Integrated Grid Planning

Forecast Assumptions Working Group

August 27, 2019

Hawaiian Electric
Maui Electric
Hawai'i Electric Light

Objectives for Today

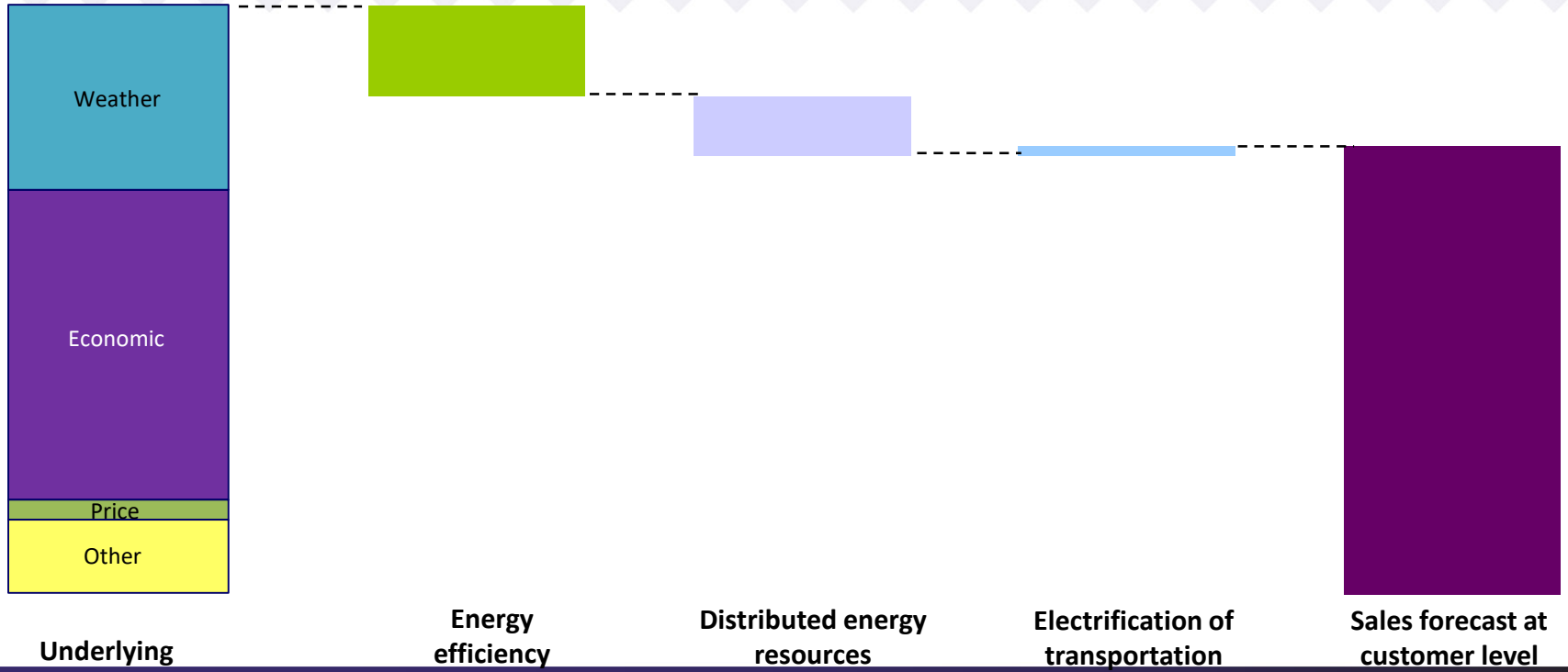
- Present assumptions used to develop forecasts
- Discuss sensitivities and scenarios to create a forecast range
- Gather feedback on assumptions and for developing sensitivities and scenarios

Forecast and Planning Assumptions

Welcome and Overview	8:30 - 8:40
Underlying Forecast Assumptions	8:40 - 9:30
– Economic Drivers	
– Electricity Price Forecast	
– Weather	
Break	9:30 - 9:40
Electrification of Transportation Assumptions	9:40 - 9:55
Distributed Energy Resources Assumptions	9:55 - 10:15
Break	10:15 - 10:30
Breakout Session	10:30 - 11:25
Break to grab a bento	11:25 - 11:45
Continue Breakout Session	11:45 - 12:35
Break	12:35 - 12:45
Report on Breakout Session	12:45 - 1:25
Wrap-up	1:25 - 1:30

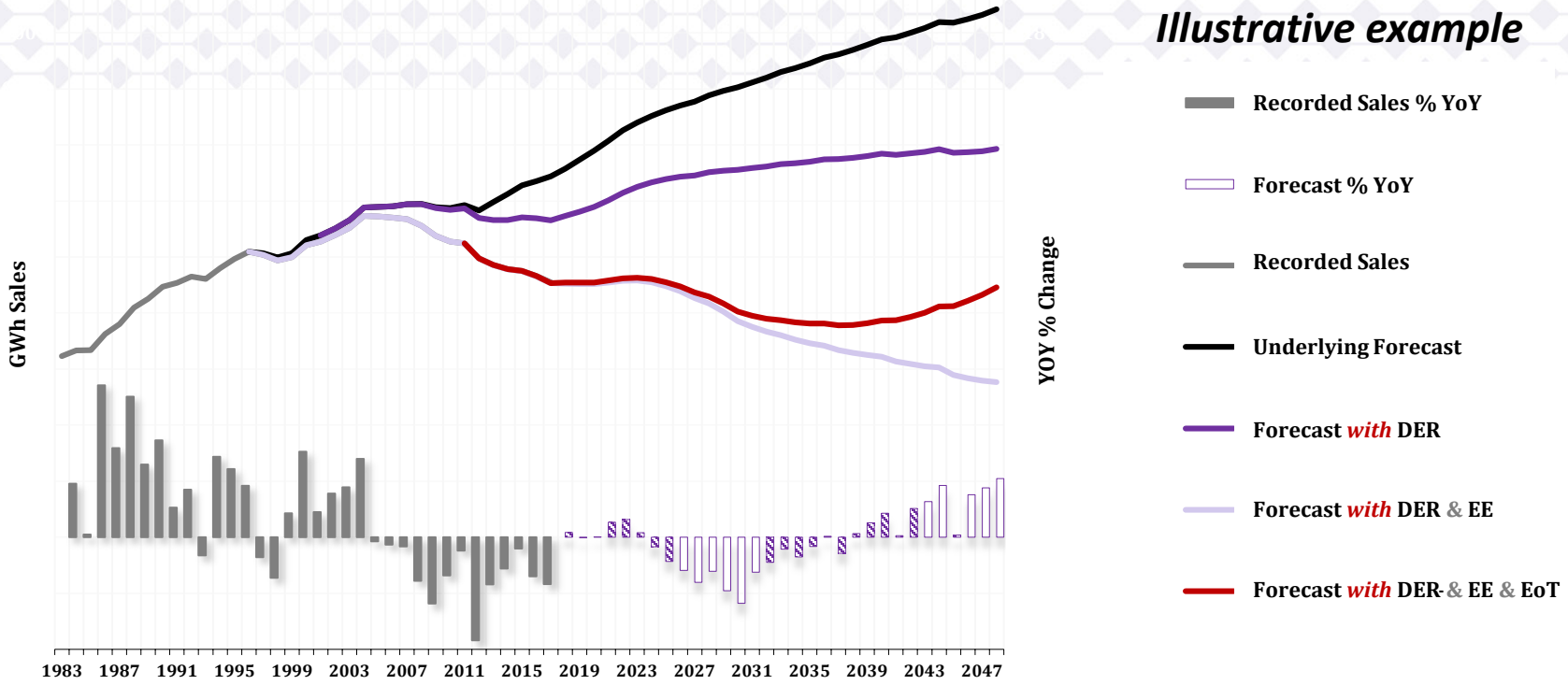
Our forecast is developed in layers

Illustrative example



Forecast will be further modified by DR and controllable DER

Our forecast is developed in layers



Forecast will be further modified by DR and controllable DER

Underlying Forecast Assumptions

Economics

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Electricity Price

Hawaiian Electric
Maui Electric
Hawai'i Electric Light

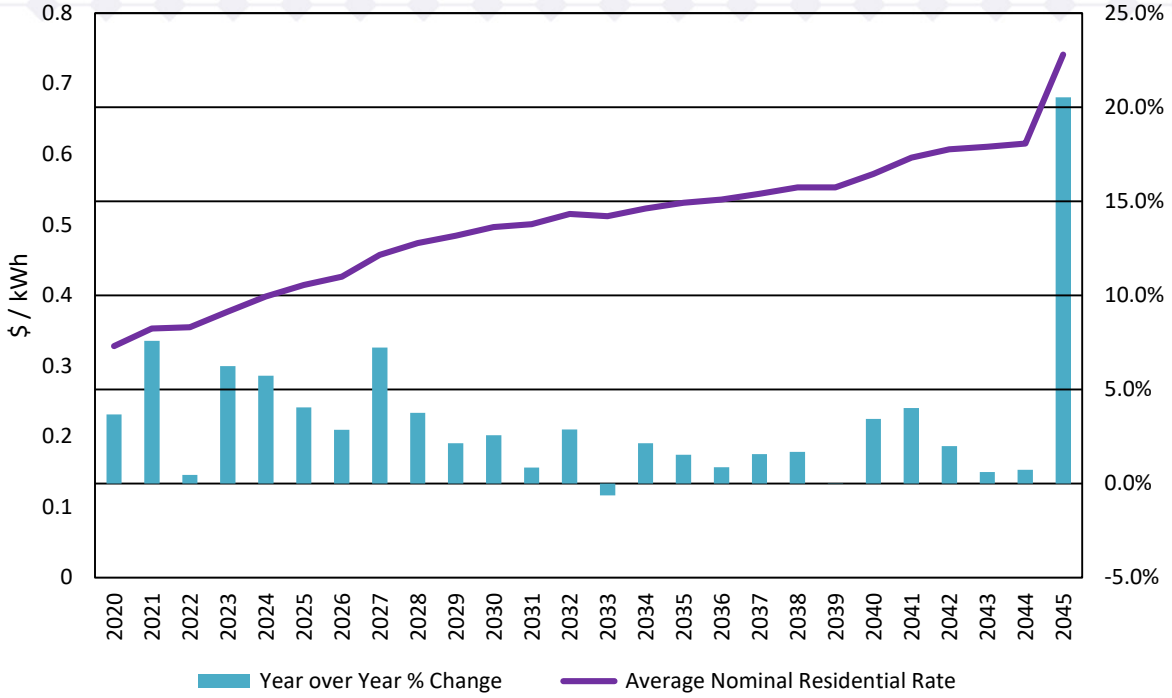
Electricity Price Forecast

Year	Updated Resource Plan for Oahu
2019	Install 20 MW West Loch PV Project
	Install 109.6 MW Clearway PV Projects
2020	Install 5 MW CBRE PV (Phase 1)
	Install 24 MW Na Pua Makani Wind Project
2021	Install West Oahu Solar – 12.5 MW PV + 50 MWH Storage
2022	AES deactivated
	Install 43.5 MW CBRE PV (Phase 2)
	Install Hoohana Solar 1 – 52 MW PV + 208 MWH Storage
	Install Mililani 1 Solar – 39 MW PV + 156 MWH Storage
	Install Waiawa Solar – 36 MW PV + 144 MWH Storage
	Install Stage 2 RFP Projects (1,300 GWH Annual Renewable Energy)
	Install Stage 2 Grid-Charged Energy Storage (200 MW, 1,200 MWh daily)
	Install Demand Response Programs from Grid Services RFP (Up to 119 MW)
	Install synchronous condensers and/or other technologies to enable reliable operation of resource portfolio
2023	Waiau 3 & Waiau 4 Removal from Service
	Install 47 MW Palehua Wind Project
2024	

