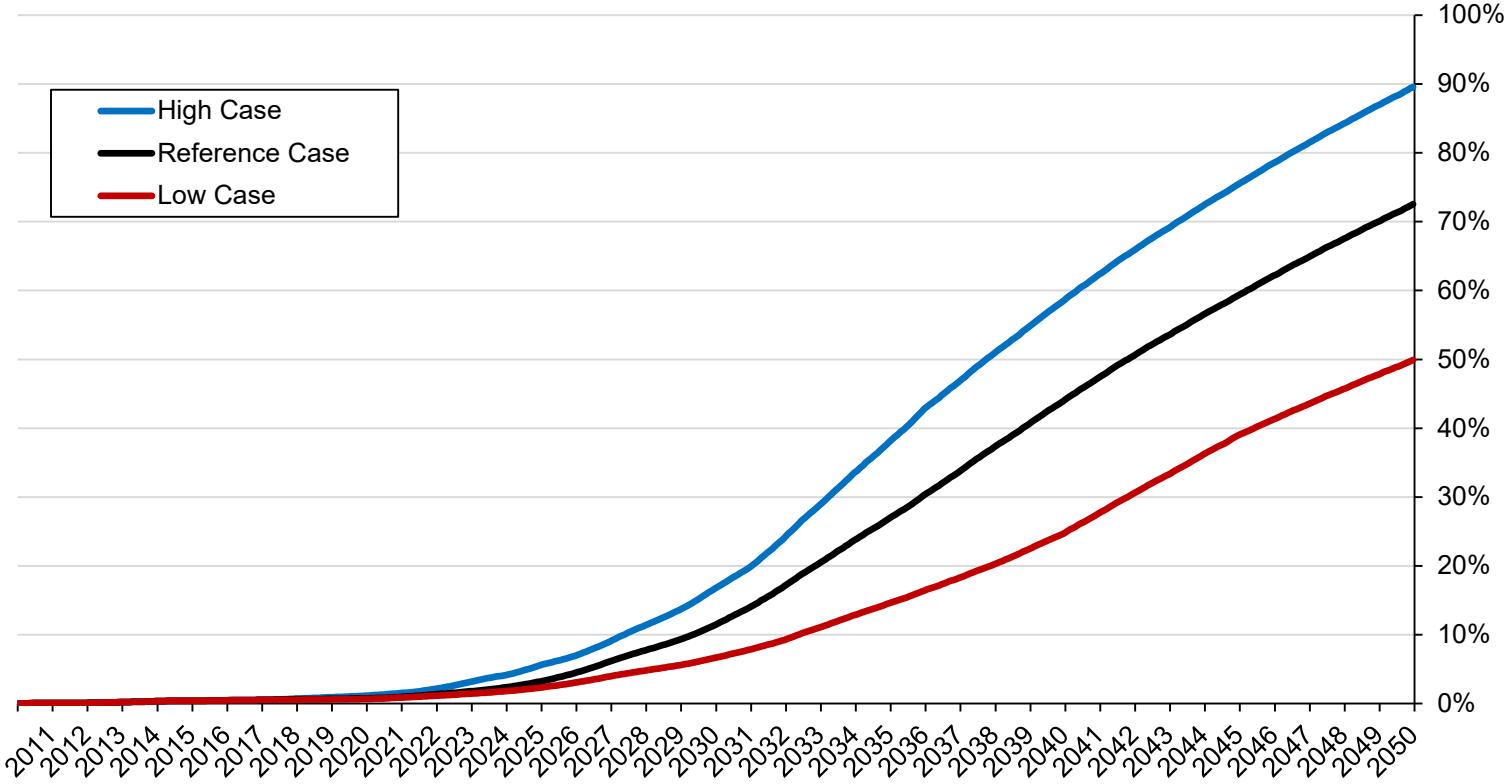
EV Forecast Comparison



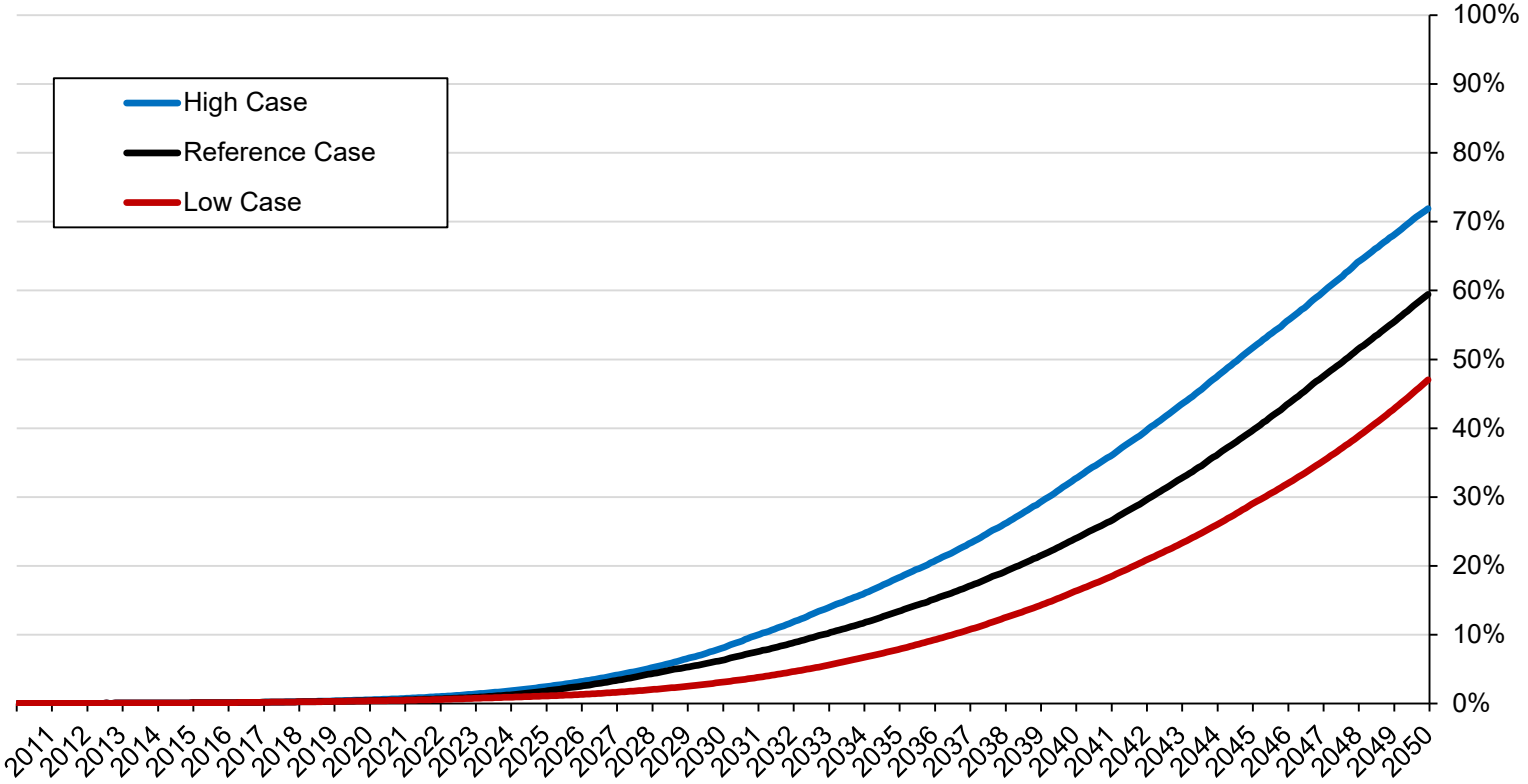
EV Saturation Scenario Example - Oahu



EV Saturation Scenario Example - Maui



EV Saturation Scenario Example – Hawaii Island



LD EV Agenda

Light Duty Vehicle Forecast

EV Saturation & EV Count Forecast

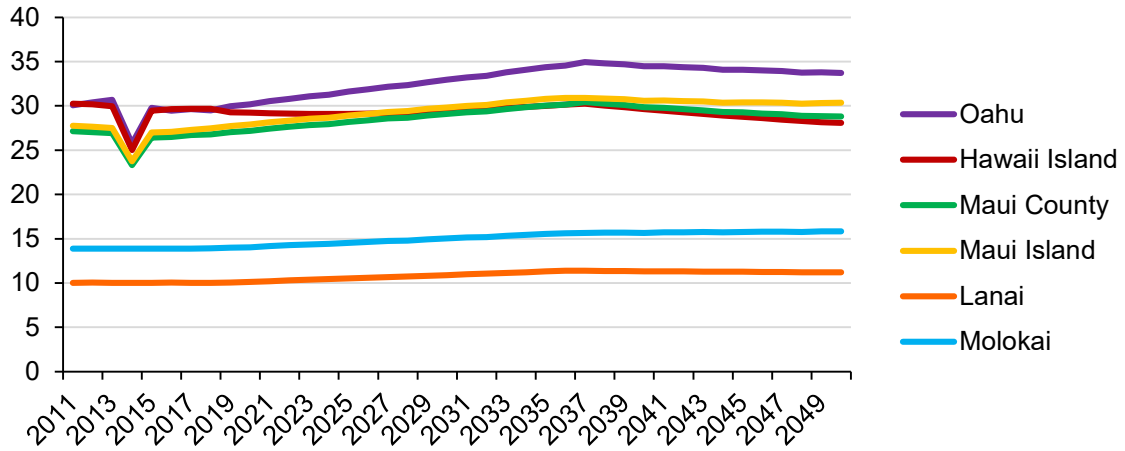
Daily Vehicle Miles Traveled & kWh per Vehicle

