Interaction of EVs In a High Renewables Island Grid


iTEC IEEE

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HNEI
Hawai'i Natural Energy Institute
University of Hawai'i at Mānoa

EVTC
Electric Vehicle Transportation Center

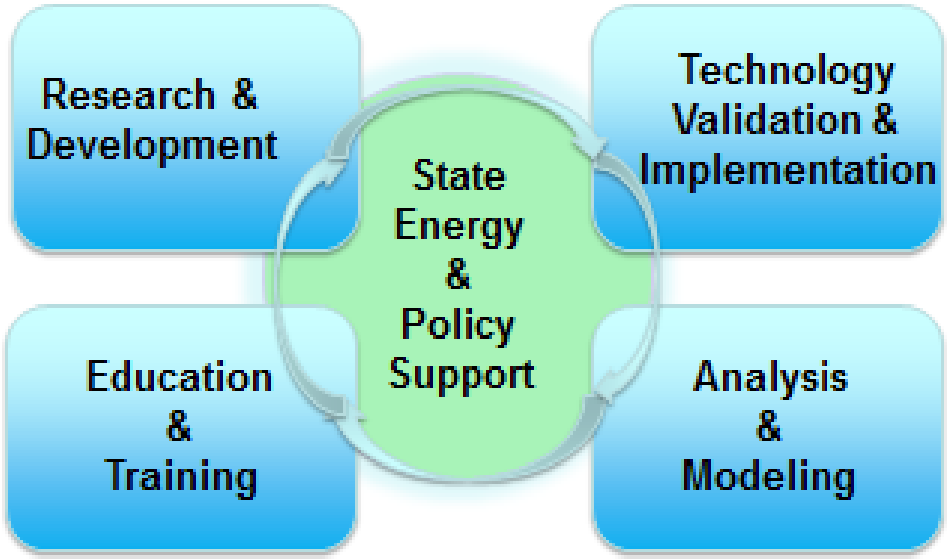
UNIVERSITY of HAWAI'I
MĀNOA

Hawaii Natural Energy Institute

- At the University of Hawaii Manoa
- Established by the Legislature in 2007
- HNEI leads many significant public-private partnerships focused on the development, testing & evaluation of emerging energy technologies to reduce Hawaii's dependence on fossil fuels

Programs:

- Alternate fuels
- Renewable generation
- Fuel cells & batteries
- Energy efficiency & Transportation
- Grid Integration



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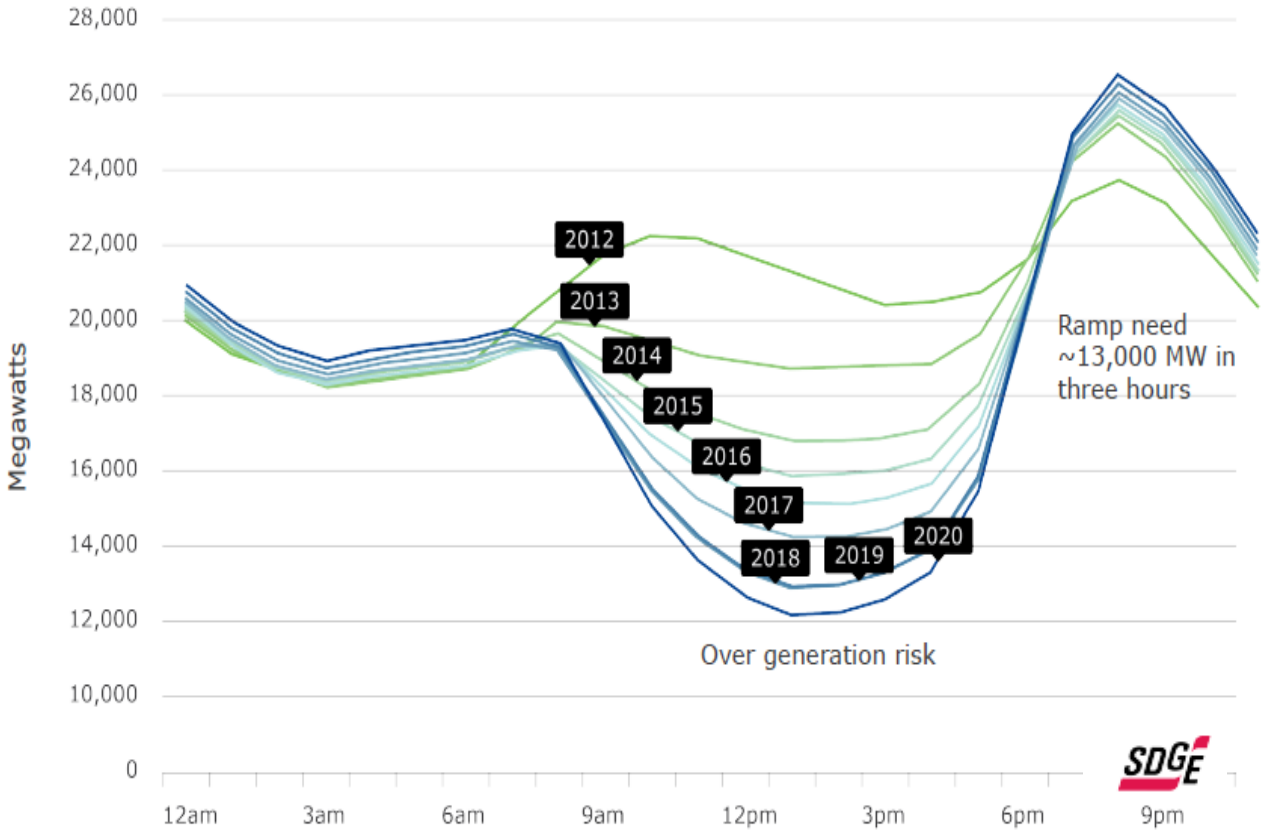
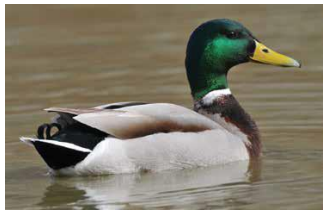
Objectives

1) Renewable Portfolio standards

- 30% by 2020
- 40% by 2030
- 70% by 2040
- 100% by 2045

2) Straighten the Duck Curve





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Electric Vehicle Transportation Center (EVTC)

HNEI is partnering with the *Florida Solar Energy Center* on a US DOT program to transform the country's transportation network into a fully integrated 'smart' EV deployment coupled with a 'smart' electric grid.