Year	Updated Resource Plan for Oahu
2025	Install 200 MW of Offshore Wind
2026	Install 151 MW CC
	Waiau 5 & 6 Removal From Service
2028	Install 151 MW CC
	Kahe 5 & 6 Removal From Service
2030	Install 165 MW 4-hour Load-Shift Battery
2031	Waiau 7 & 8 Removal From Service
2032	Install 302 MW CC (2 x 151 MW)
2035	Install 168 MW 4-hour Load-Shift Battery
	Kahe 1 & 2 Removal From Service
2039	Kahe 3 & 4 Removal From Service
2040	Install 280 MW of Grid-Scale PV
	Install 420 MW 4-hour Load-Shift Battery
2045	Install 1180 MW of Grid-Scale PV
	Install 1525 MW 4-hour Load-Shift Battery
	Install 68 MW ICE (4 x 17 MW)
	CIP CT-1, Waiau 9 & 10, Airport DSG, Schofield, 154 MW Military Generation biodiesel conversion
	KPLP biodiesel conversion

Electricity Price Forecast

Illustrative Example of Rates and Year over Year Change

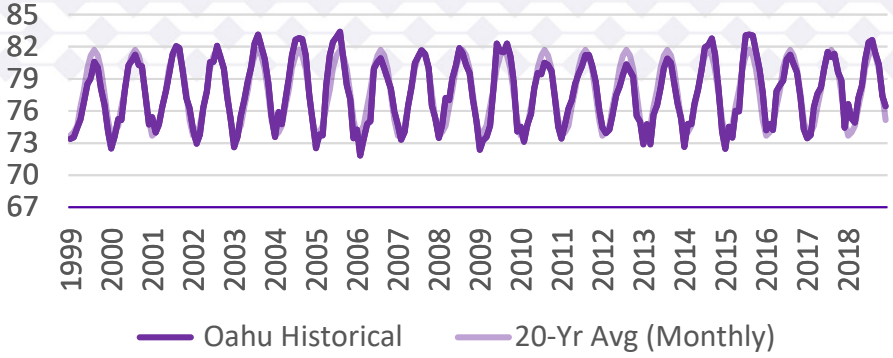


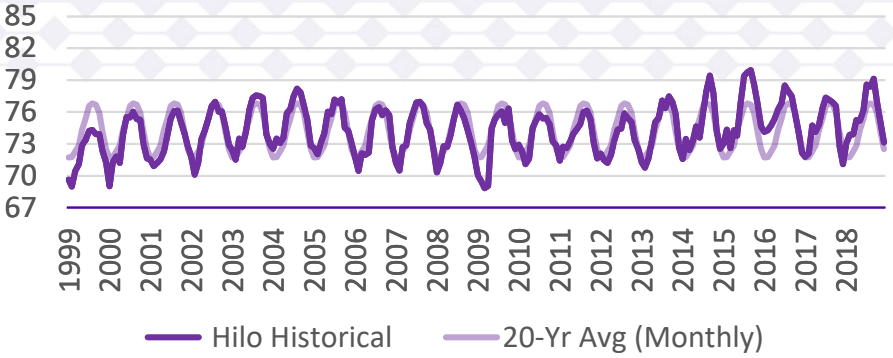
Weather Assumptions

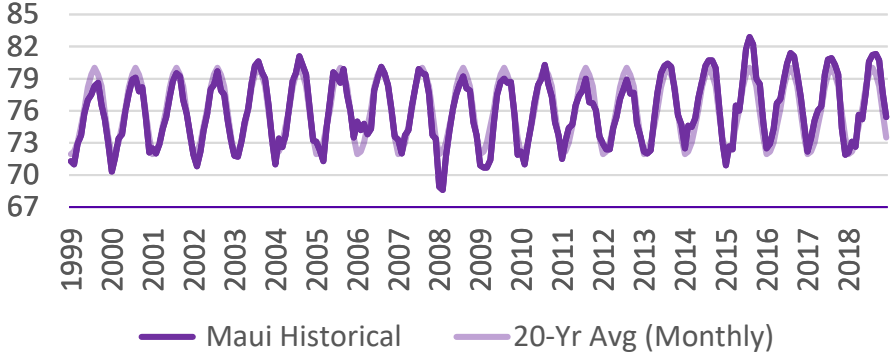
Weather Variables

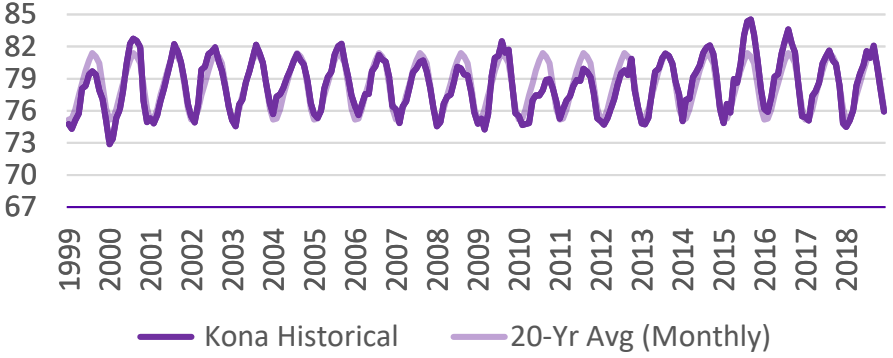
- One or more weather variables are included in most of the underlying sales models
- Weather variables considered include measures of:
  - Temperature (average temperature, cooling degree days)
  - Humidity (relative humidity, dew point)
  - Combination of both
  - Other
- Focusing on average monthly temperature (˚F)
  - Average monthly temperature = Average of daily average temperatures
  - Average daily temperature = Average of daily minimum and daily maximum

Historical Average Monthly Temperature (Degrees Fahrenheit)