Charging Profiles

Total Energy Sales

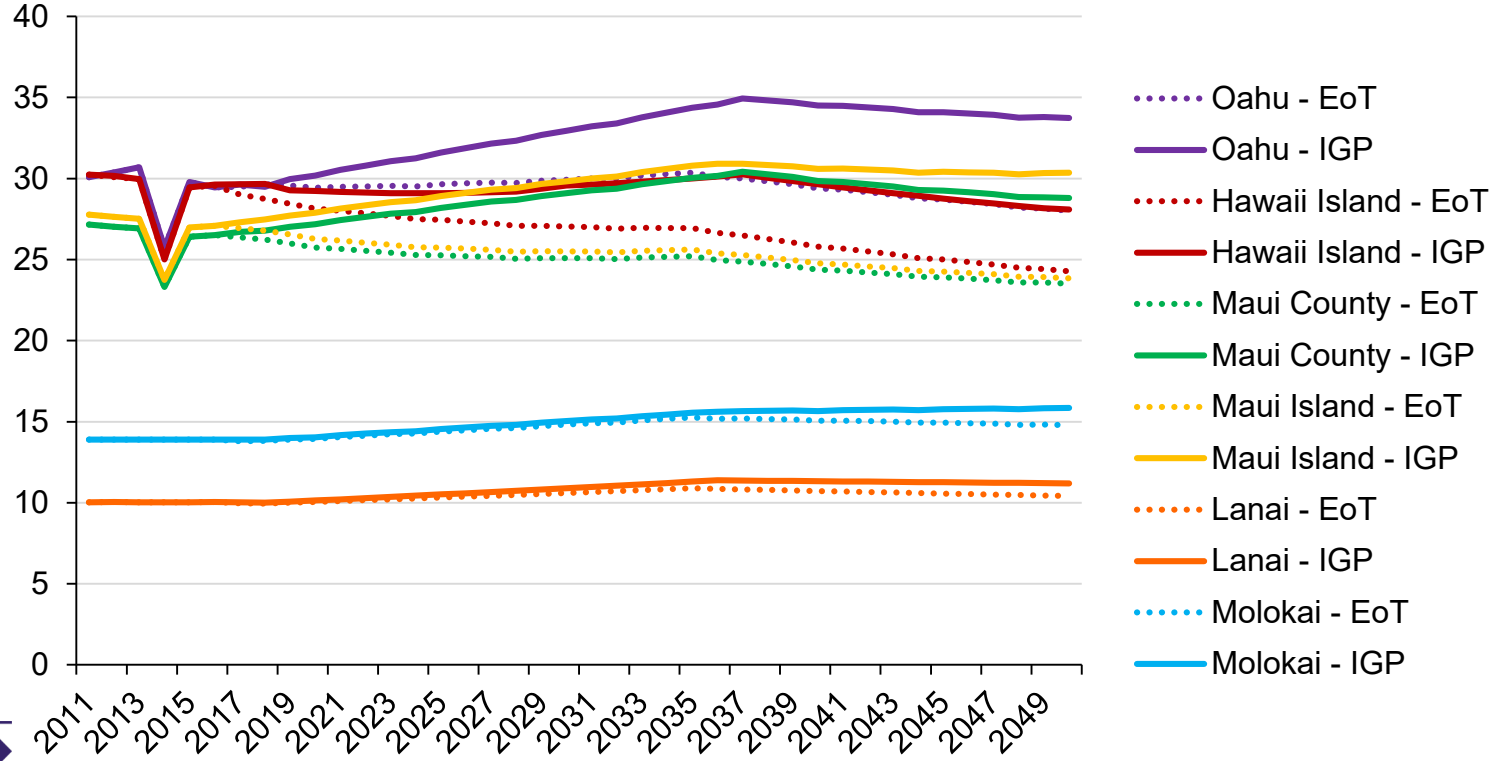
Daily Vehicle Miles Traveled per Vehicle

- Updated actual VMT by county based on annual DBEDT report
- Incorporates updated Federal Highway Administration's VMT outlook
  - 20-year annual growth: + 1.1%
  - 30-year annual growth: + 0.7%



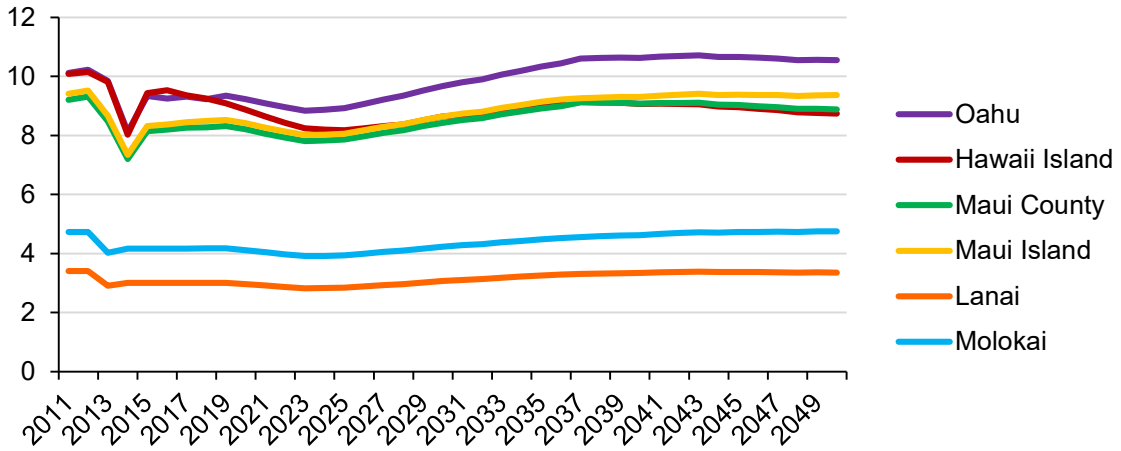
Daily VMT per Vehicle

Comparison to EoT Roadmap



Daily kWh per Vehicle

- Updated actual EV registration data by county from IHS and utilized the fuel economy by vehicle as determined by the U.S. Dept. of Energy
- Incorporates EIA's updated EV fuel economy forecast and considers following:
  - Longer range vehicles (e.g. 300-mile range)
  - Larger vehicles (e.g. CUVs, SUVs, Trucks)



Daily kWh per Vehicle

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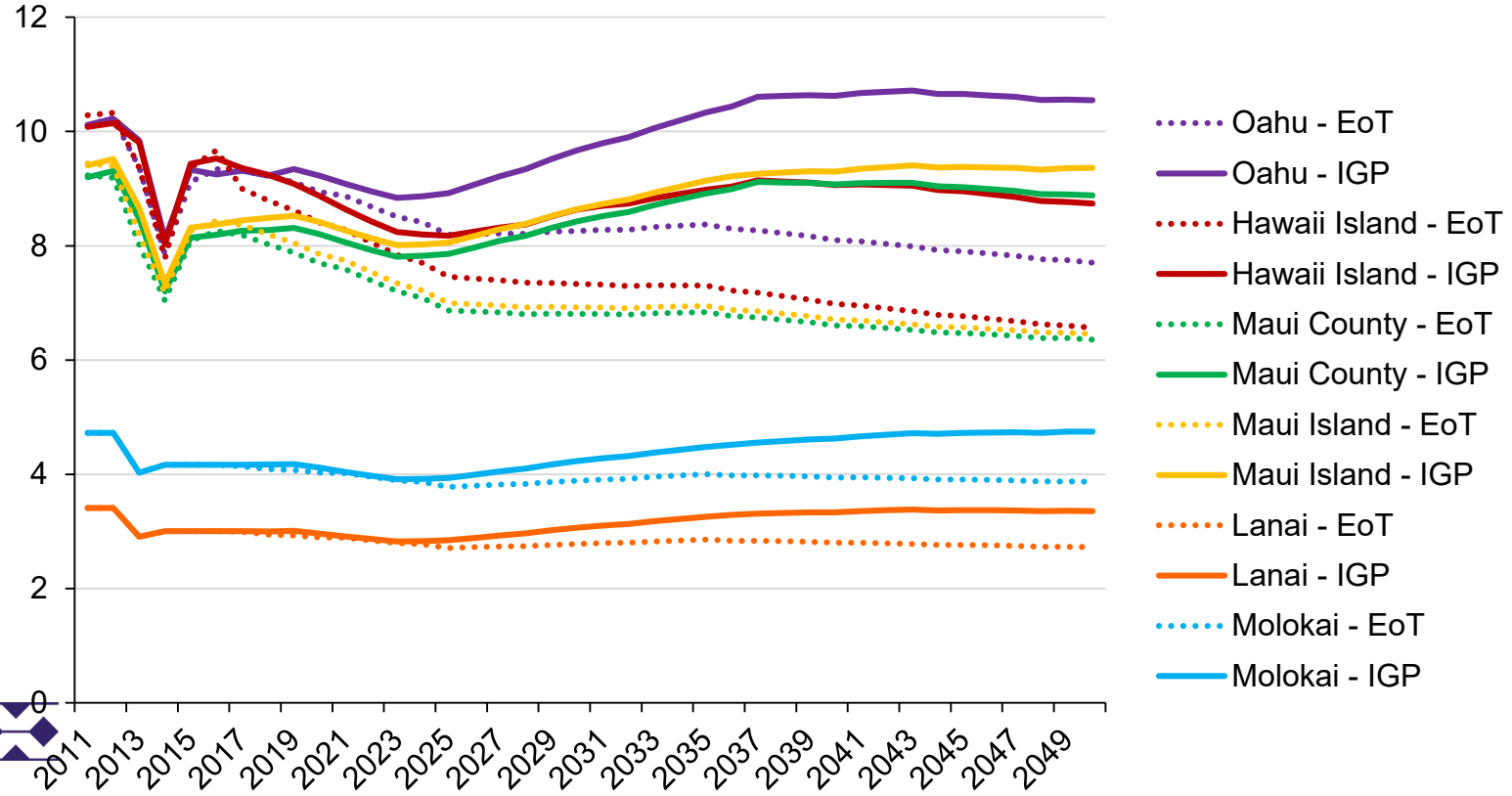