HNEI's focus is the technical and economic benefits and challenges of EVs on an electric grid characterized by high penetration of intermittent renewable energy.

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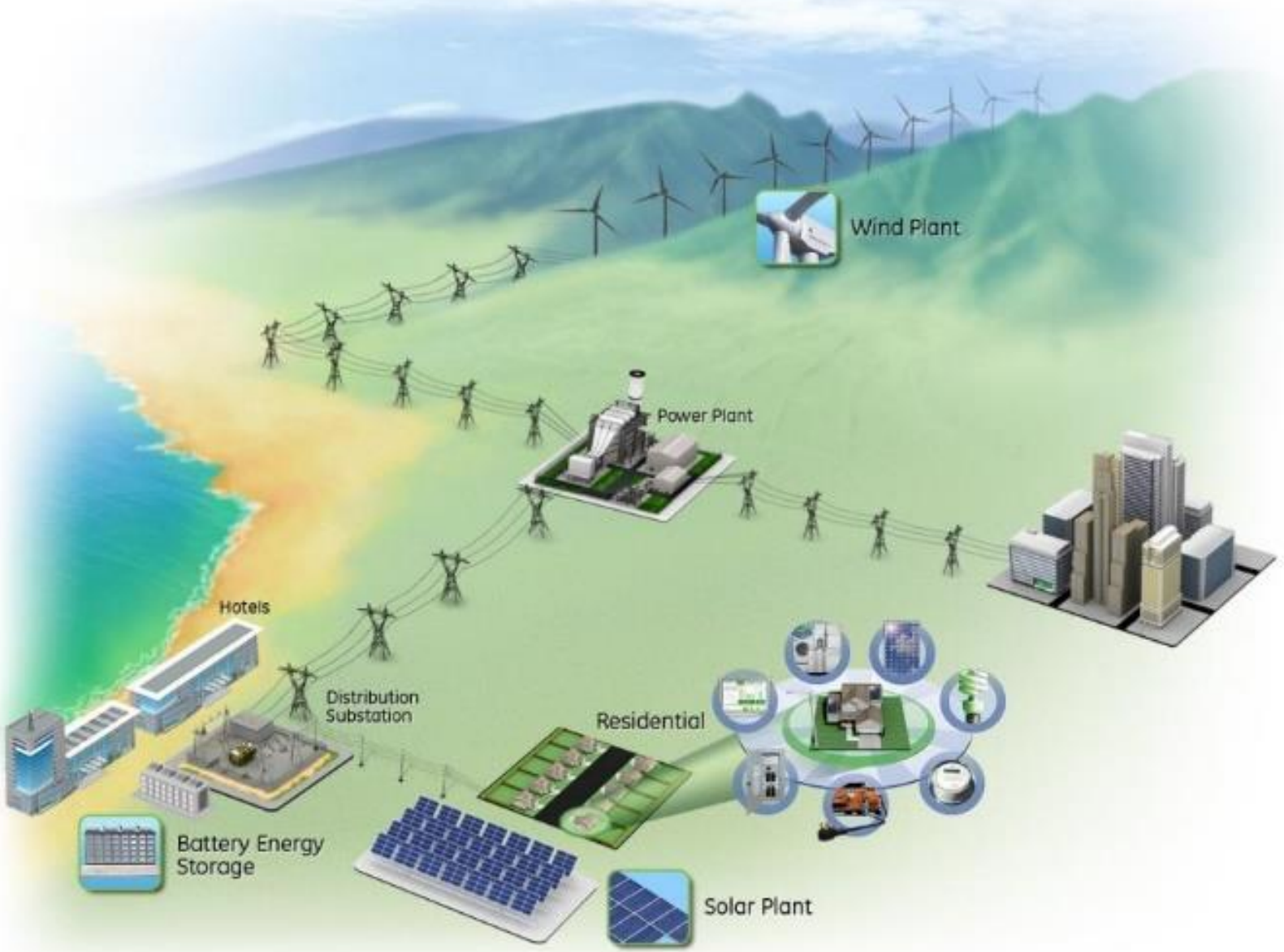
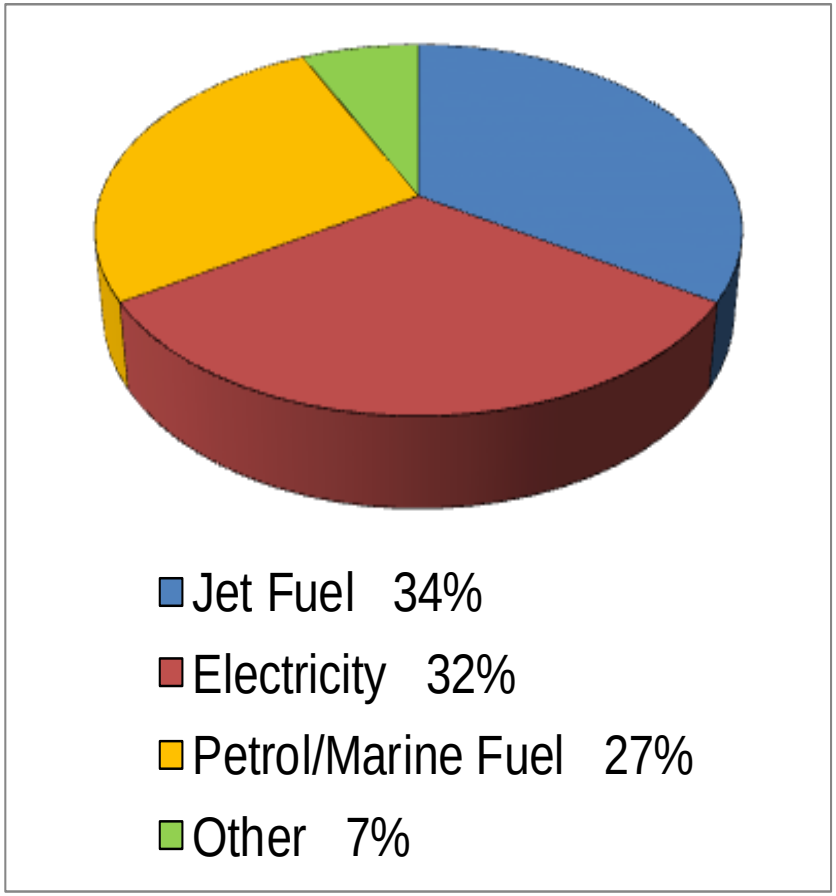
FSEC™