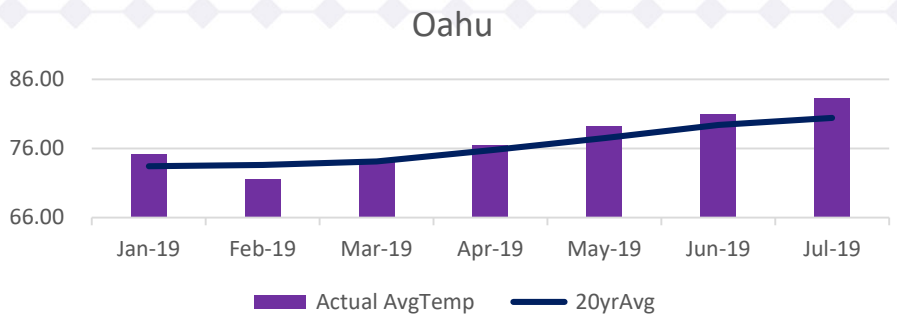


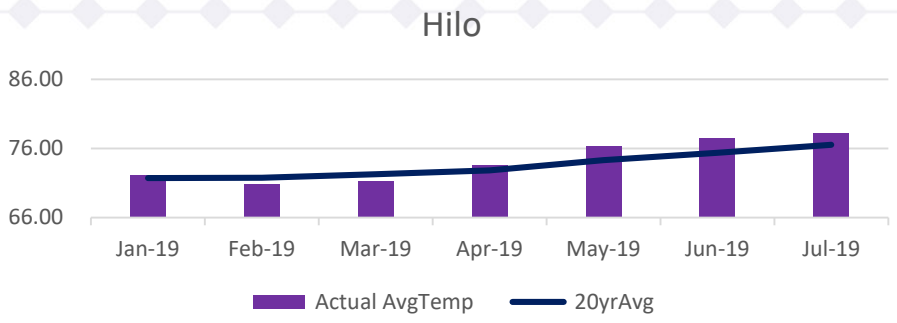


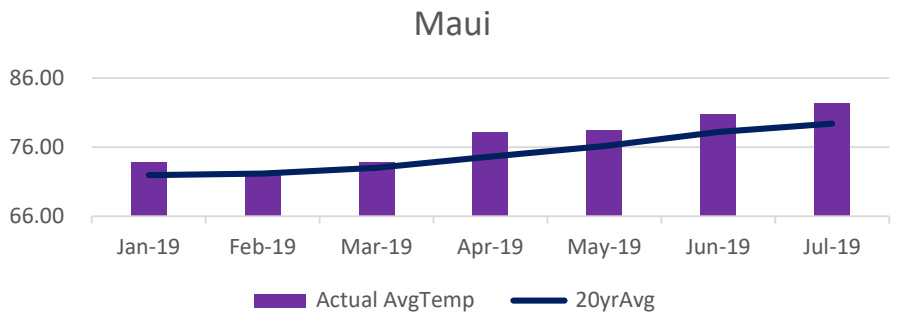


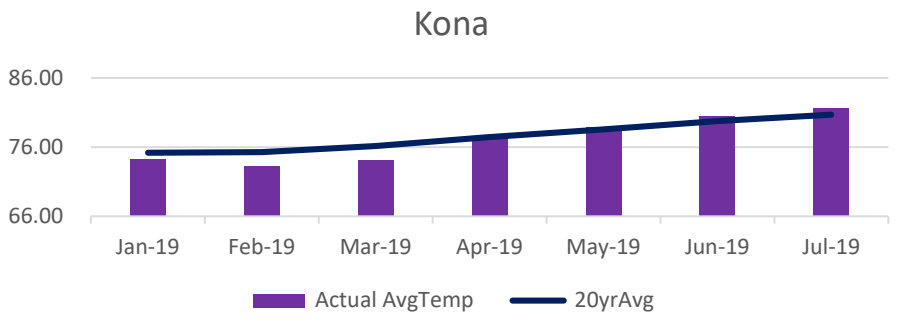


2019 Monthly Temperatures vs 20-Yr Average (Degrees Fahrenheit)







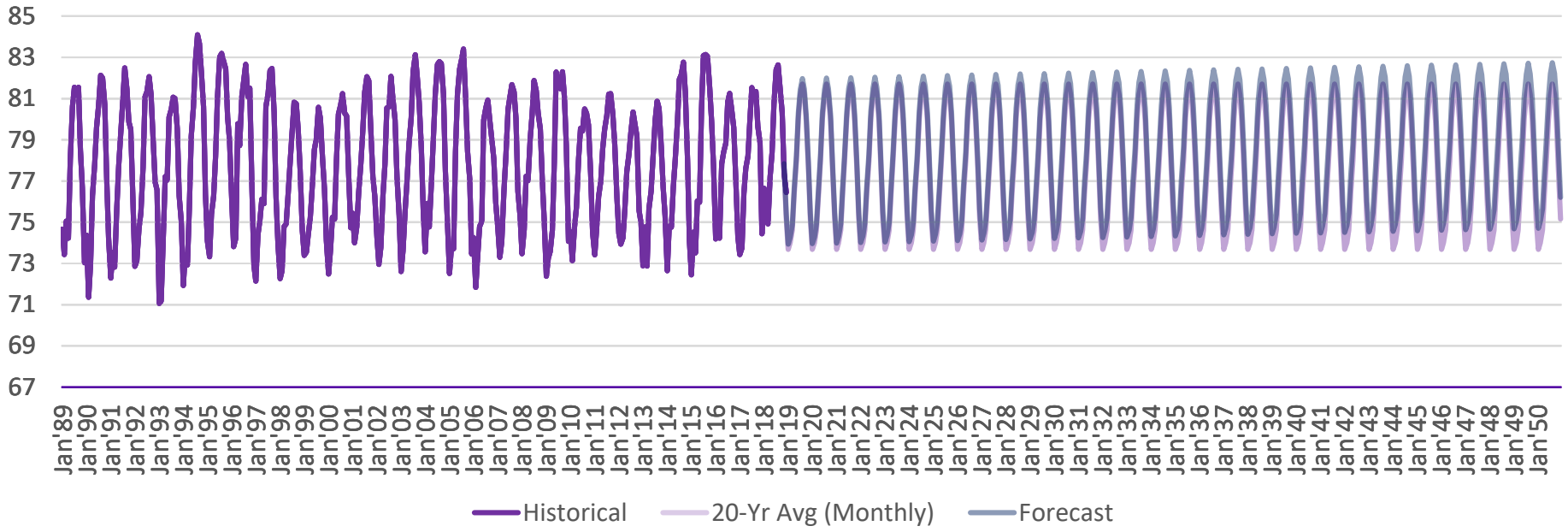


Weather Forecast Assumptions

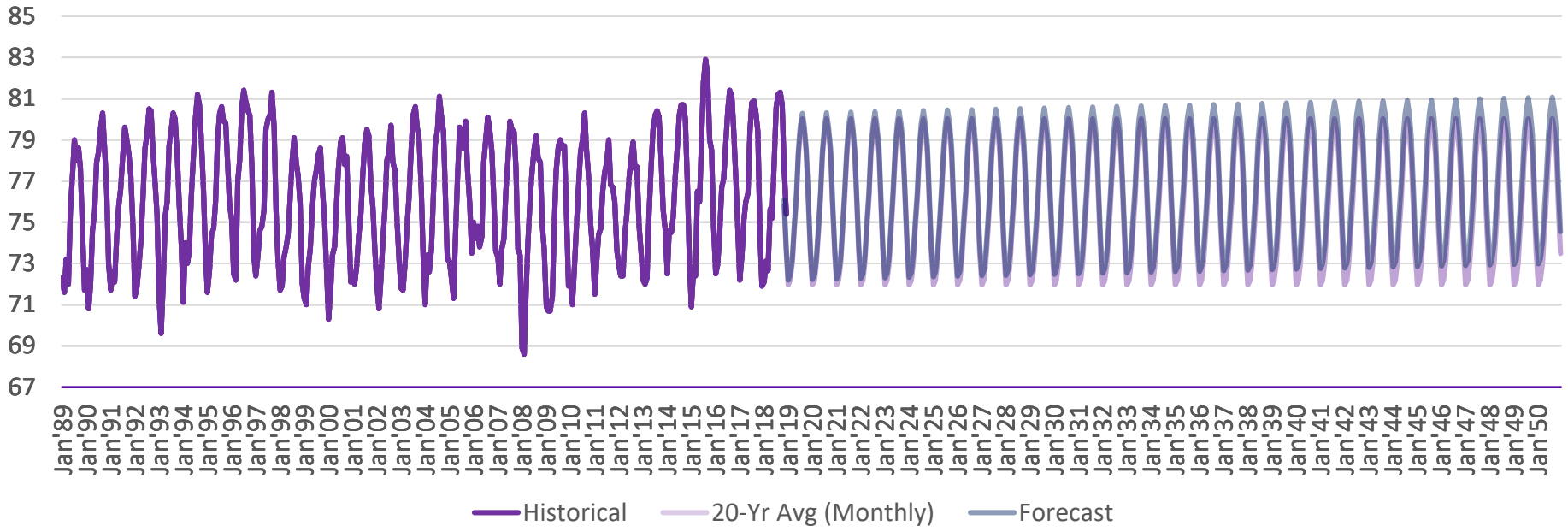
- Prior forecasts assumed a historical rolling average for weather variables for Oahu, Maui and Hawai`i Island
- Recognize that we should include some measure of climate change
- Analysis of historical trends by island resulted in a forecast assumption of 0.5 ˚F increase in average temperature every 20 years applied to the 20-year historical average
- NOAA *Regional Climate Trends and Scenarios for the U.S. National Climate Assessment, Part 8. Climate of the Pacific Islands*
  - Two future climate scenarios developed for the Hawaiian Islands
  - Includes analysis of average annual temperature in 2021-2050 compared to 1971-1999 base period
  - Both scenarios project a 1-2 °F increase in annual average temperature by 2035

"The resulting climate conditions are to be viewed as scenarios, not forecasts, and there are no explicit or implicit assumptions about the probability of occurrence of either scenario."
(p. 26, http://scenarios.globalchange.gov/regions/hawaii-and-pacific-islands)

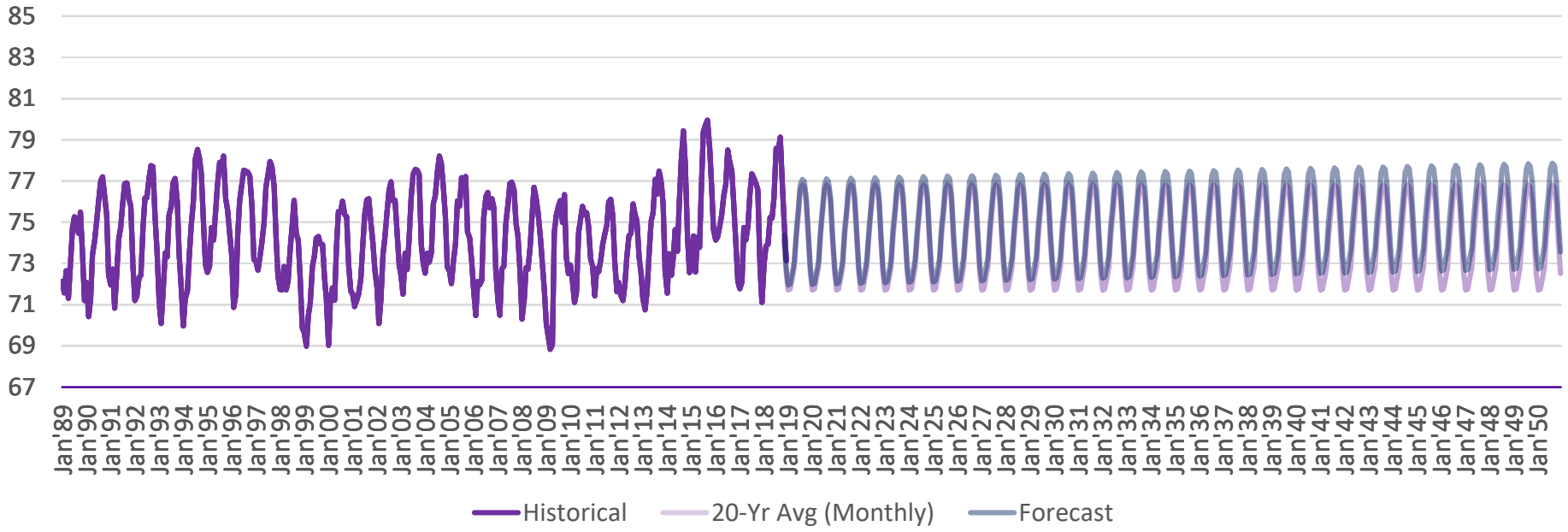
Oahu Average Temperature Forecast (Degrees Fahrenheit)



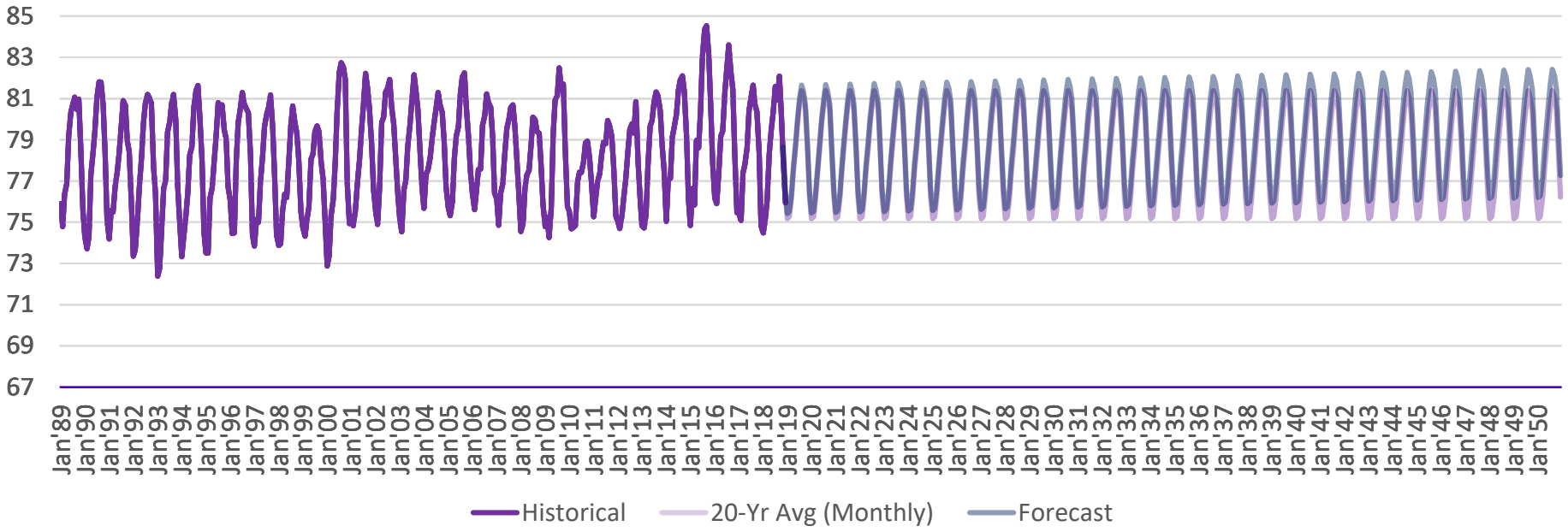
Maui Average Temperature Forecast (Degrees Fahrenheit)