LD EV Agenda

Light Duty Vehicle Forecast

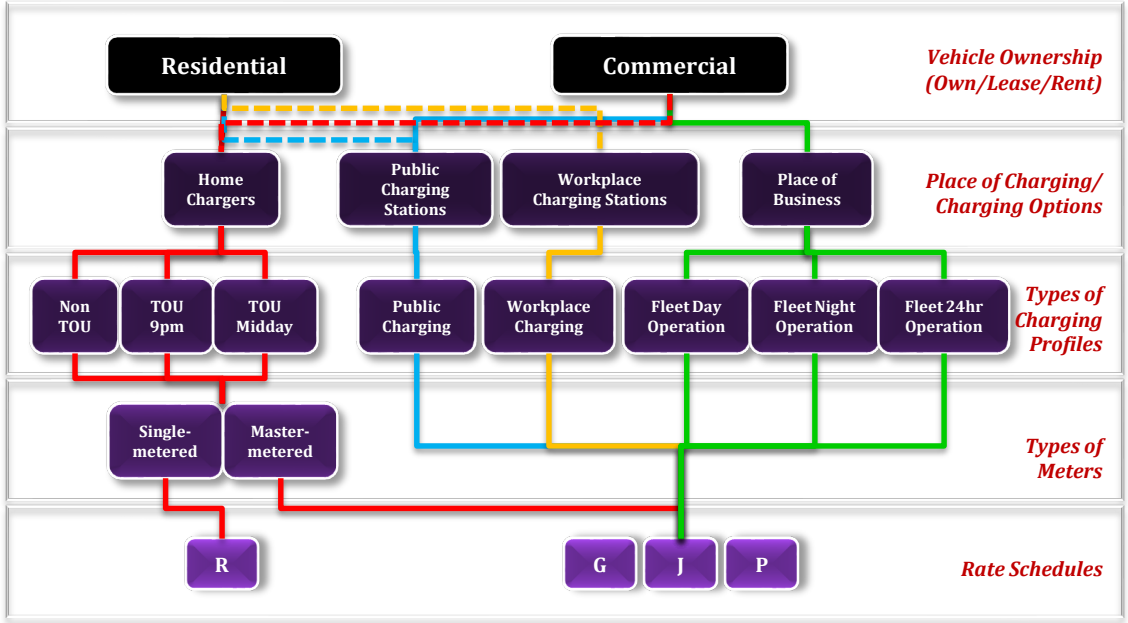
EV Saturation & EV Count Forecast

Daily Vehicle Miles Traveled & kWh per Vehicle

Charging Profiles

Total Energy Sales

Charging Segmentation

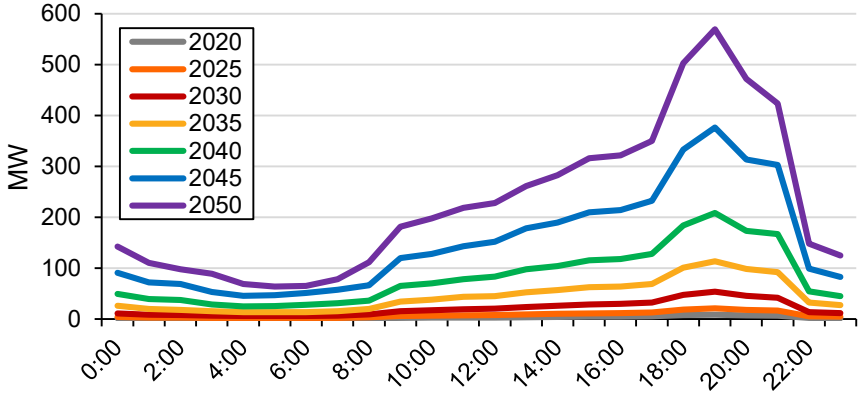


Charging Profile Updates

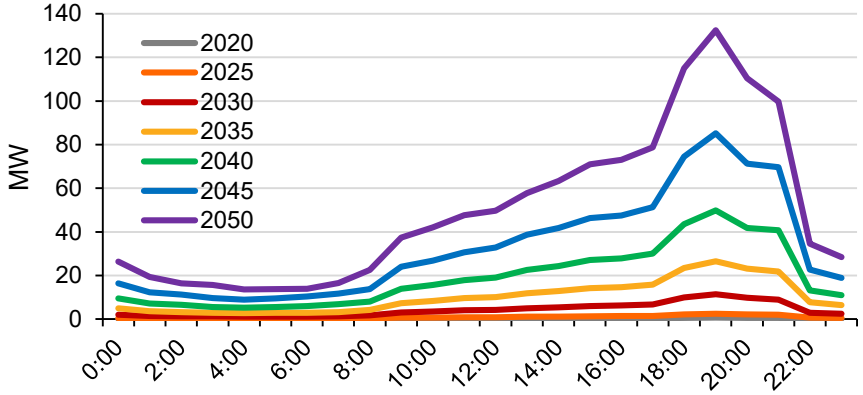
- EV count Res/Comm split based on number of PV installations
- Commercial split determined by kW PV capacity installed

- Removed TOU-Midnight profiles and reallocated to Public Charging (75%) and Workplace Charging (25%)
- Generated updated 8760 Commercial and Residential profiles

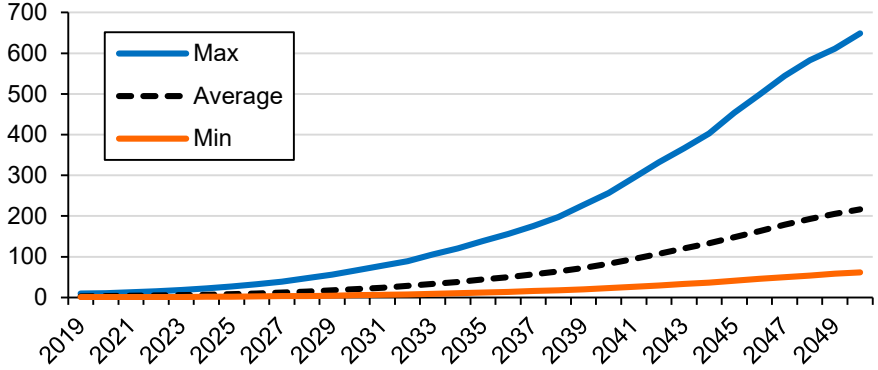
Avg. Charging Profile by Year - Oahu



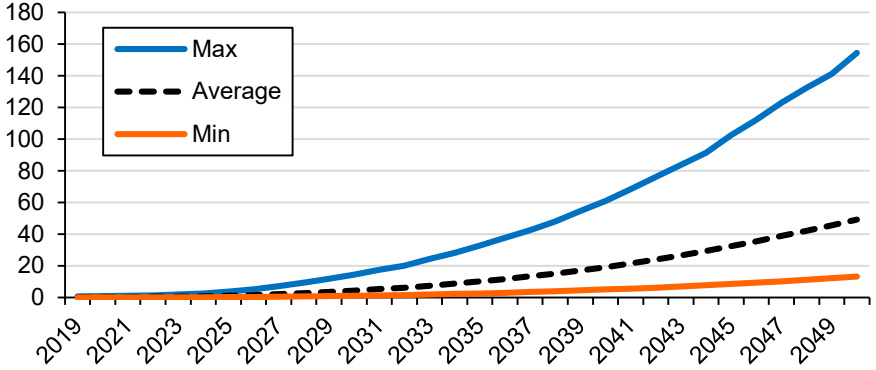
Avg. Charging Profile by Year - Hawaii Island