EV Integration on the Grid



Hawaii Today

- **All fossil fuels imported**
- **77% of electricity is fossil**
- **Electricity costs over time follow oil cost**
- **Highest electricity rates in the US at $0.28 per kWh**
- **Renewable produced 23% electricity**



Petroleum use in Hawaii

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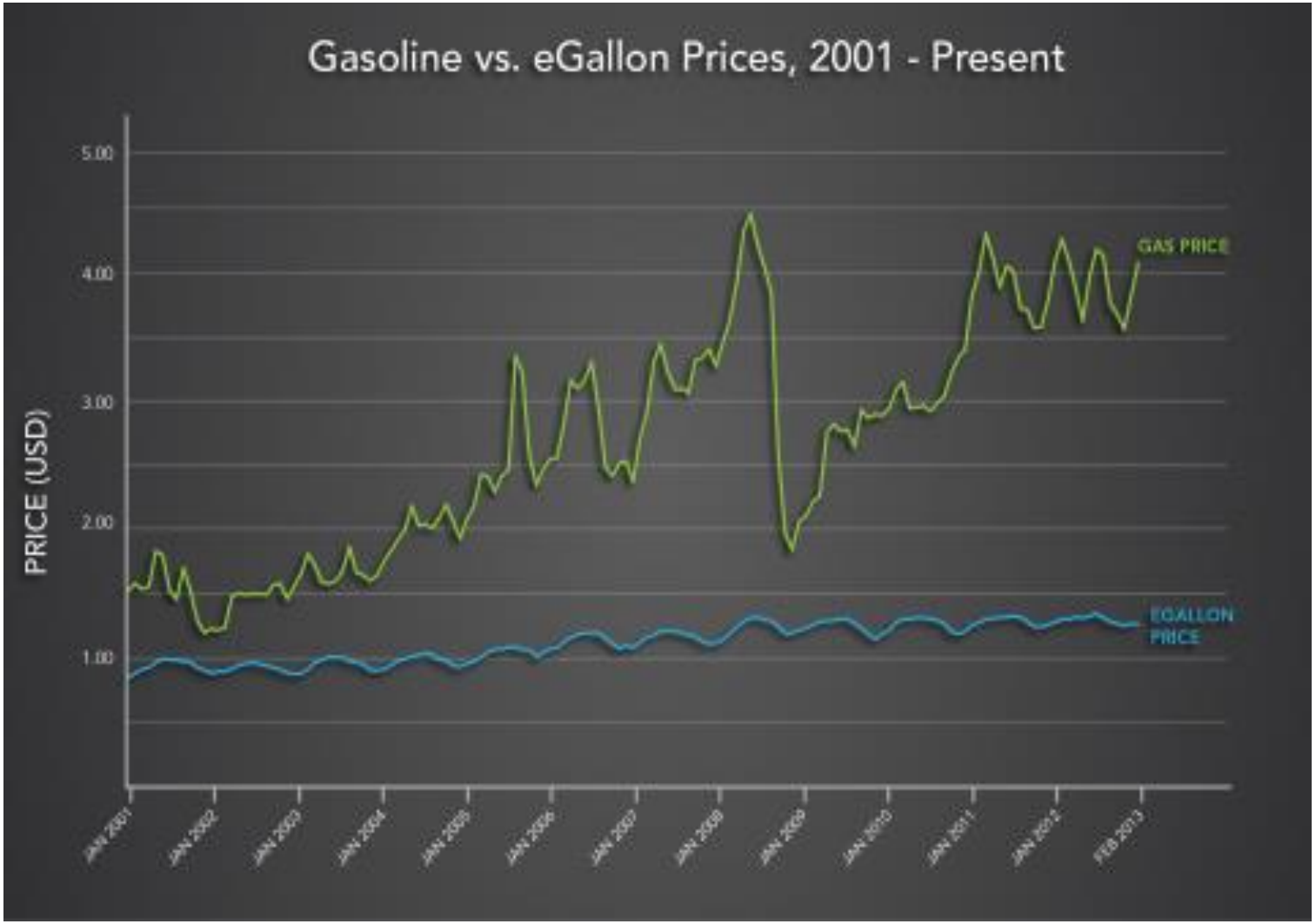
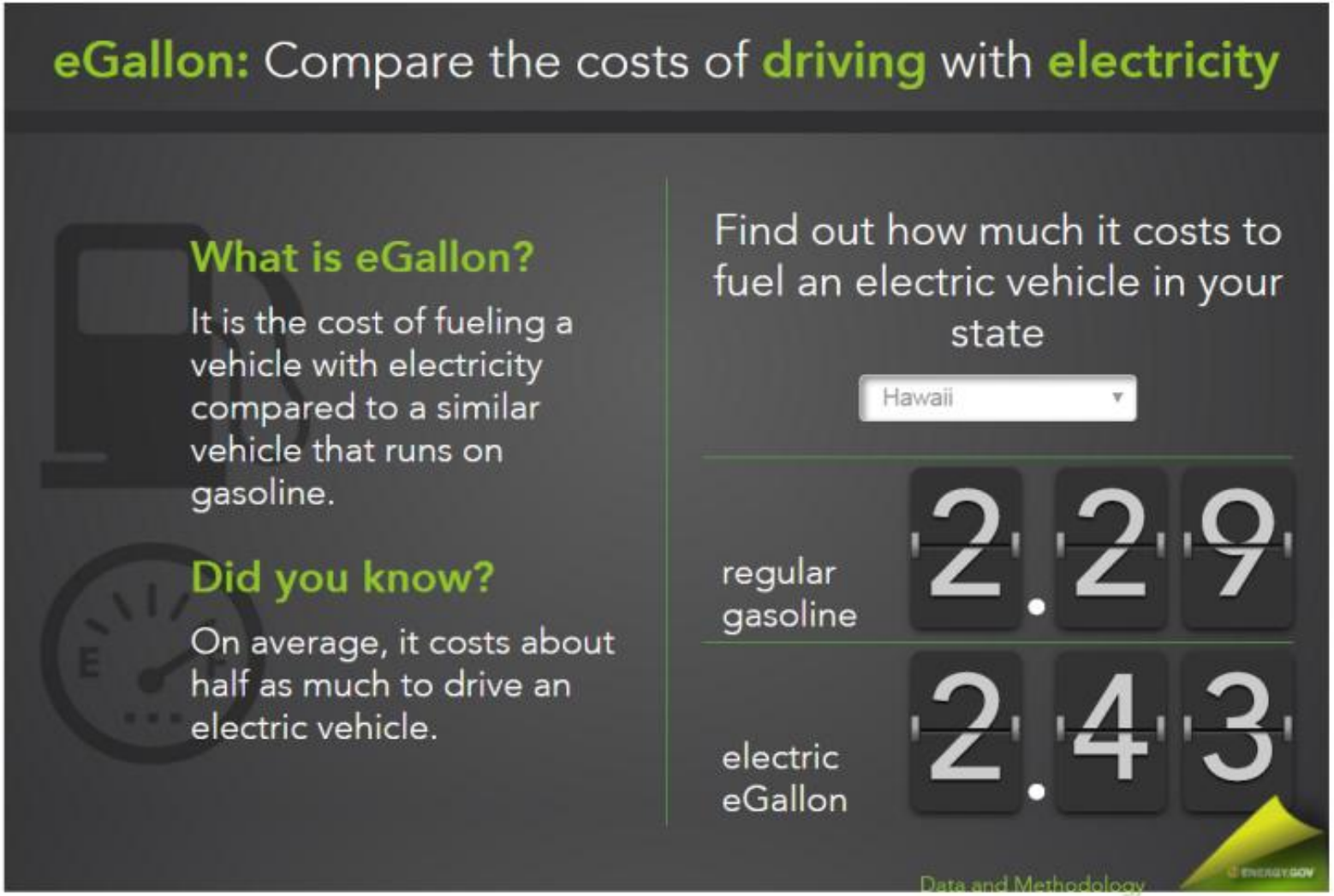
Hawaii's Electric Rates Track Oil Prices