Hilo Average Temperature Forecast (Degrees Fahrenheit)



Kona Average Temperature Forecast (Degrees Fahrenheit)



How Other Utilities Incorporate Climate Change

- Base Case
  - No assumption for climate change
  - Incorporate a rolling historical average calculated annually
  - Utilize a trended normal weather assumption to account for gradually warming temperatures
- Scenario that includes extreme weather

Electrification of Transportation

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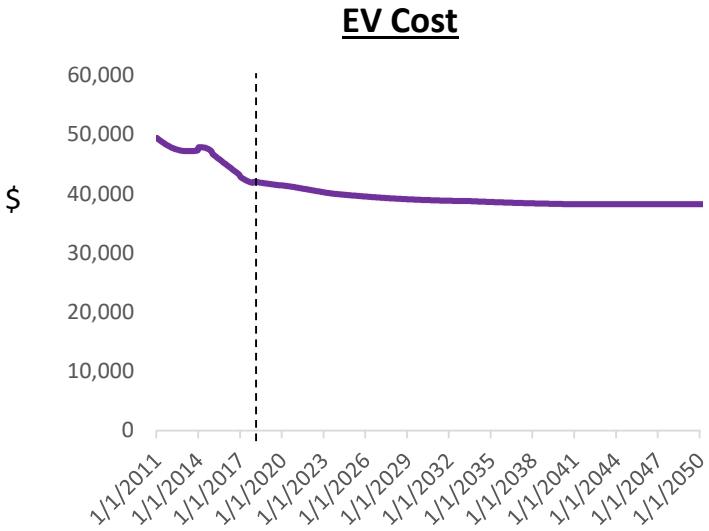
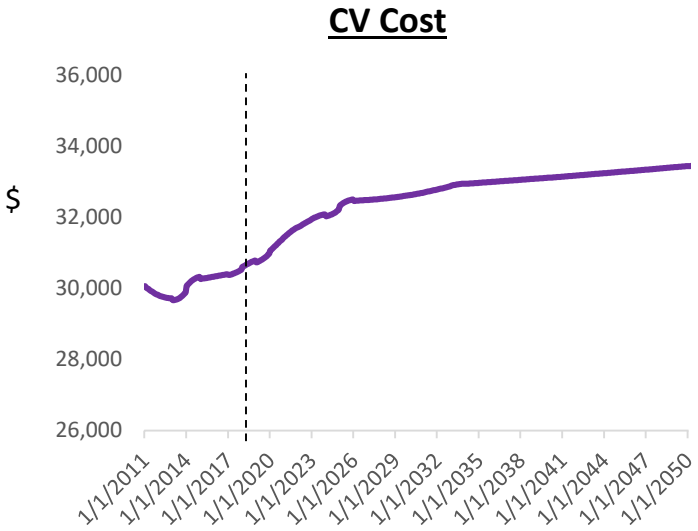
Inputs to the Light Duty Electric Vehicle ("EV") Forecast

- Number of light duty EVs
  - Vehicle Costs
  - Fuel Economy
  - Gas/Electricity Prices
  - Discounts
  - Income
  - PV Installations
  - Number of Charge Ports
- Total light duty vehicles
- Charging profiles

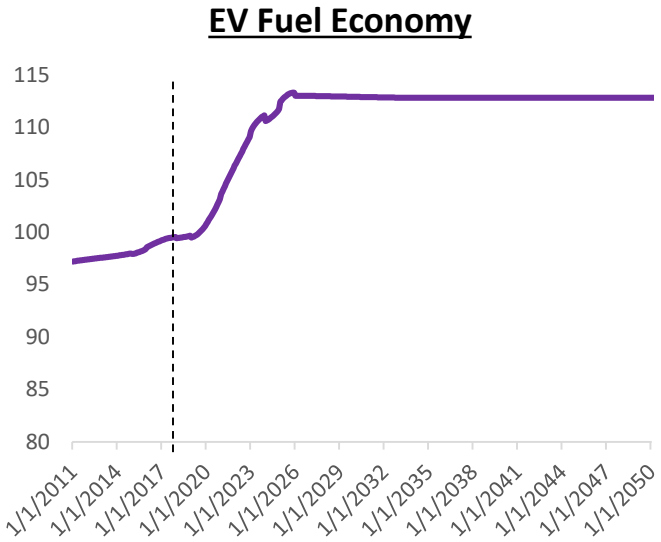
Vehicle Costs ($2018)

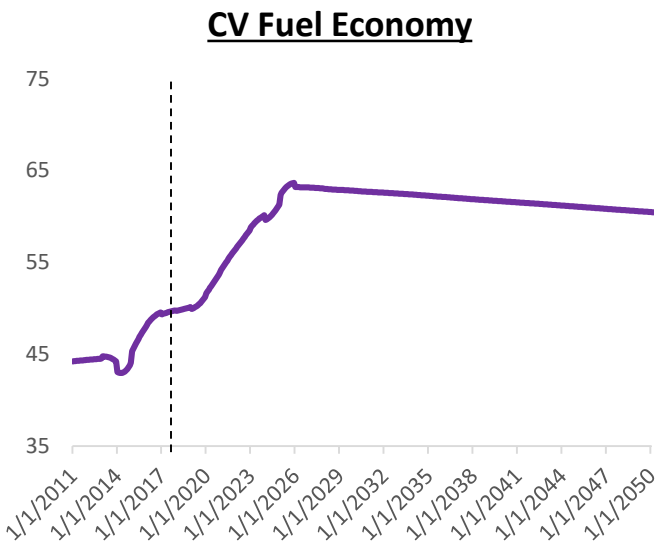




Source: Reference case EIA AEO 2019 Forecast

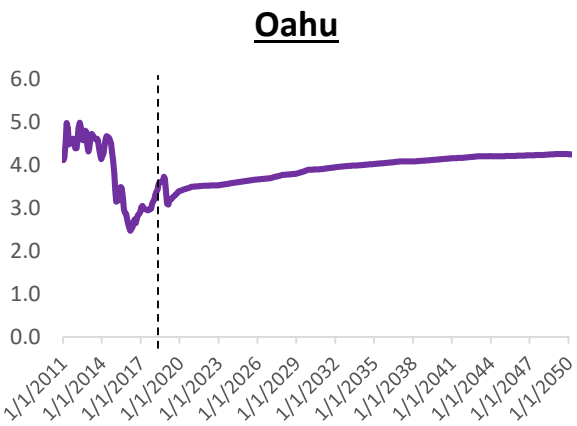
Fuel Economy (mpg/mpge)

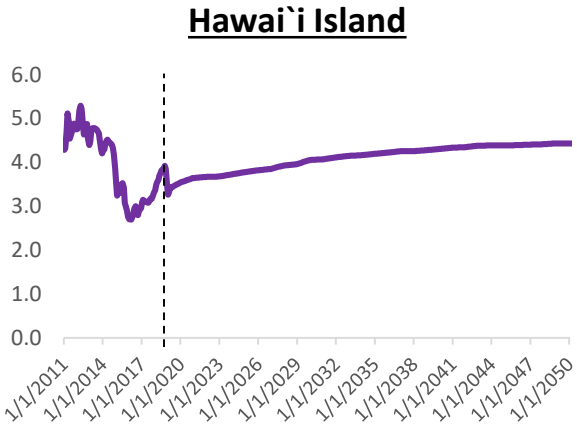


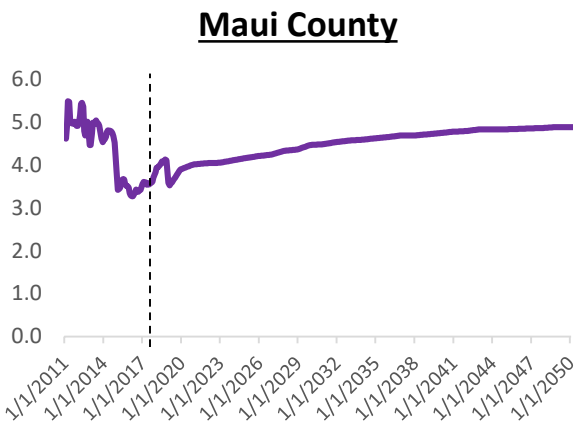


Source: EIA AEO 2019 Forecast

Gas Price ($/gal)

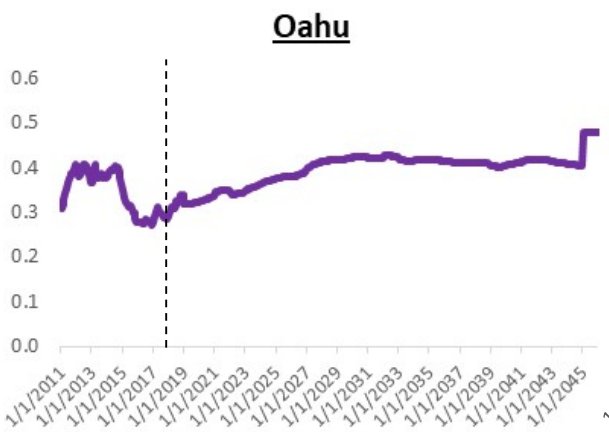


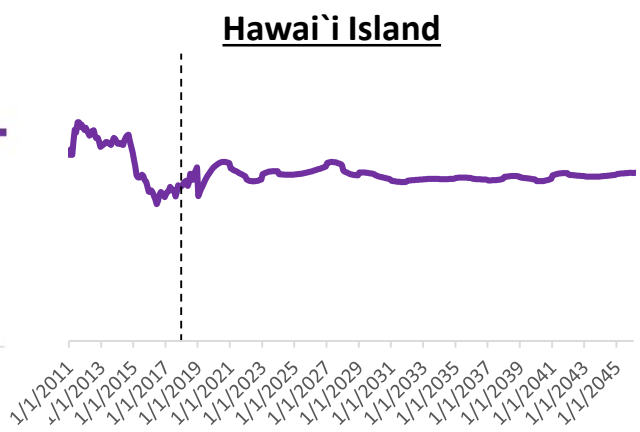


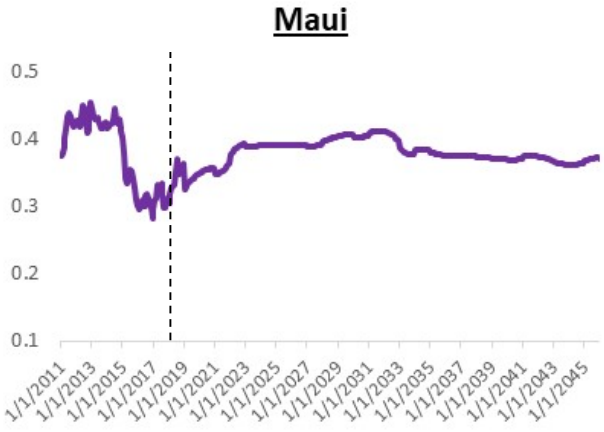


Source: EIA AEO 2019 Forecast

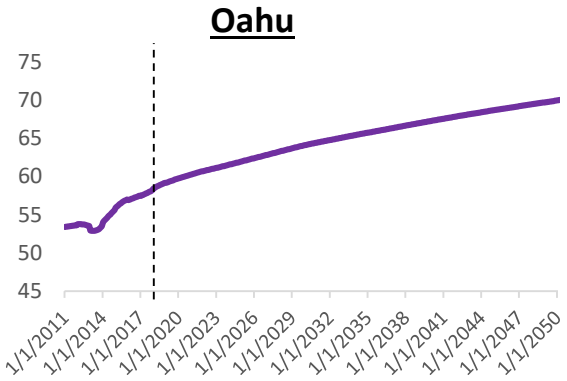
Electricity Price ($/kWh)