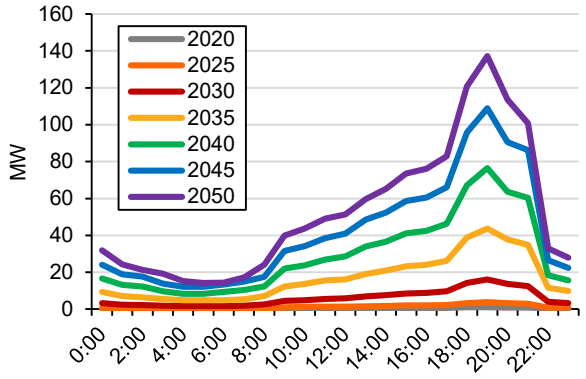
Annual MW Stats - Oahu



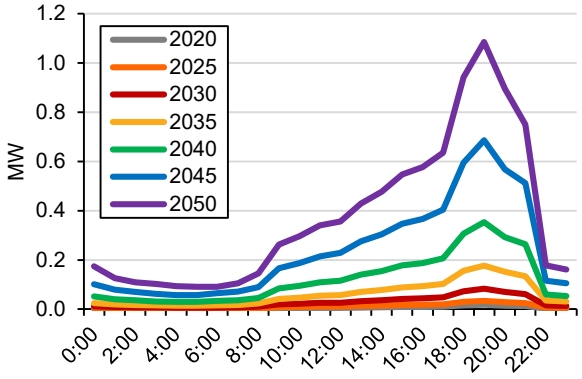
Annual MW Stats - Hawaii Island



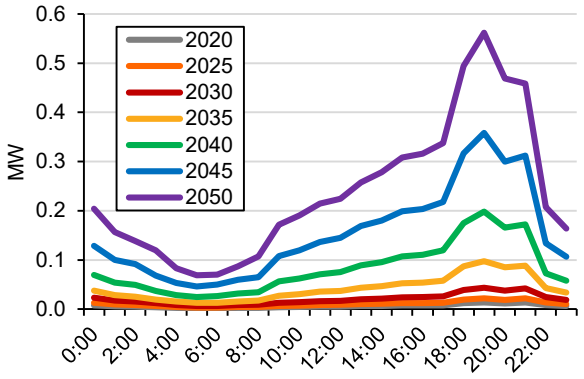
Avg. Charging Profile by Year - Maui



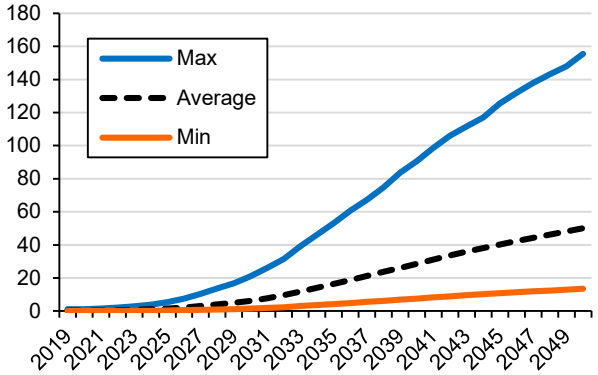
Avg. Charging Profile by Year - Molokai



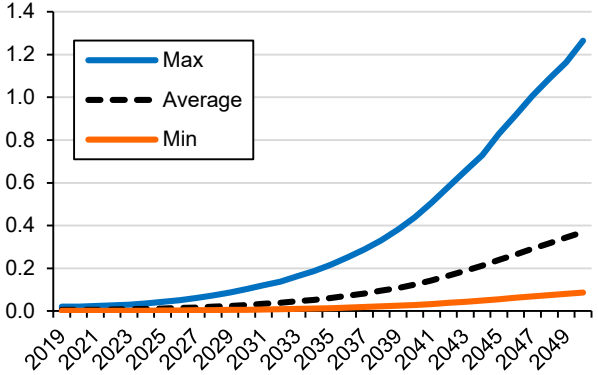
Avg. Charging Profile by Year - Lanai



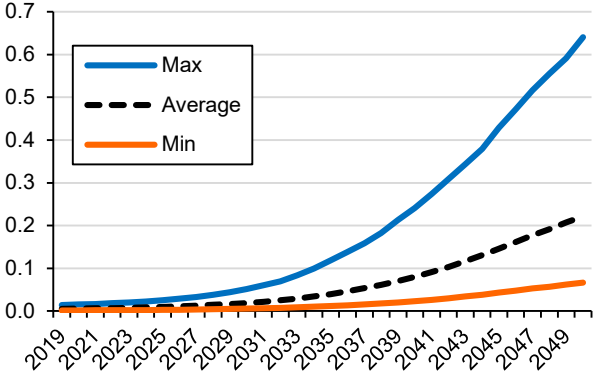
Annual MW Stats - Maui Island



Annual MW Stats - Molokai



Annual MW Stats - Lanai



LD EV Agenda

Light Duty Vehicle Forecast

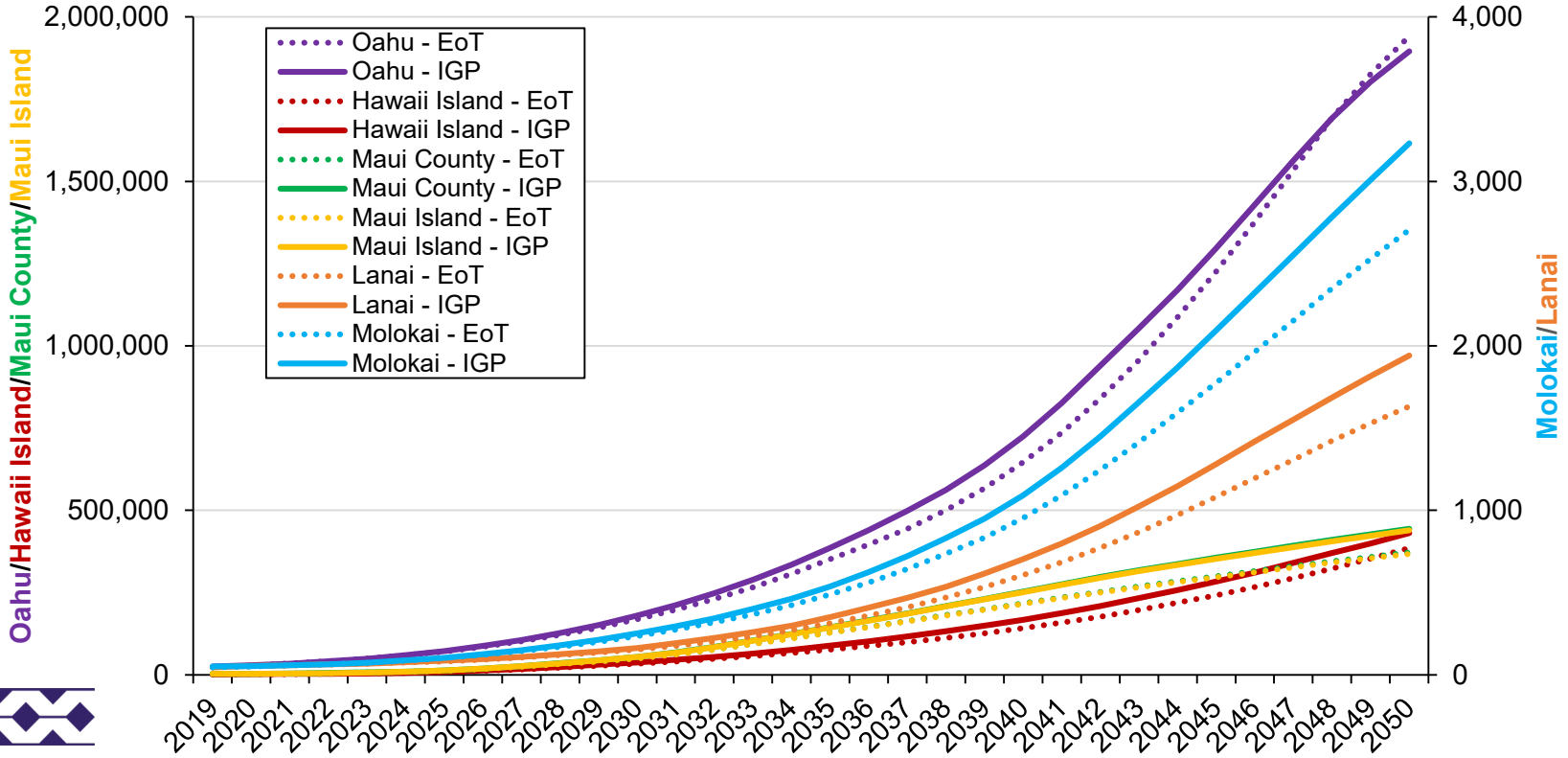
EV Saturation & EV Count Forecast

Daily Vehicle Miles Traveled & kWh per Vehicle

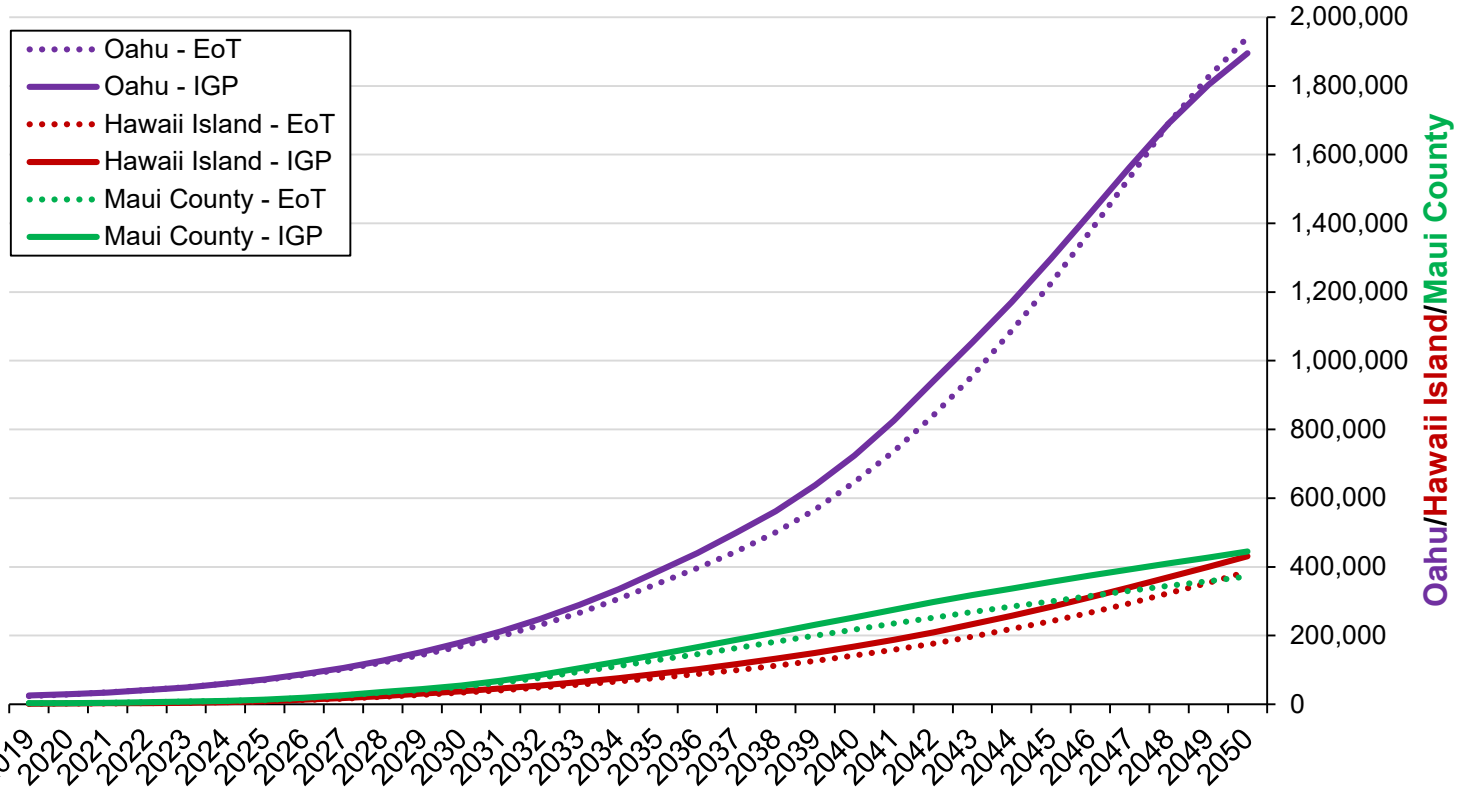
Charging Profiles

Total Energy Sales

MWh Sales – Comparison to EoT Roadmap