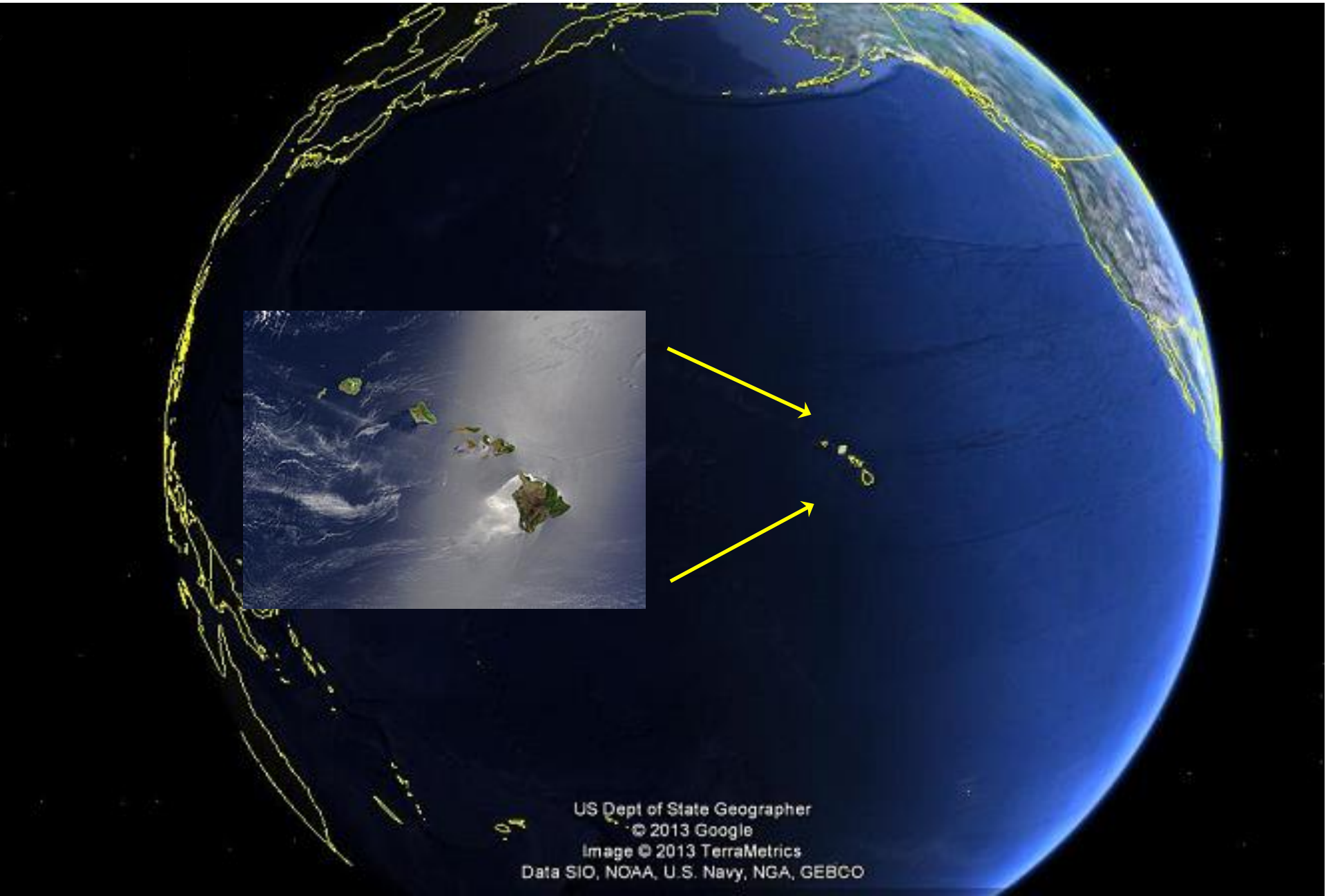
Source: US DOE online "eGallon"

Even with the low price of oil…



Source: US DOE eGallon (May 2016)