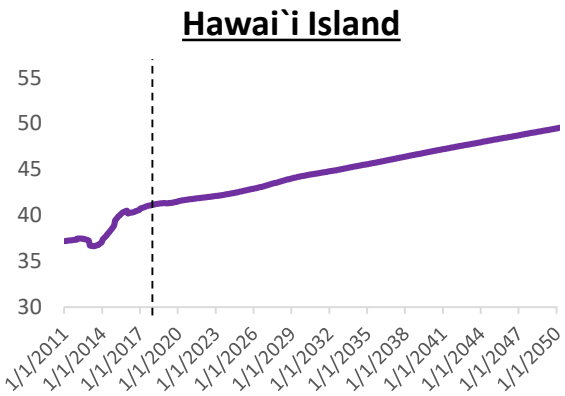


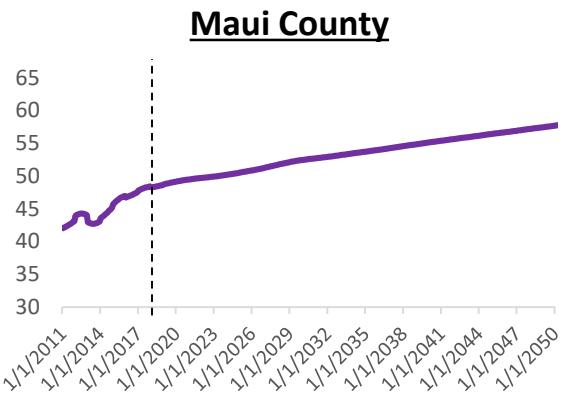




Income ($2018)