MWh Sales – Comparison to EoT Roadmap



Hawaiian Electric

Electric Bus Forecasting

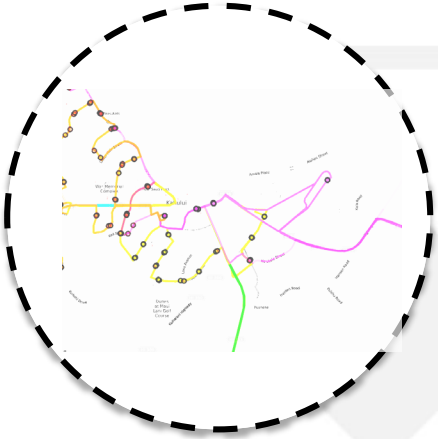
Method

Collaborative discussions to gather preliminary assumptions on future state of EV Bus fleets.

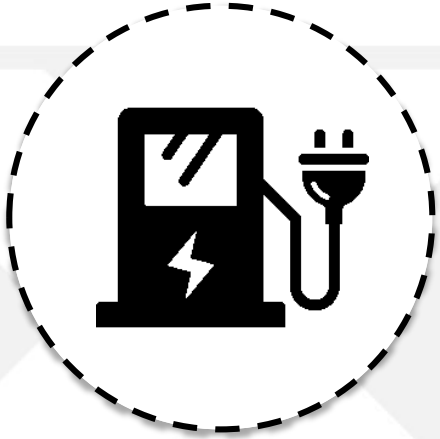
Data analysis and forecasting to determine potential impact to sales and hourly load demands.

Generate ideas between partners to develop charging rates to align impact to customers' bills with grid needs.

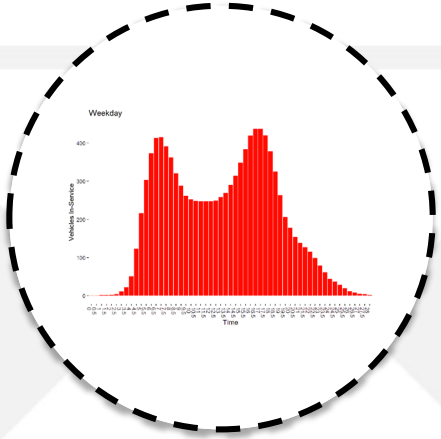
Assumptions



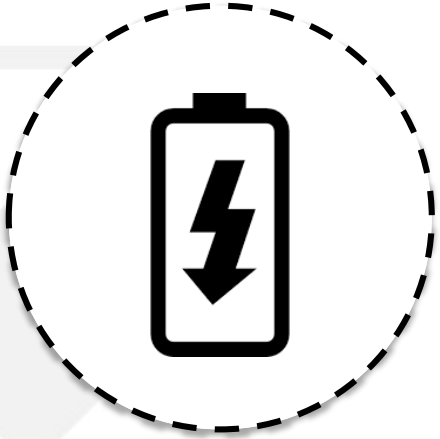
Route Information
Miles traveled



Location of chargers
(bulk/opportunity)



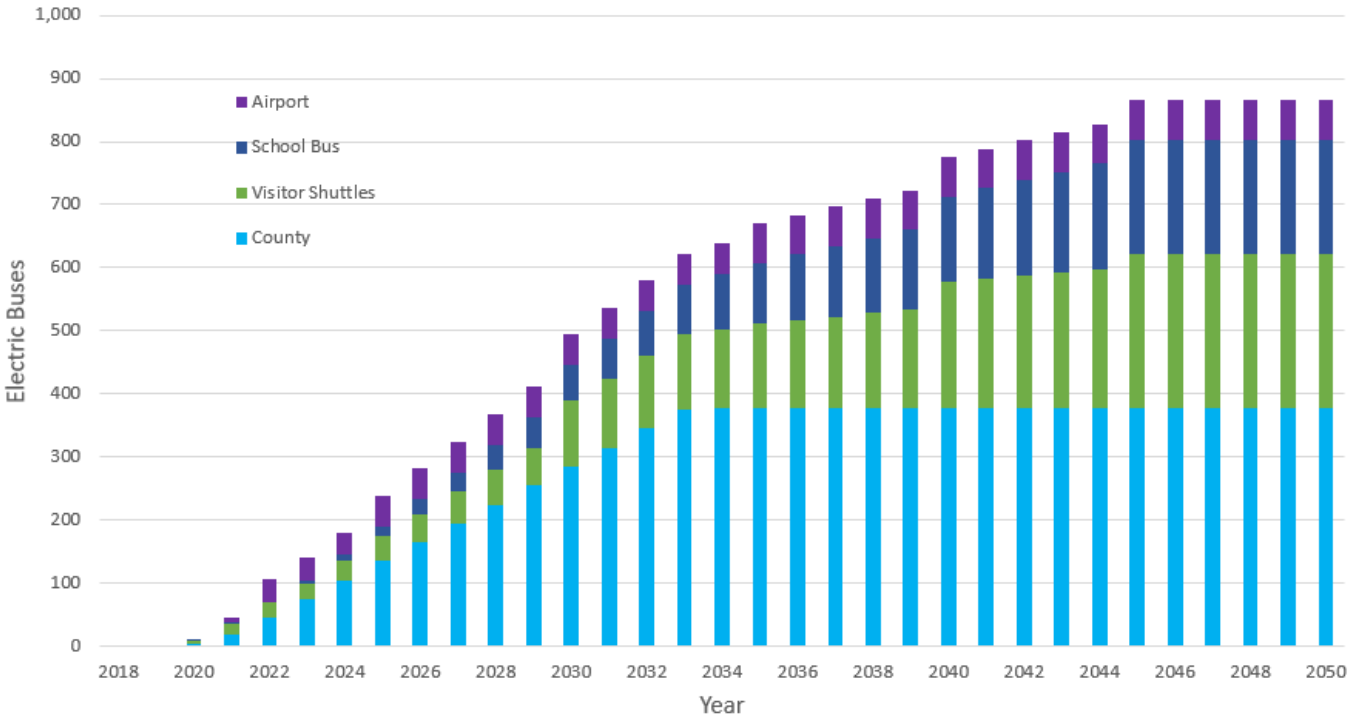
Operating Hours



Technical Specifications
(Battery size, charging rate, kWh/mi.)