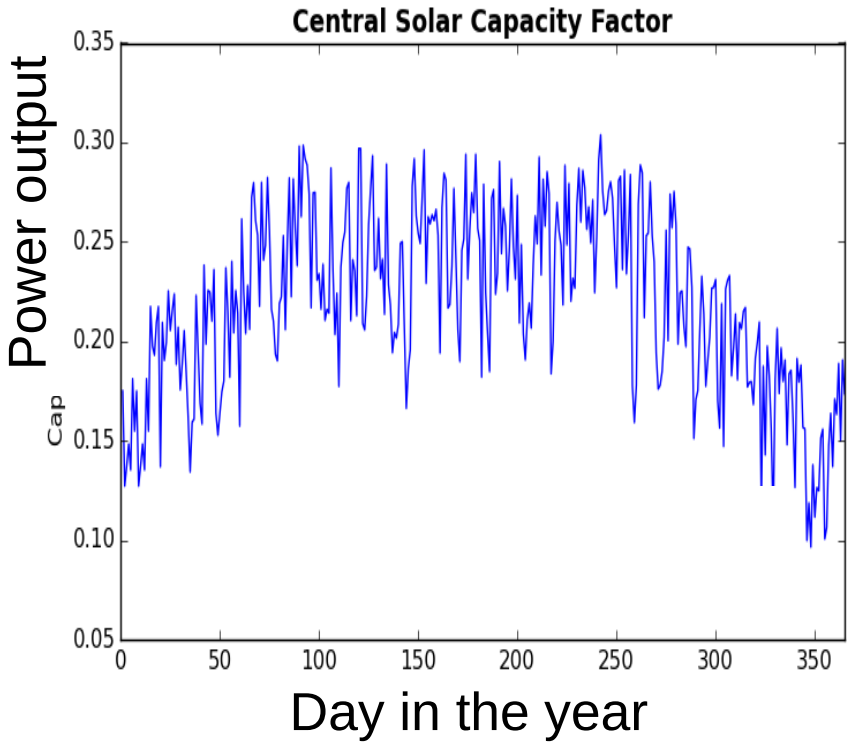
Why Hawaii for EV/Grid Integration?



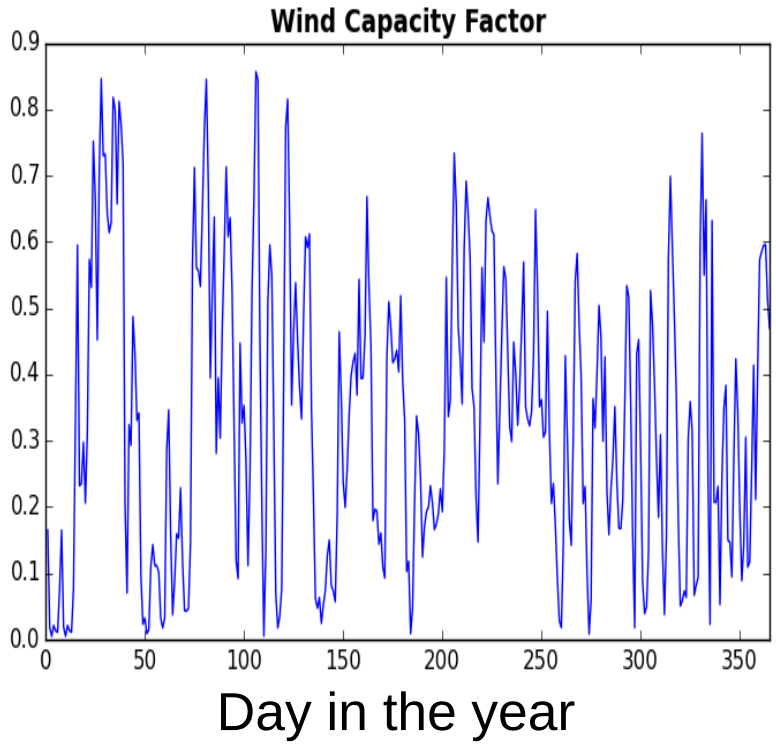
Wind and Solar Resources

High day-to-day variation

Solar



Wind



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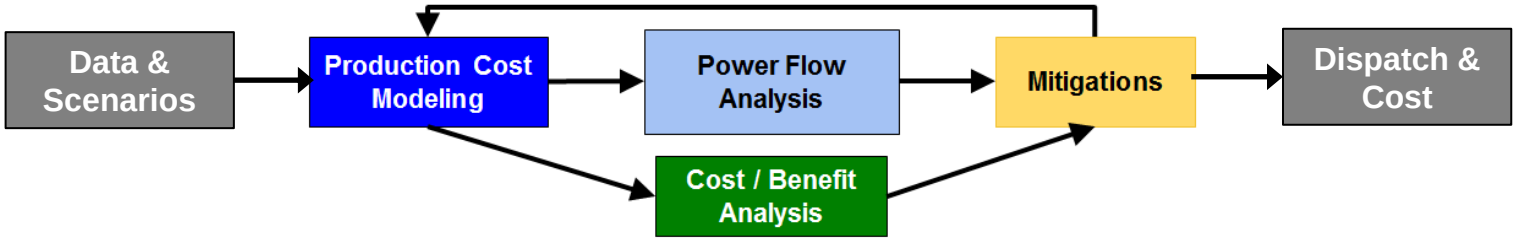
Pathway to a Renewable Energy Future

- **Develop models to evaluate future changes to Hawaii energy systems**
- **Identify strategies to maximize use of renewable generation**
- **Estimate costs and impacts to state economy.**

Use quantitative analysis to inform policy.

HNEI-GE Modeling

- **GE Multi Area Production Simulation (GE MAPS) was used for power grid simulation; fuel use, reduction in wind and solar curtailment**