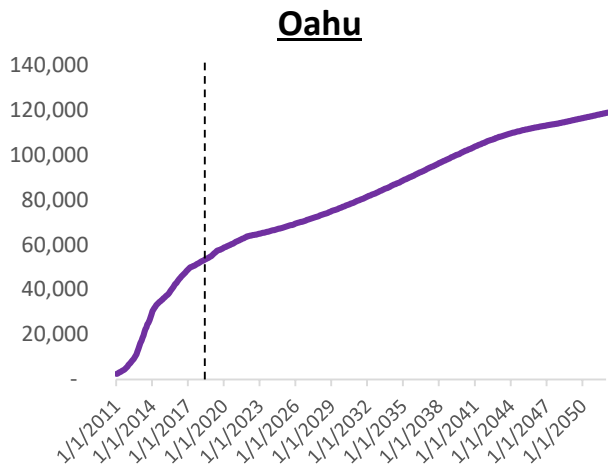


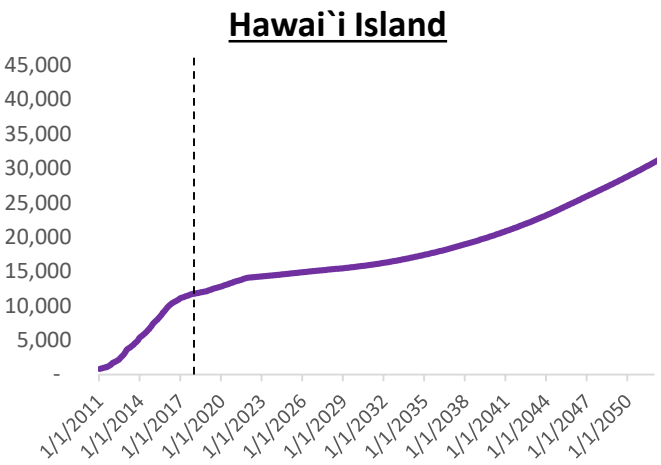


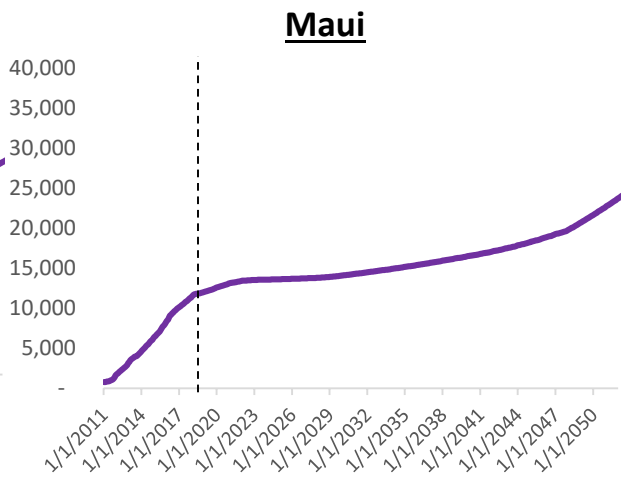


Source: UHERO’s 2019 Economic Forecast

PV Installations

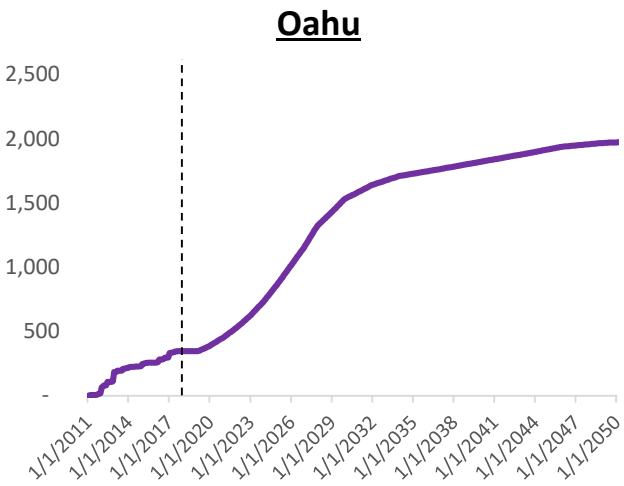


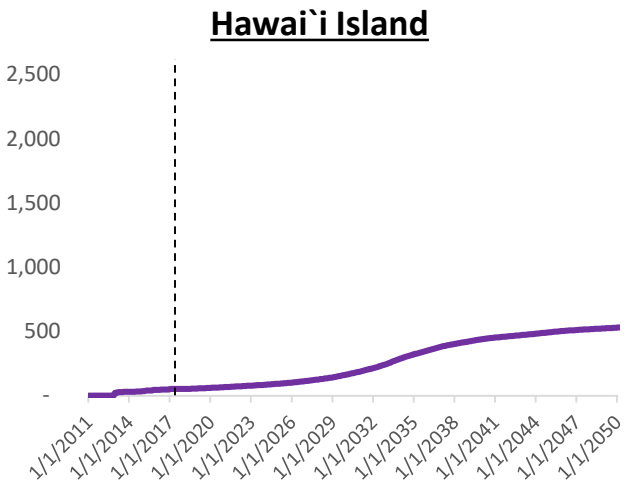


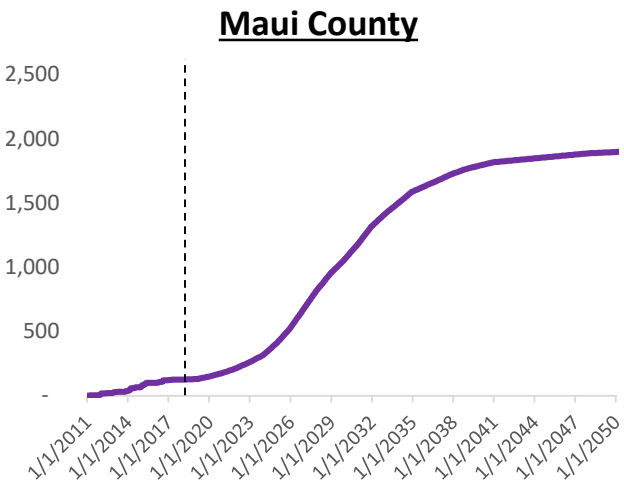


Will be updated with new forecast

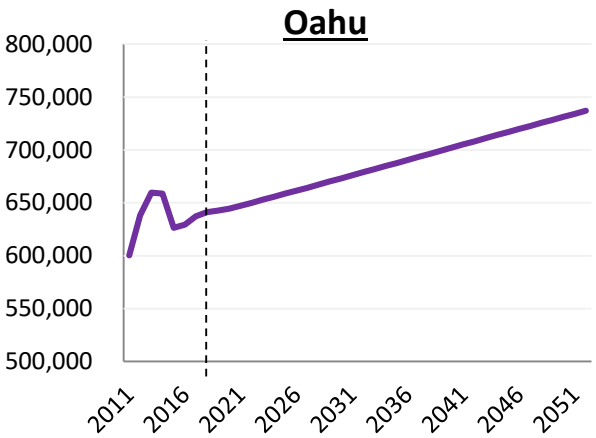
Charging Ports

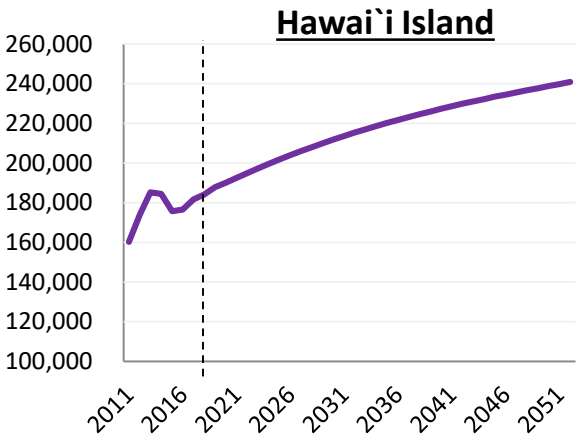


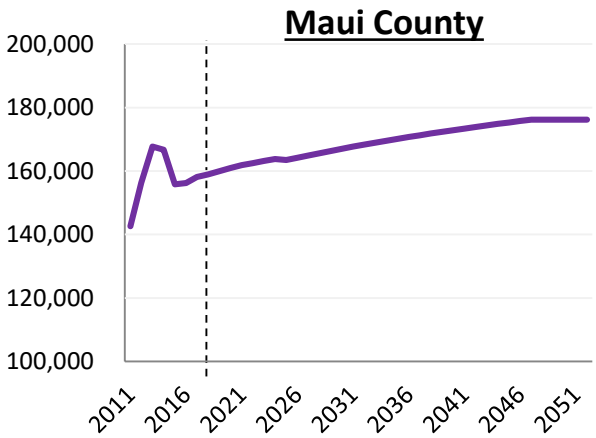




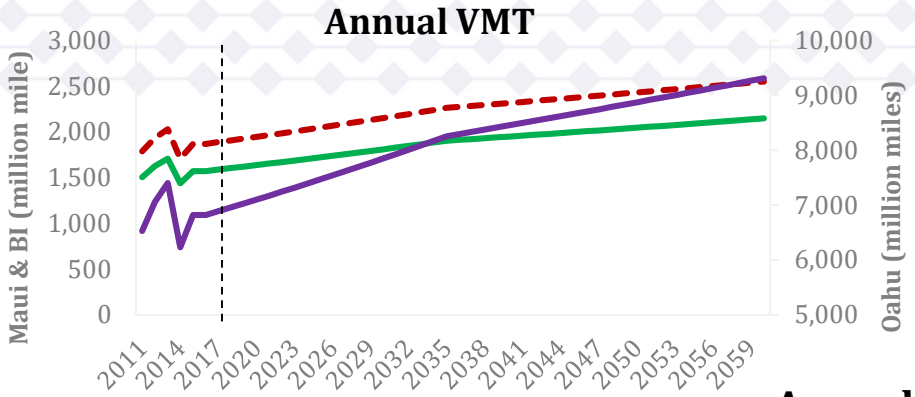
Total Light Duty Vehicles

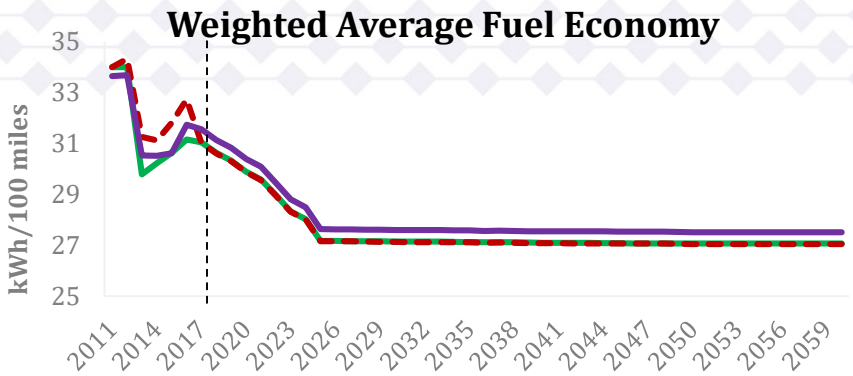


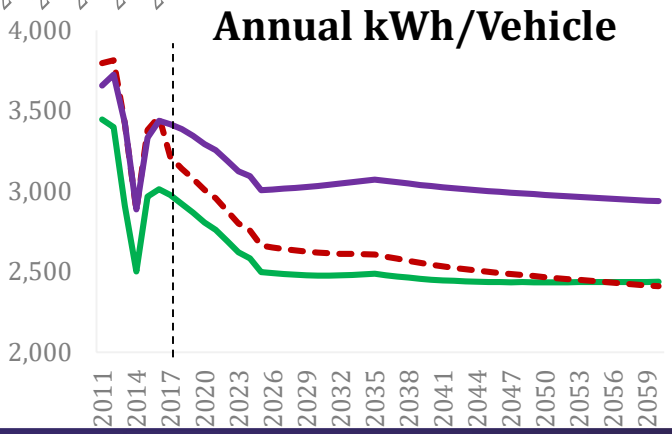




Inputs to EV Forecast







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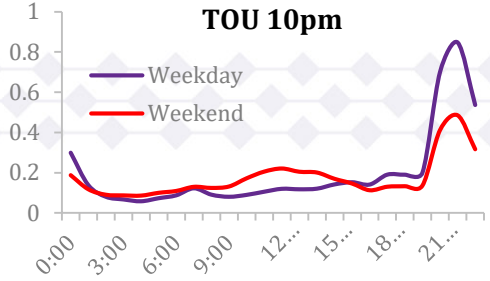
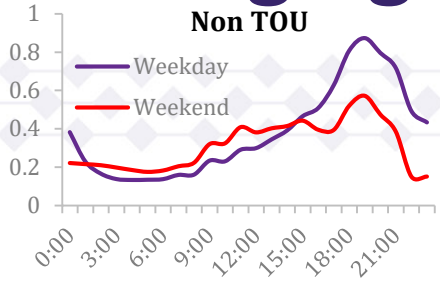
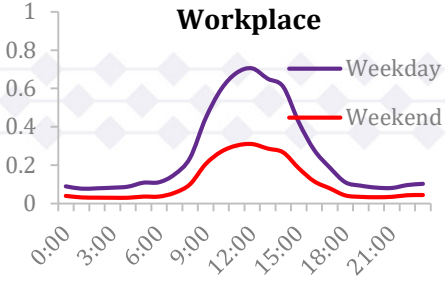
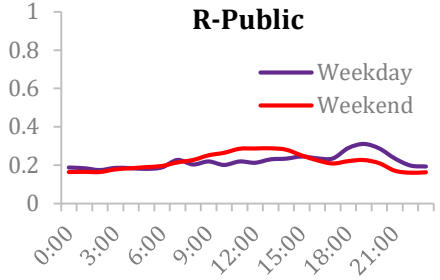
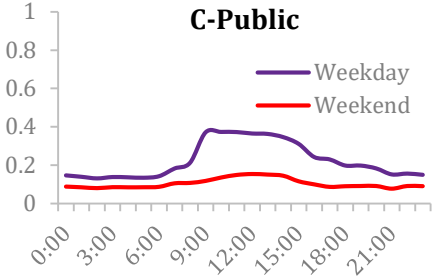
Average Charging Profiles

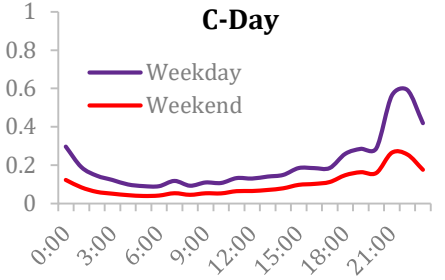


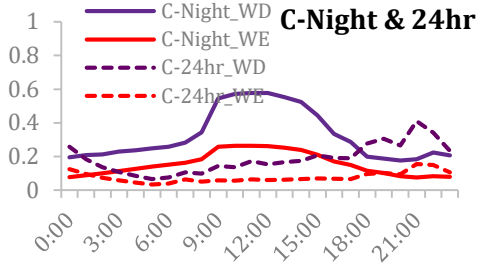


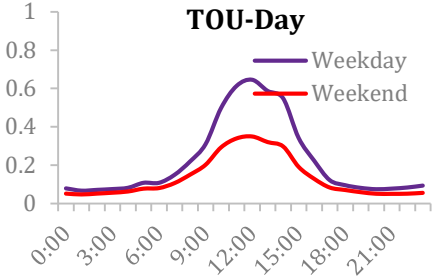


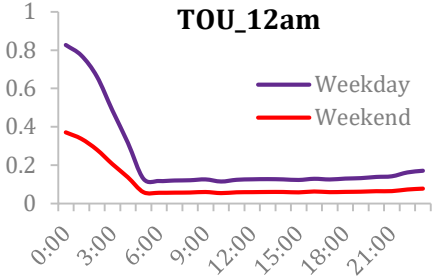










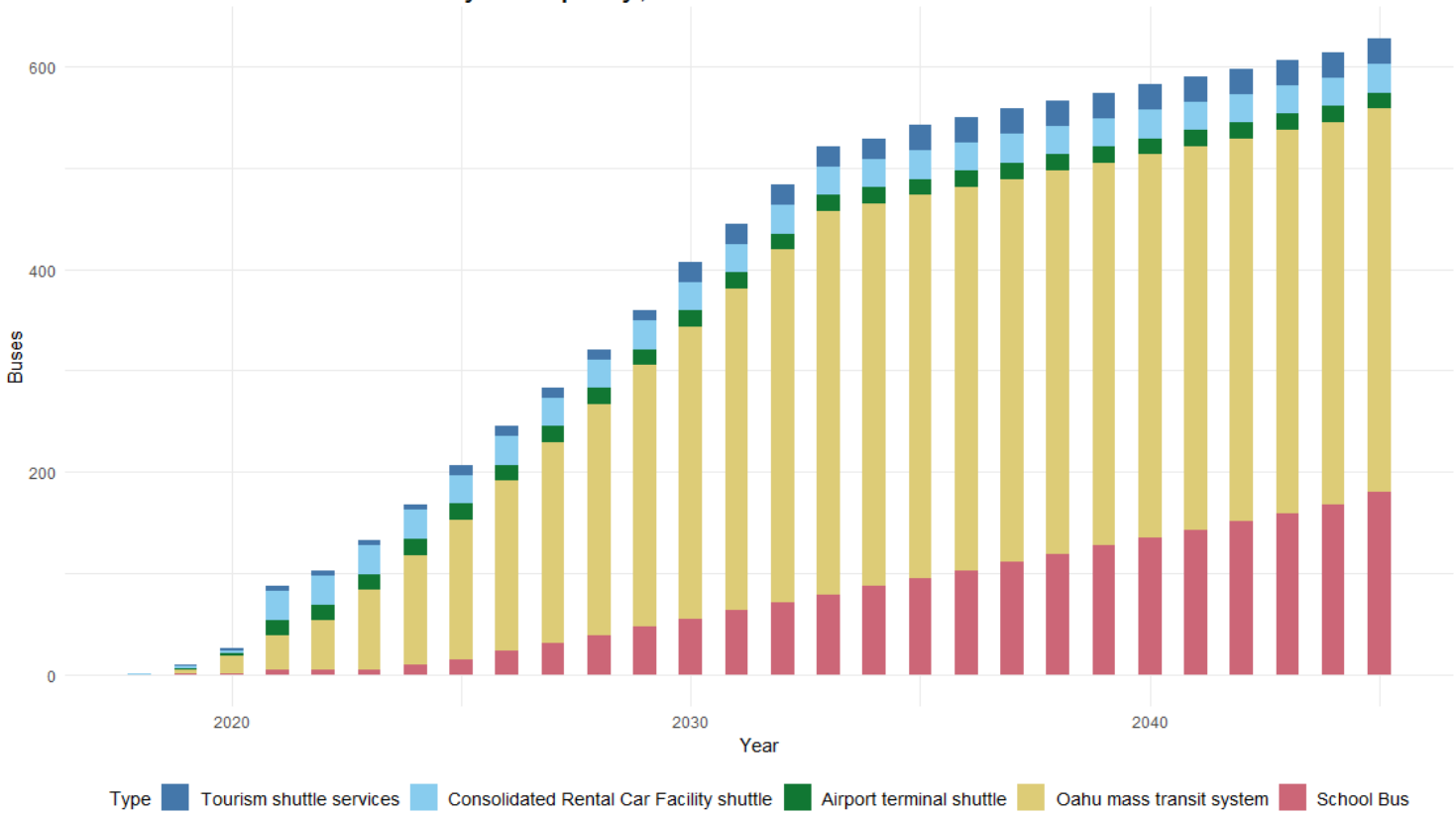


E-Bus Assumptions

- Number of buses per bus operator
- Route information/miles traveled
- Location of chargers
- Operating hours
- Technical specs (battery size, charging rate, kWh/mile)