E-Bus Forecast

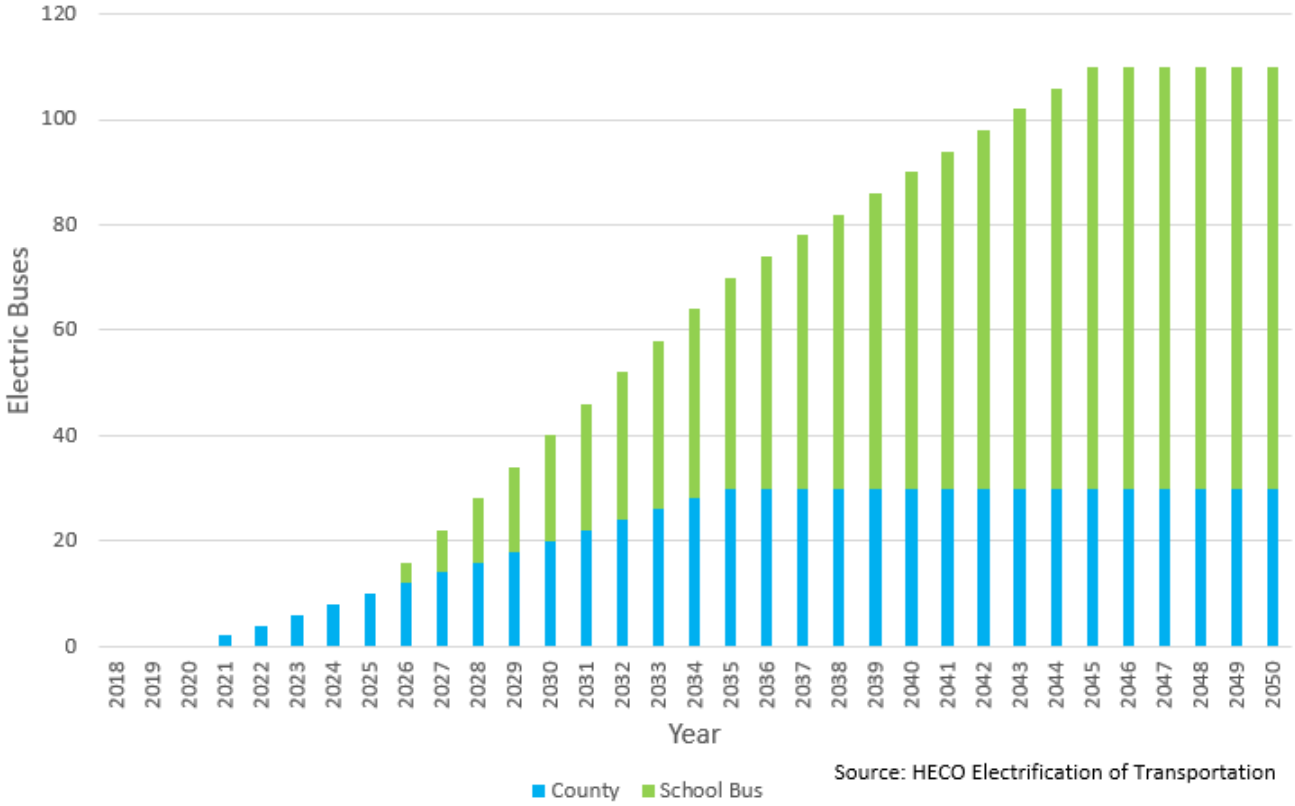
Oahu



Source: HECO Electrification of Transportation

E-Bus Forecast

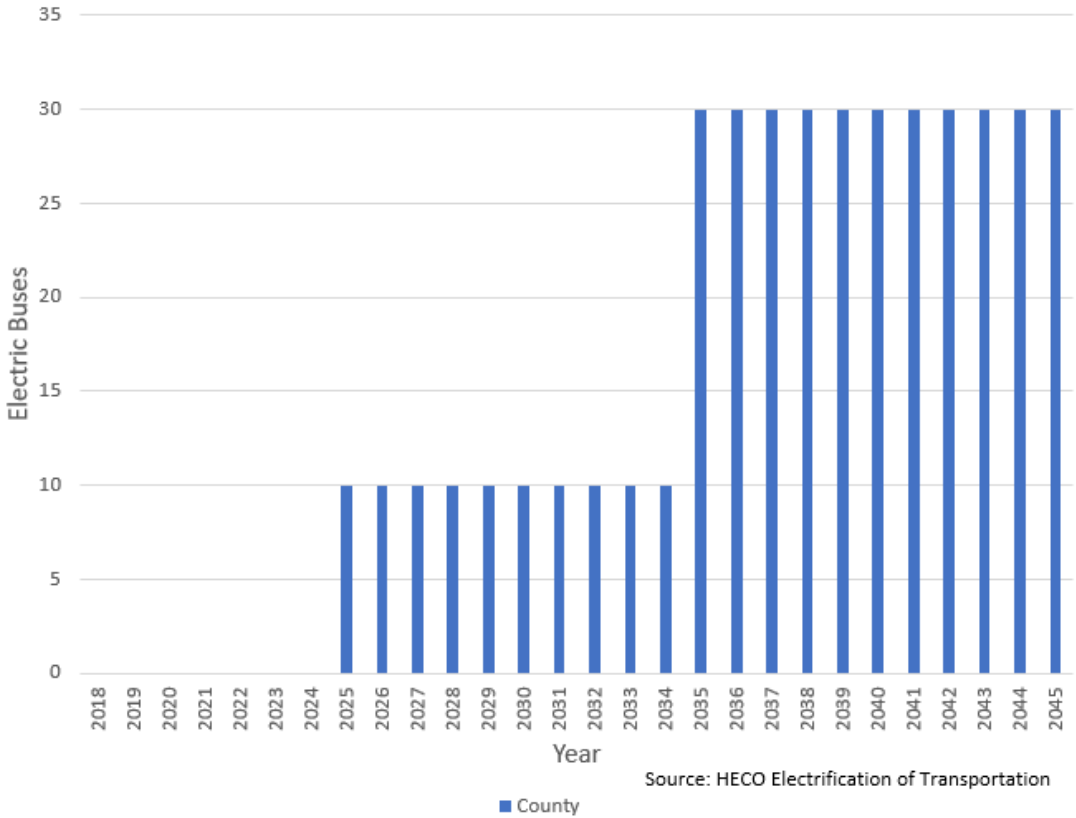
Maui



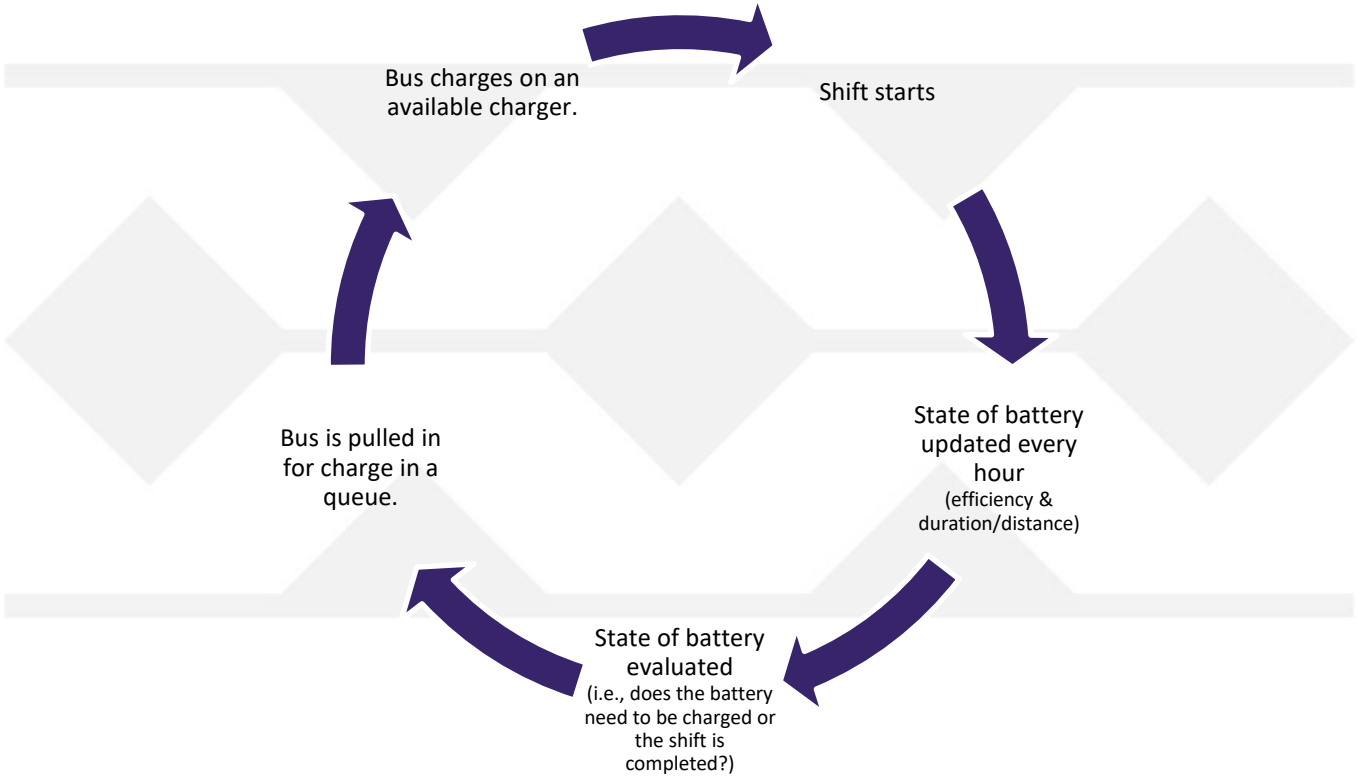
Source: HECO Electrification of Transportation