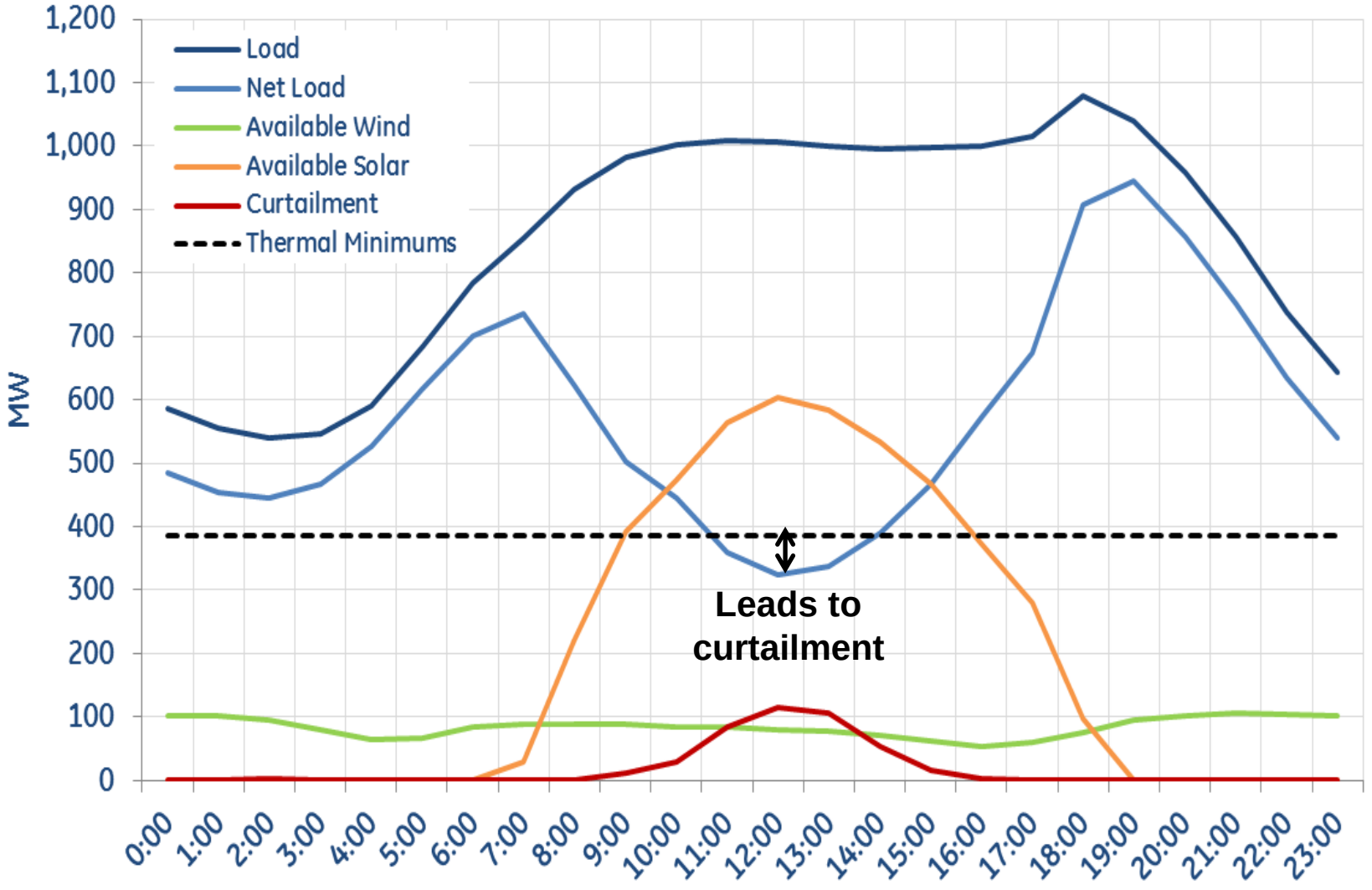


- **Potential, cost effective pathways to 40% wind plus solar identified**
- **“Advanced” mitigations needed for higher penetrations**

Hawaii's Renewable Portfolio Standards

- **30% by 2020**
- **40% by 2030**
- **70% by 2040??**
- **100% by 2045??**

24 Hour Load Profile with High Renewable Penetration



*Teach the Duck to Fly**

- ~~**Reduce renewable energy output**~~

  ~~**Option – curtailment**~~

- **Increase utility load midday**

  Option – charge electric EVs midday

- **Decrease utility load at peak**

  Option – reduce EV charging at peak

*Lazar, J. (2016). *Teaching the "Duck" to Fly, Second Edition.* Montpelier, VT: The Regulatory Assistance Project.
Available at: http://www.raponline.org/document/download/id/7956

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Reduce Curtailment Using EV Charging

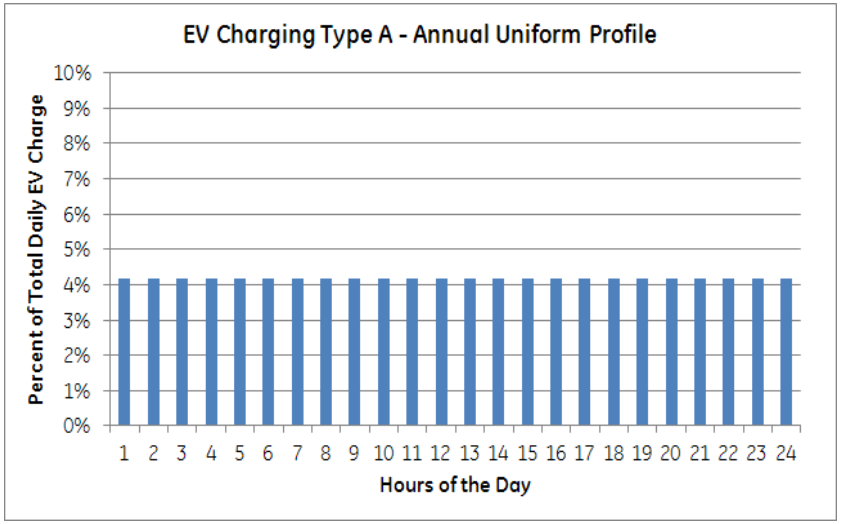
Analysis Assumptions

- **Average plug-in EV uses 30 kWh/100mi**
- **11,000 miles traveled per year**
- **Over 130,000 EVs on Oahu by 2045, and 260,000 with EIA high oil price (~ 22% of passenger vehicles on Oahu)**