Electric Bus Forecast

Annual EV Bus counts by company, 2018-2045



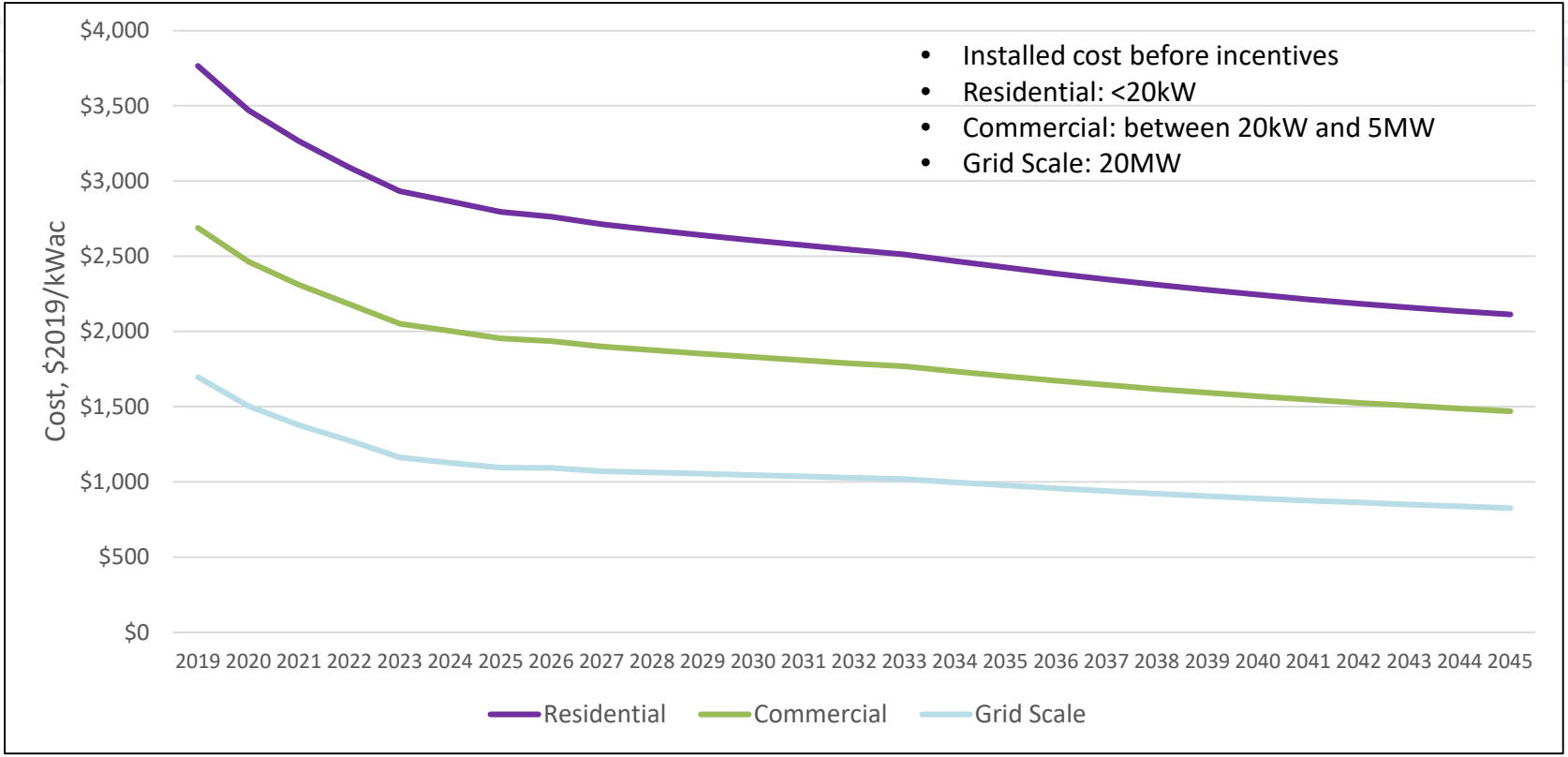
Distributed Energy Resources

Hawaiian Electric
Maui Electric
Hawai'i Electric Light

Inputs to DER Forecast

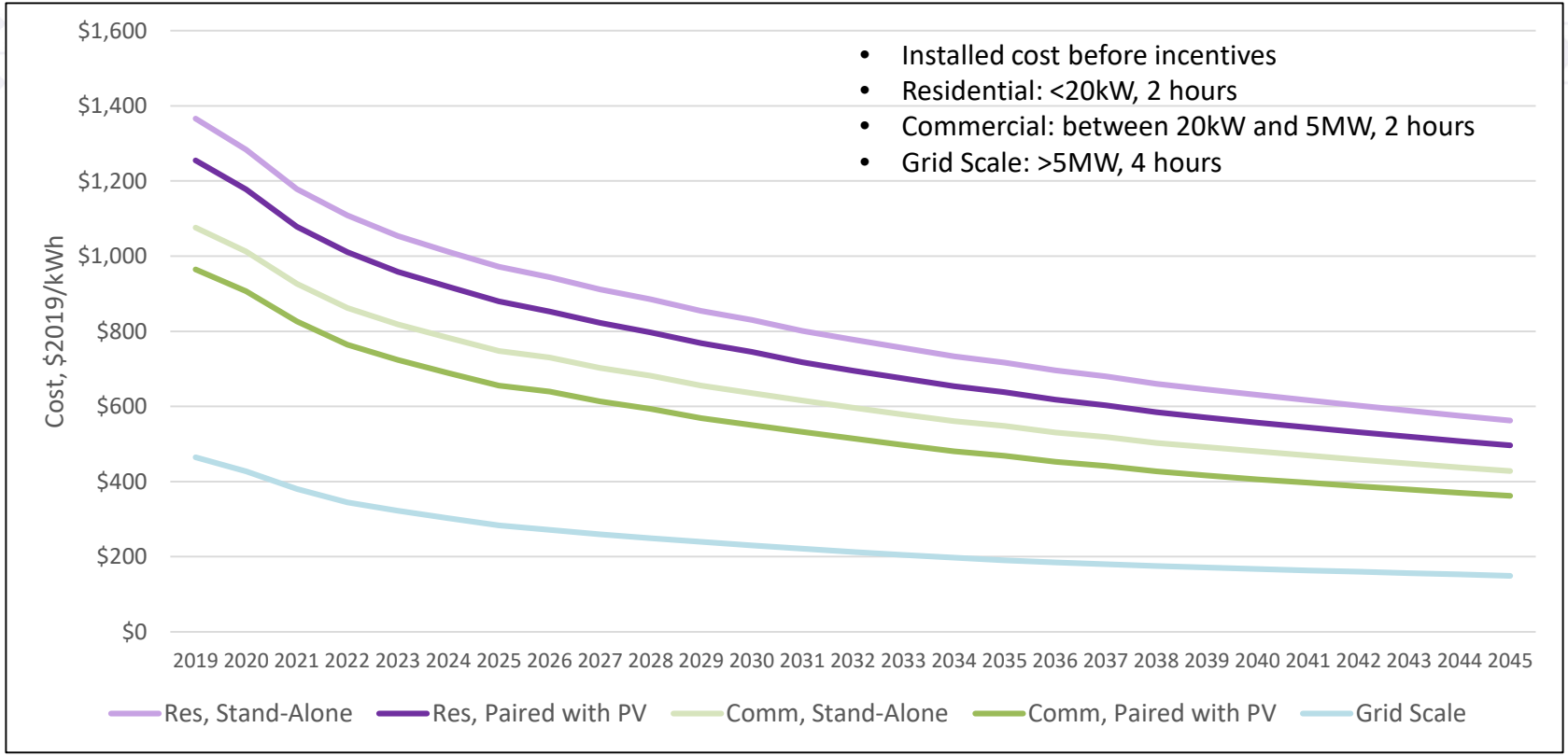
- Economic assumptions
  - PV and battery installed costs
  - Incentives
  - Electricity price
  - Program structure
  - Panel degradation, maintenance and replacement
- Addressable market
- Solar resource assumptions
  - Unitized generation profiles
  - Capacity factors