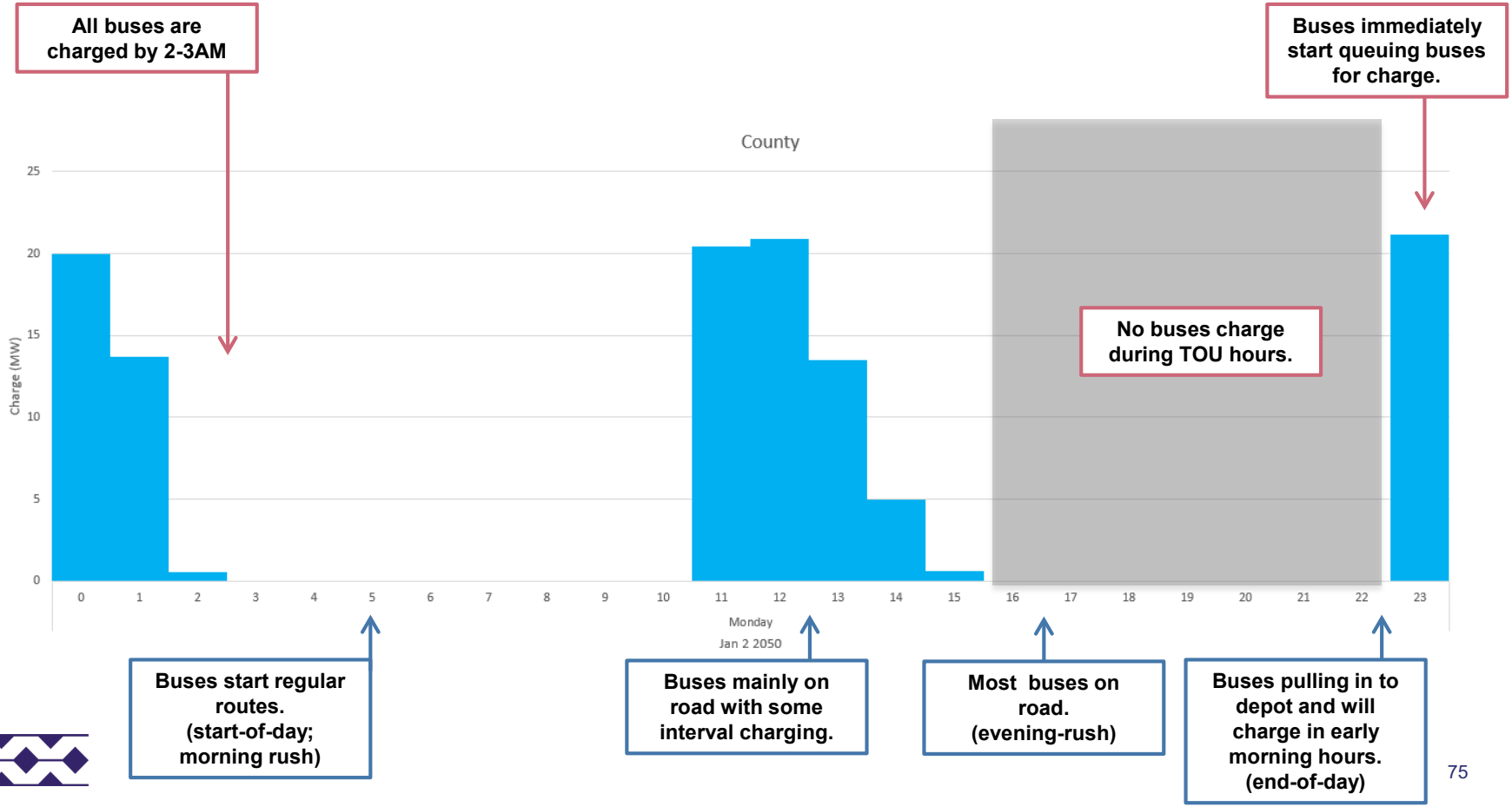
E-Bus Forecast

Hawai`i

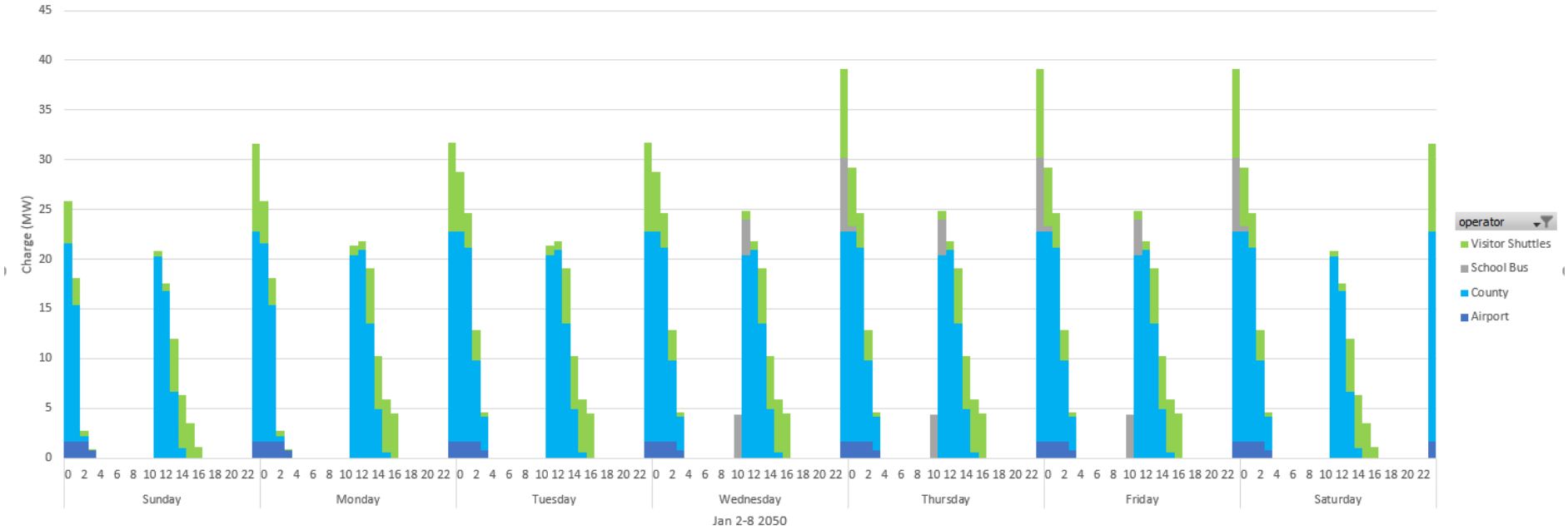


E-Bus Charging Profile




All buses are charged by 2-3AM
Buses immediately start queuing buses for charge.
County
Charge (MW)
25
20
15
10
5
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Monday
Jan 2 2050
No buses charge during TOU hours.
Buses start regular routes. (start-of-day; morning rush)
Buses mainly on road with some interval charging.
Most buses on road. (evening-rush)
Buses pulling in to depot and will charge in early morning hours. (end-of-day)

A “typical” week charging profile



Energy Efficiency

Sensitivities

Sensitivities for discussion

- Develop high/low adoption forecasts around the “layers” – DER, light duty EVs and energy efficiency for all islands
- Resource plan modeling sensitivities

Modeling Sensitivities

Several modeling sensitivities have been proposed by stakeholders in the Solution Evaluation & Optimization Working Group.

These sensitivities can be characterized as:

- Constraining future transmission and limiting grid-scale renewable buildout
- Considering new customer behaviors related to EV charging, load shifting
- Freezing DER at current levels

Forecast Iteration

1. Various planning sensitivities will be modeled in RESOLVE.
2. The model results will be used to inform a DER forecast iteration.
   - Grid service needs that are met with grid-scale resources may instead be met with DER, assuming that the DER can provide equivalent services.
   - The timing and quantity of the DER that is adjusted in the forecast will depend upon the results of the sensitivity analyses.

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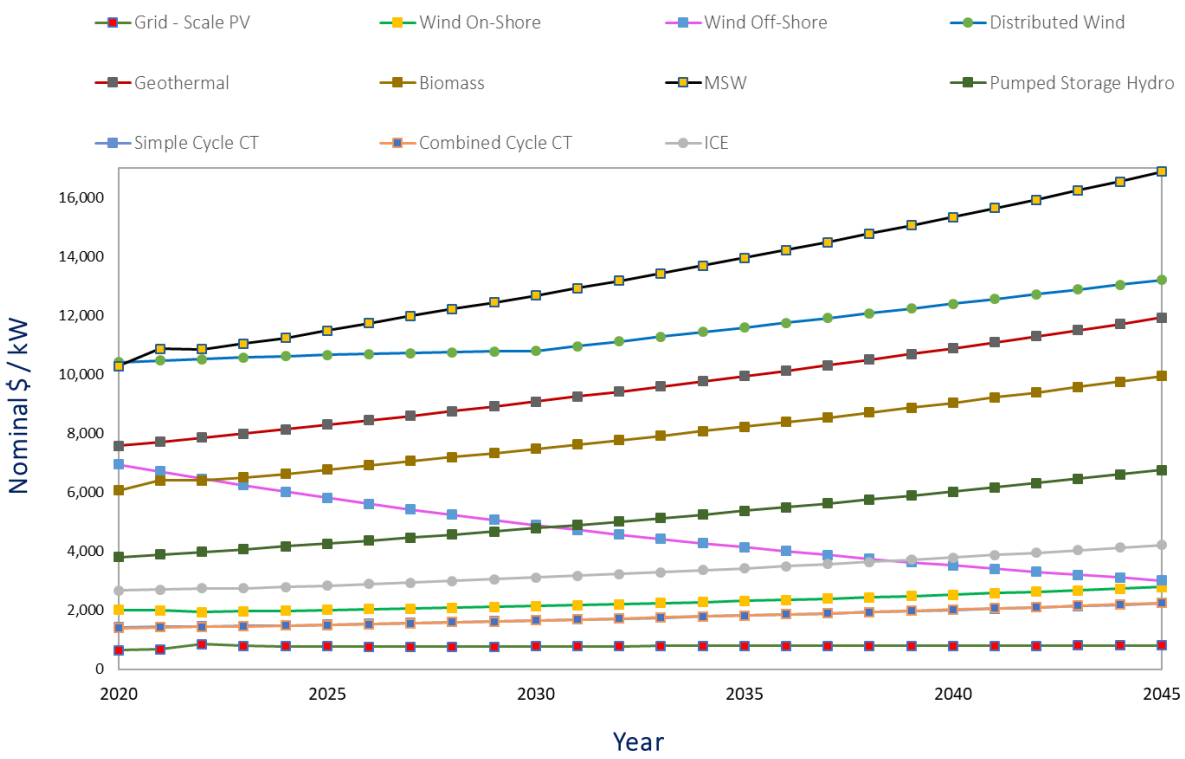
Resource Cost Forecasts