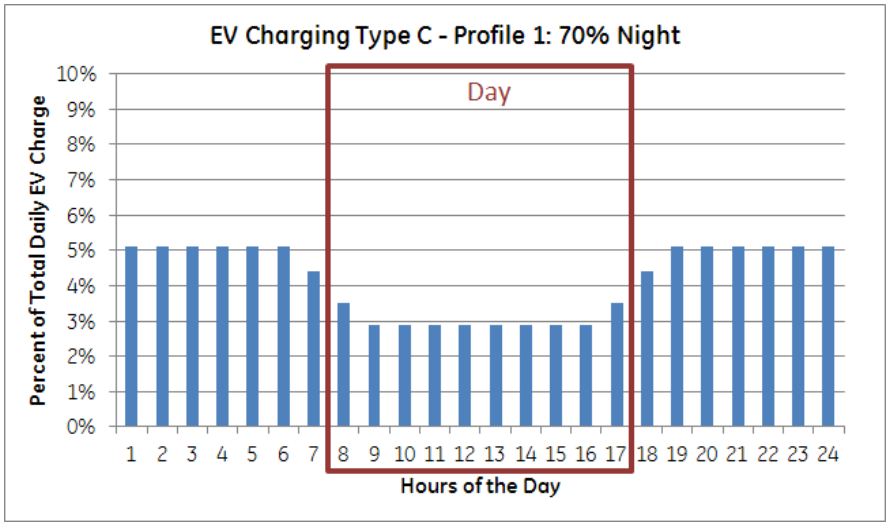
*Update to *Factors Affecting EV Adoption: A Literature Review and EV Forecast for Hawaii,* Coffman, M., Bernstein , P. & Wee, S., (2015)