Solar PV Cost Projections, Real Dollars

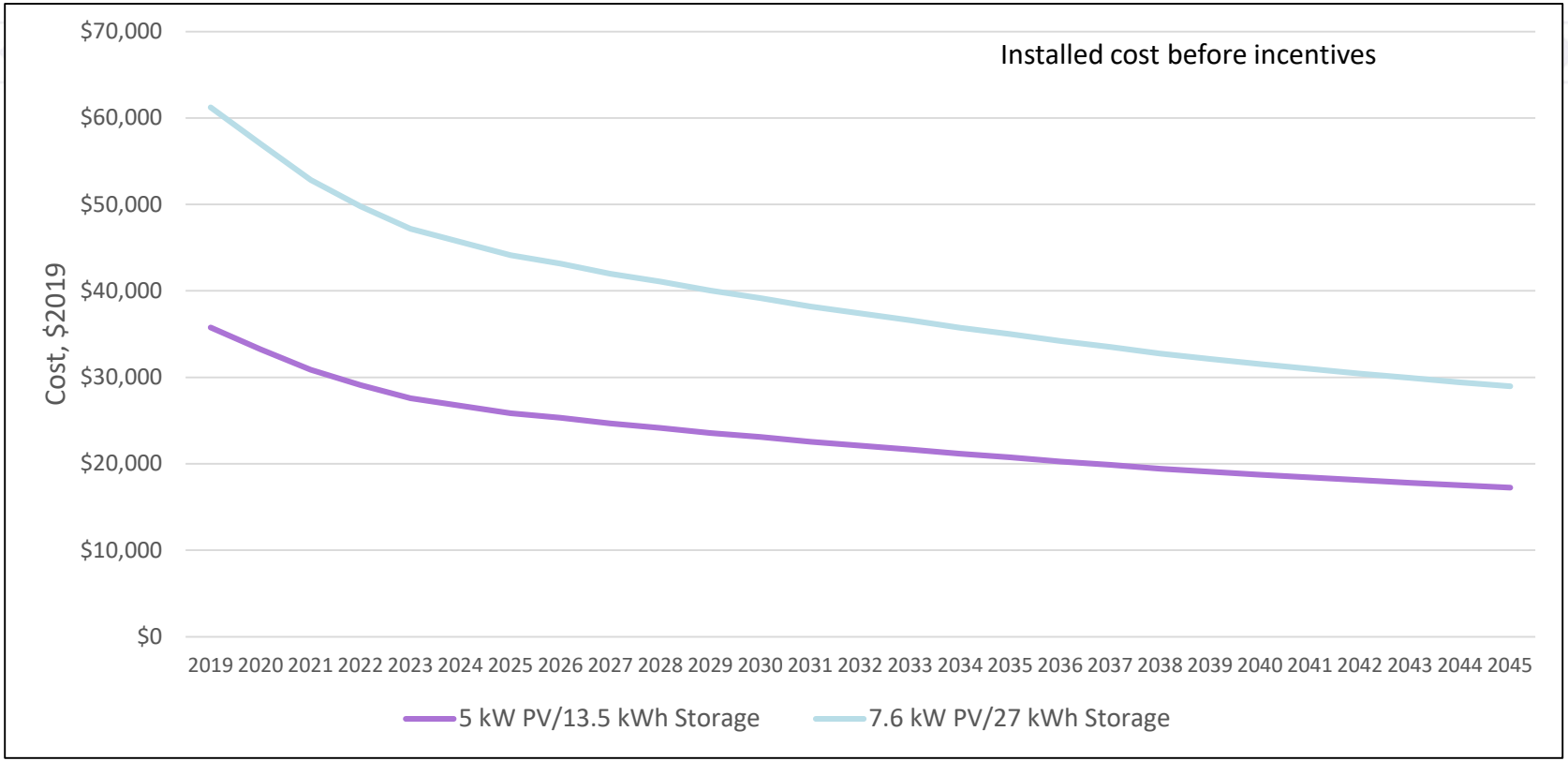


- Installed cost before incentives
- Residential: <20kW
- Commercial: between 20kW and 5MW
- Grid Scale: 20MW

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

Future Program Structures

- Standard interconnection agreement (SIA) utilized by large commercial customers with load exceeding potential on-site PV generation
- Standard DER Tariff
  - Time-variant compensation for export aligned with system needs
  - Controllable by utility for system stability emergency
- CBRE forecast: Actual project proposals and programmatic targets
- 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%
Hawai`i	40%
Maui	43%

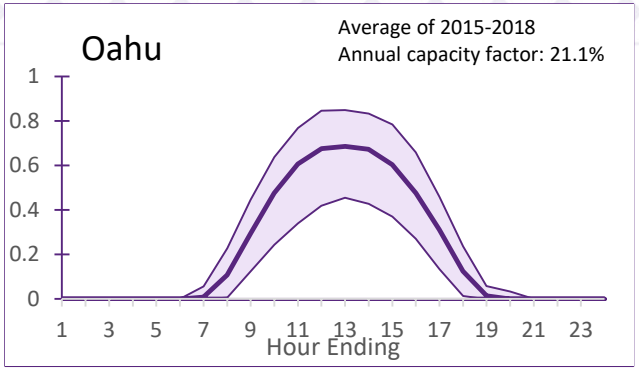
- Commercial Rate Classes
  - Private and public ownership
  - Exclude structures with >6 stories
  - Small and medium commercial consumption above threshold

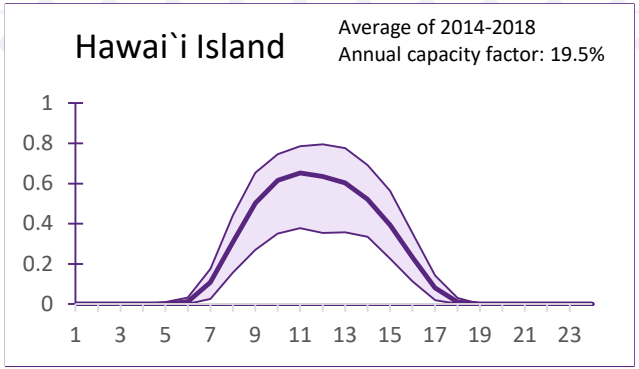
Island	Percent of G Customers	Percent of J Customers	Percent of P Customers
Oahu	37%	53%	110%
Hawai`i	35%	68%	110%
Maui	41%	63%	110%

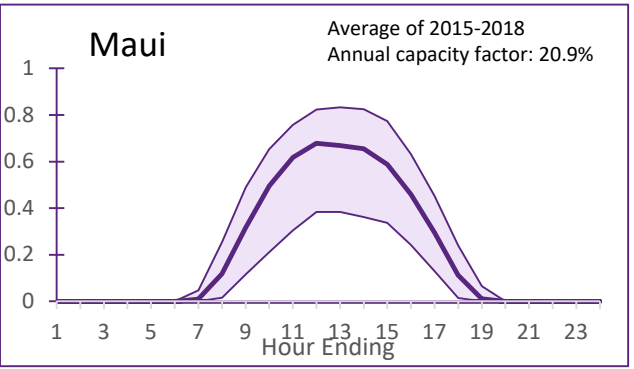
Panel Degradation, Maintenance, Replacement

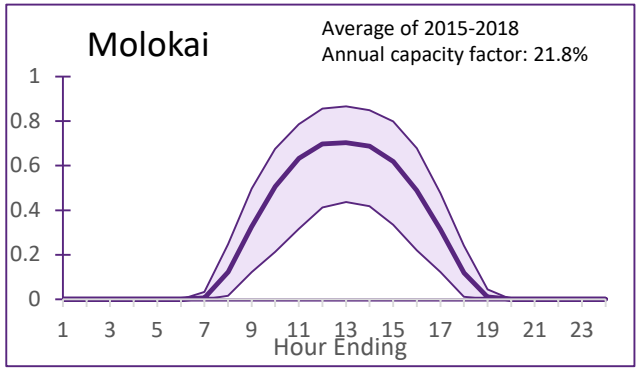
- PV system
  - Output degrades at rate of 0.5% per year
  - No removal or replacement
  - Maintenance cost is 1% of capital investment per year
- Battery replacement after 15 years in service

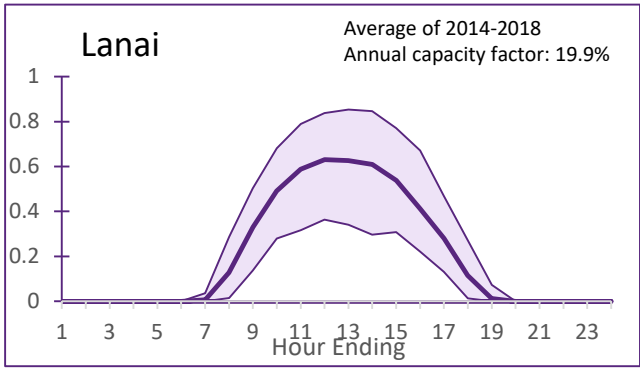
Solar Resource Unitized Profiles (kWh/kW)











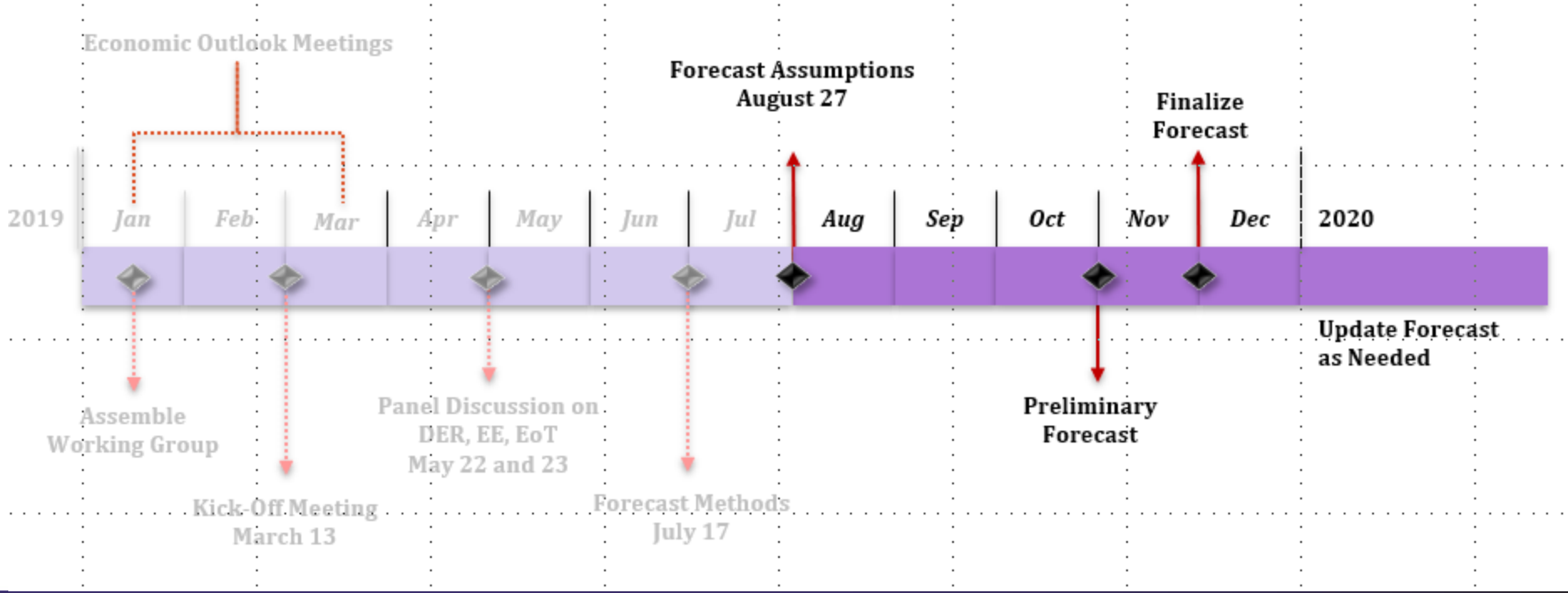
Forecast and Planning Assumptions

◆ Welcome and Overview	8:30 - 8:40
◆ Underlying Forecast Assumptions	8:40 - 9:30
– Economic Drivers	
– Electricity Price Forecast	
– Weather	
◆ Break	9:30 - 9:40
◆ Electrification of Transportation Assumptions	9:40 - 9:55
◆ Distributed Energy Resources Assumptions	9:55 - 10:15
◆ Break	10:15 - 10:30
◆ Breakout Session	10:30 - 11:25
◆ Break to grab a bento	11:25 - 11:45
◆ Continue Breakout Session	11:45 - 12:35
◆ Break	12:35 - 12:45
◆ Report on Breakout Session	12:45 - 1:25
◆ Wrap-up	1:25 - 1:30

Next Steps

Hawaiian Electric
Maui Electric
Hawai'i Electric Light

Next Steps


Economic Outlook Meetings
Forecast Assumptions
August 27
Finalize
Forecast
2019
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2020
Update Forecast
as Needed
Assemble
Working Group
Kick-Off Meeting
March 13
Panel Discussion on
DER, EE, EoT
May 22 and 23
Forecast Methods
July 17
Preliminary
Forecast


Mahalo!
Hawaiian Electric
Maui Electric
Hawai'i Electric Light