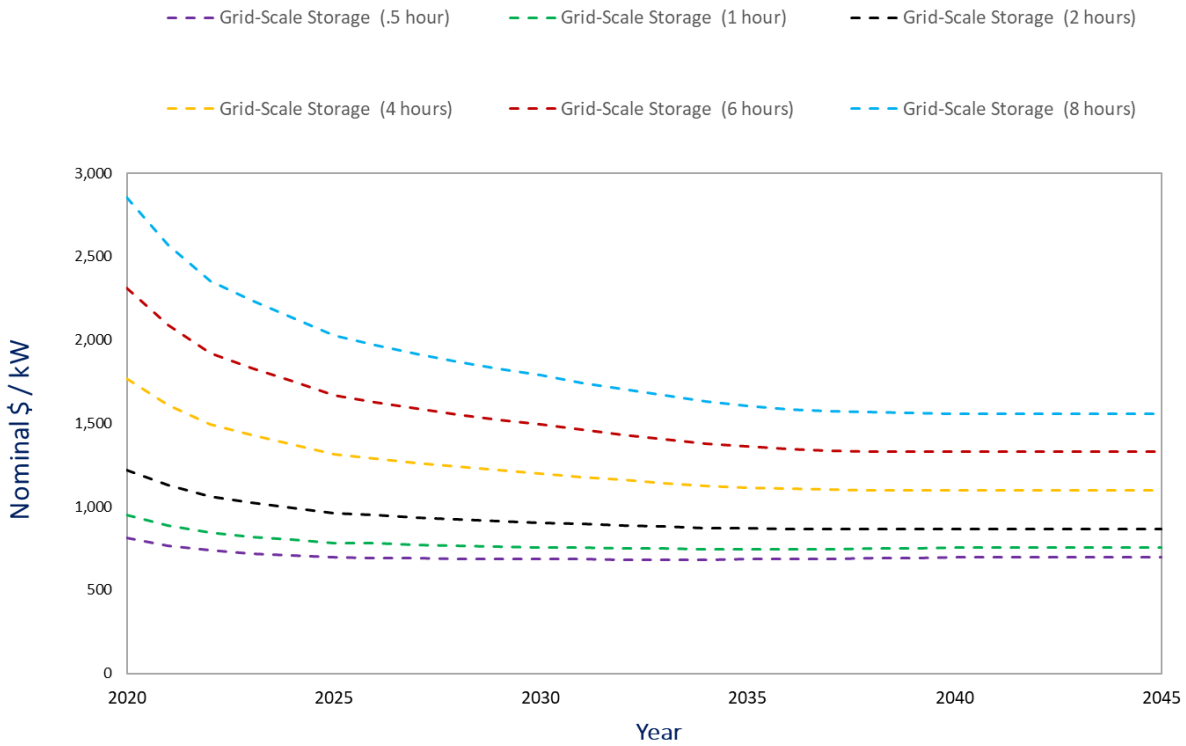
Generating Resource Cost Forecast Estimate ($ / kW)



Assumed Sizes of Source Data

- Grid - Scale PV – 20 MW
- Grid – Scale Wind – 20 MW
- Wind On-Shore – 20 MW
- Wind Off-Shore – 600 MW
- Distributed Wind – 21 – 100 kW
- MSW – 50 MW
- ICE – 50 MW
- Pumped Storage Hydro – 50 MW
- Geothermal – 30 MW
- Simple Cycle CT – 100 MW
- Combined Cycle CT – 702 MW
- Biomass – 50 MW

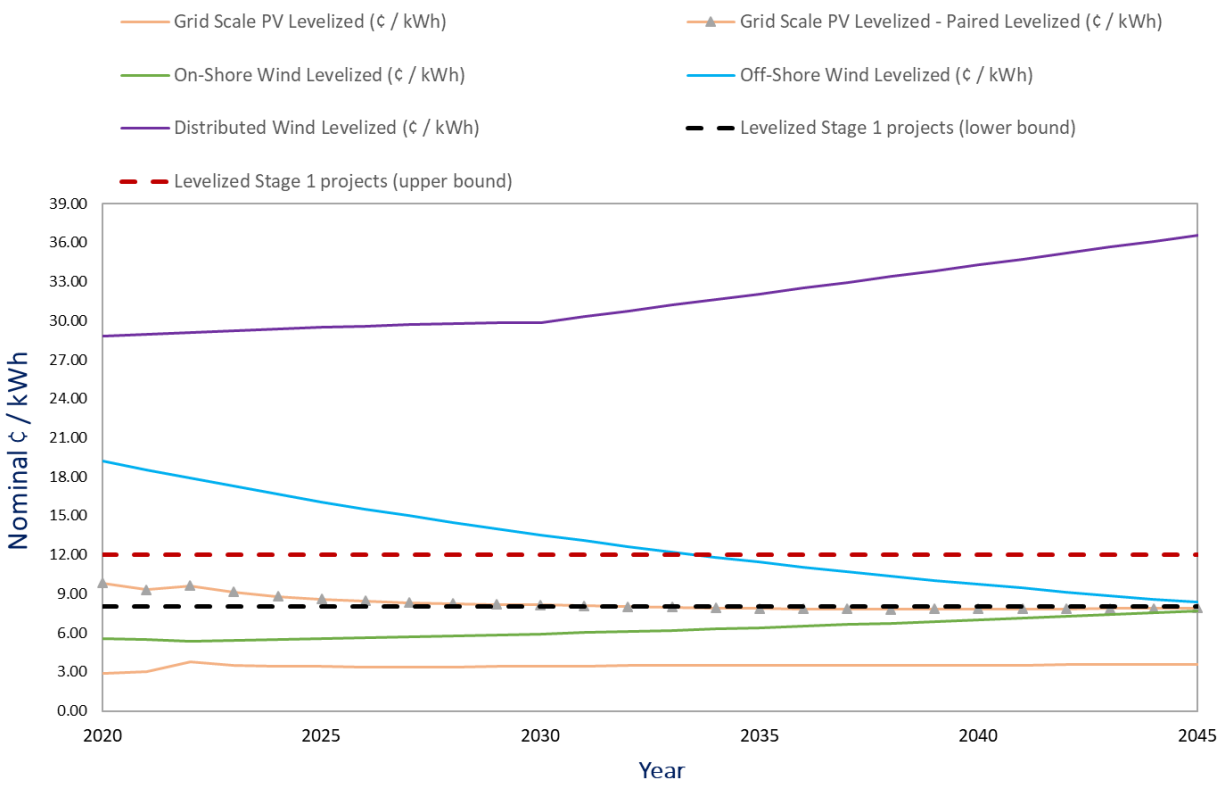
Storage Resource Cost Forecast Estimate ($ / kW)



Assumed Sizes of Source Data

- Grid-Scale Storage – 20 MW

Nominal Levelized Resource Cost Estimates (Variable Resources)



- Grid-scale paired resources assume 4-hour storage.
- Does not include interconnection cost.

Next Steps

Deliverables and feedback

Assumptions

- Presentation material
- Assumptions will be posted to the website

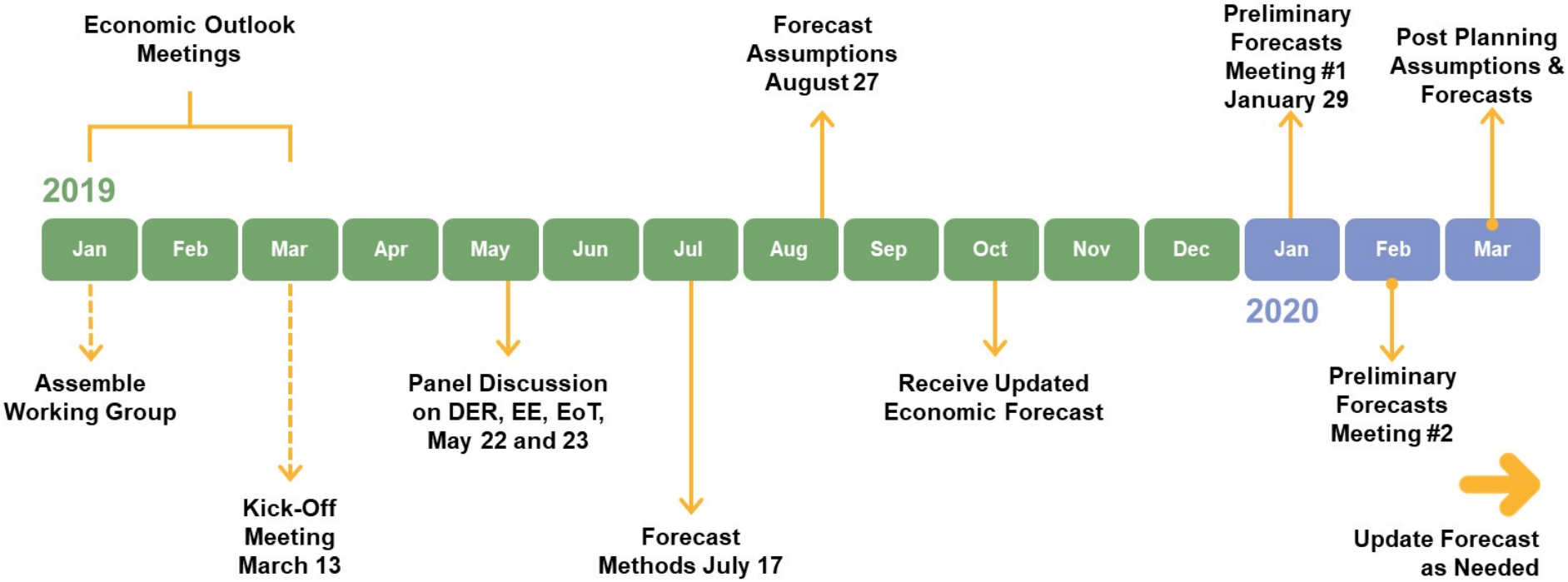
Forecasts

- Presentations – January 29 and February 26
- Forecasts will be posted to the website

Feedback

- Provide feedback on today's meeting material by February 12
- Provide feedback on February 26 meeting by March 12

What's Ahead


Economic Outlook Meetings
Forecast Assumptions August 27
Preliminary Forecasts Meeting #1 January 29
Post Planning Assumptions & Forecasts
2019
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
2020
Assemble Working Group
Kick-Off Meeting March 13
Panel Discussion on DER, EE, EoT, May 22 and 23
Forecast Methods July 17
Receive Updated Economic Forecast
Preliminary Forecasts Meeting #2
Update Forecast as Needed


Mahalo!