Possible EV Charging Profiles

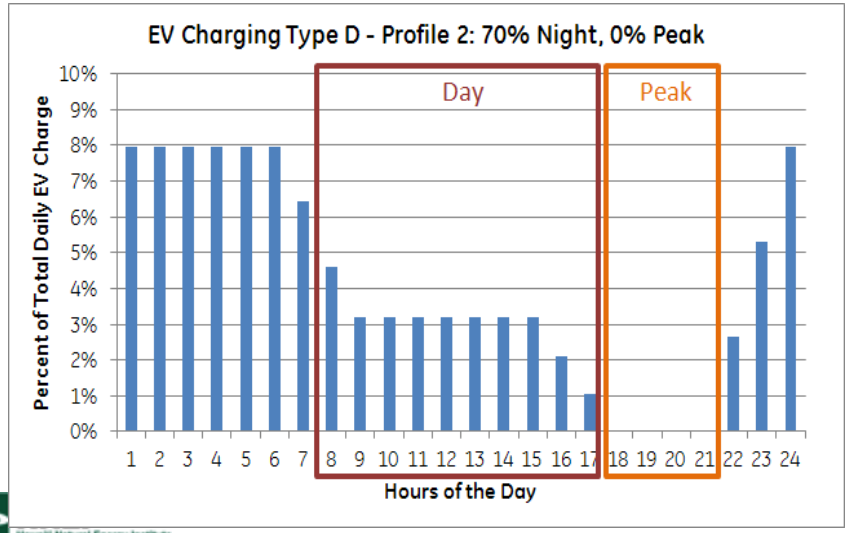
Uniform Charging



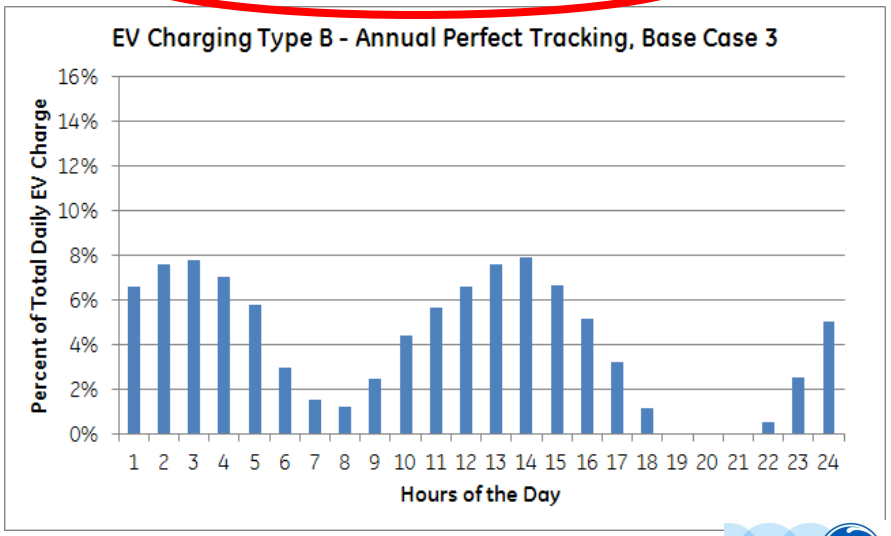
Profile 1: 30% daytime, 70% at night



Profile 2: Same as Profile 1, but 0% Peak



Perfect Tracking



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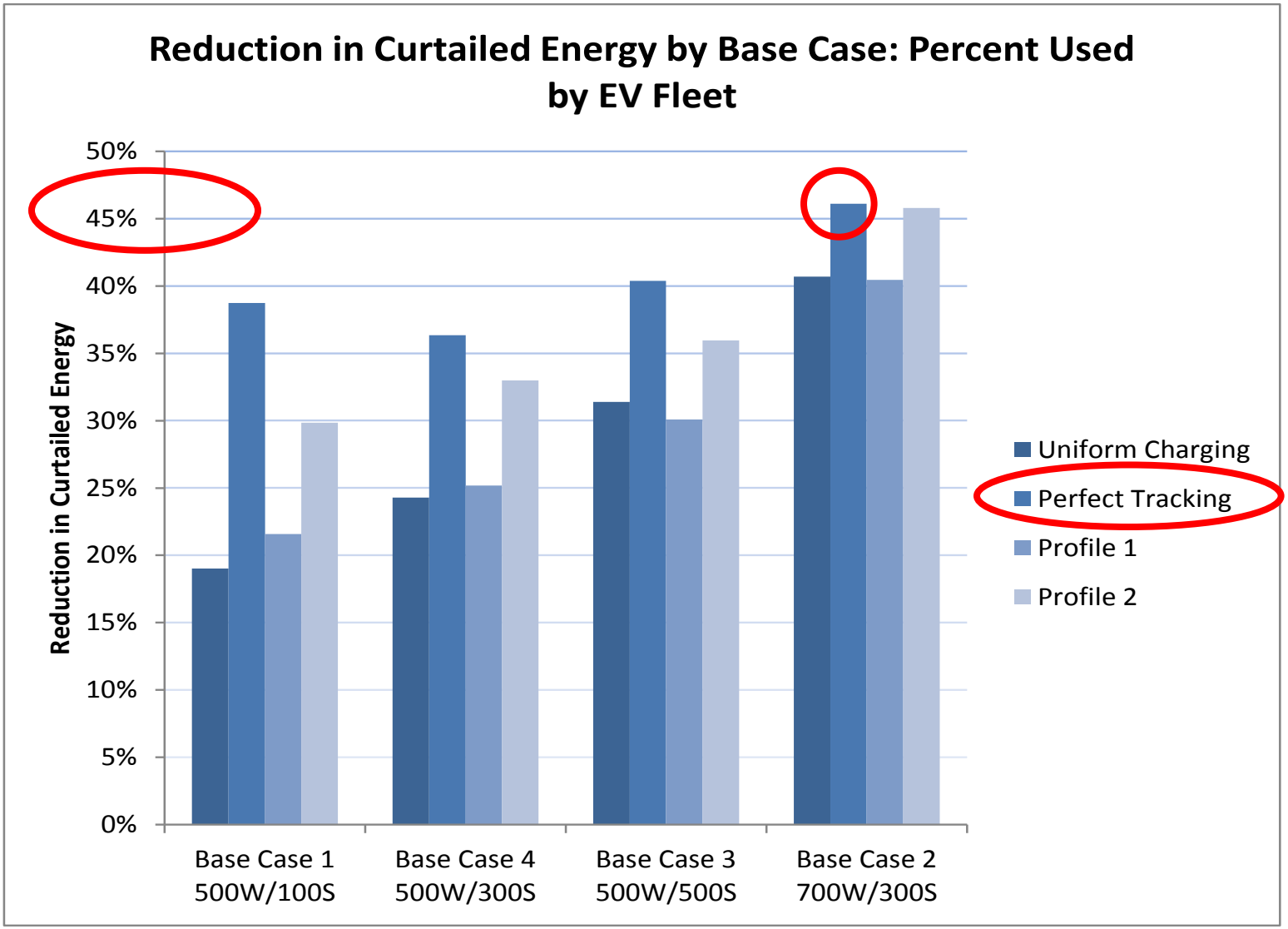
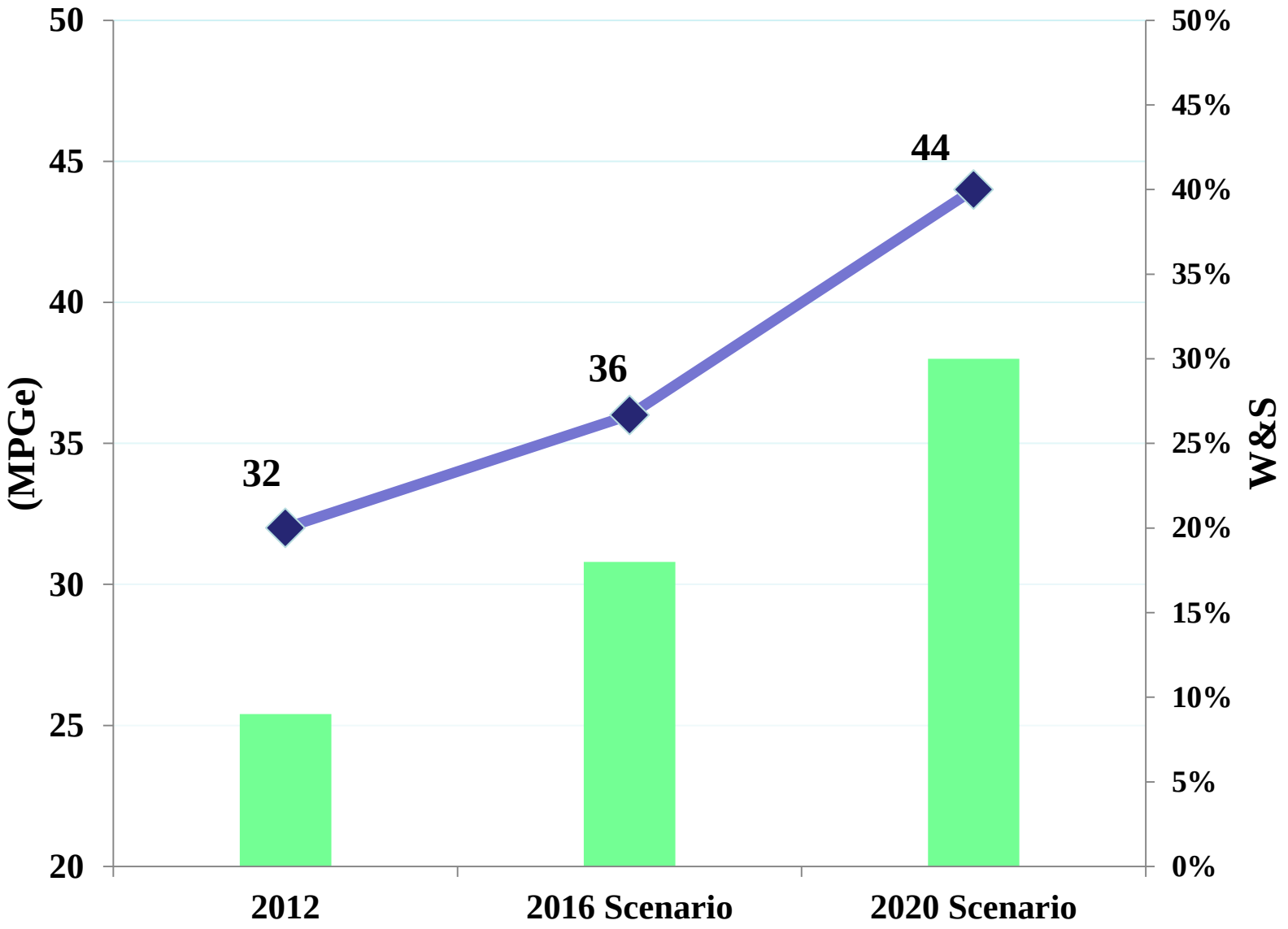
Reduction in Curtailed Energy Resulting from EV Charging



Progress in EV Mileage On Oahu



Conclusions

- **Hawaii presents a "Post Card from the Future"**
- **EVs do not reduce curtailment as much as expected, especially wind**
- **Need midday/workplace charging on Oahu**

Acknowledgement: work performed under the Electric Vehicle Transportation Center and funded under a subaward from the Florida Solar Energy Center, through a grant from the U.S. Department of Transportation

Thank You

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