

# Oahu Wind Integration Study

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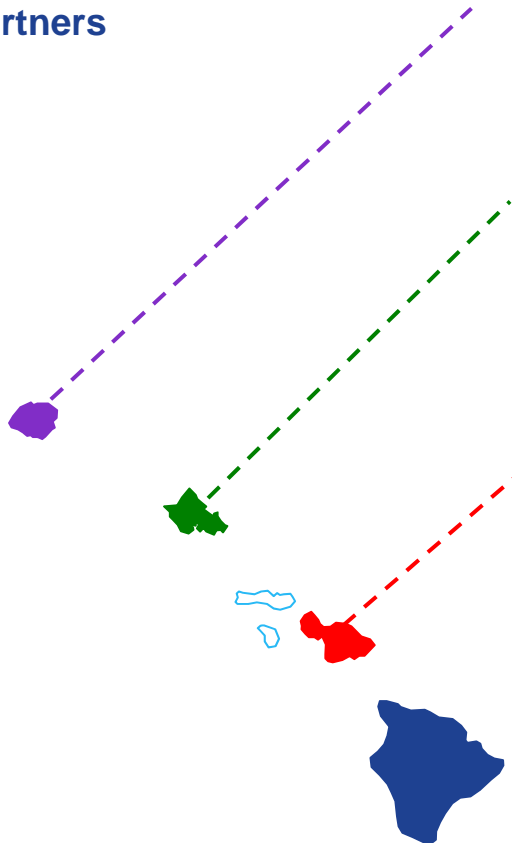


# Hawaii Island Integration Studies

- **HIIS are detailed integration studies to assess the feasibility and impacts of integrating new generation, operating procedures, and DSM technologies onto the grid.**
- **Studies are funded by USDOE with cost share from industry partners including the utility companies**
- **Oahu Wind Integration Transmission Study (OWITS) is a detailed technical integration study to assess the feasibility to integrate up to 400 MW of wind from nearby islands connected through undersea high voltage DC (HVDC) cable (plus Oahu based renewables)**
- **Levels of renewables studied have potential significant challenge to Oahu grid (peak = 1200 MW, off peak = 600 MW)**
- **Hawaii Clean Energy Initiative includes commitments from utility for integration to pursue large interisland wind projects**

# OWITS Study is Part of Broader Effort to Understand Renewable Integration in Hawaii

Approximately \$20 million investment by DOE and industry partners



Kauai Energy Roadmap - Future roadmap for possible increased penetration of renewable energy.

## Oahu Grid Study

Validated Oahu grid model being used to address integration of large wind projects between Oahu and other islands

*Ongoing efforts include high penetration solar*

Maui Grid Modernization - Energy storage, generation and demand-side management technologies to reduce peak load and enable further expansion of renewable energy

## Maui Grid Study

Validated power systems model used to address impacts of increased wind and the necessary mitigation technologies

*Efforts pending to explore high penetration solar*

## Big Island Energy Roadmap

- Identify strategies for increased energy security and the penetration of renewable energy
- Storage demonstration project being initiated
- Demonstration of hydrogen integration for grid management

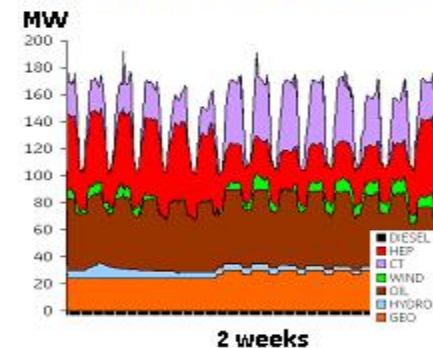
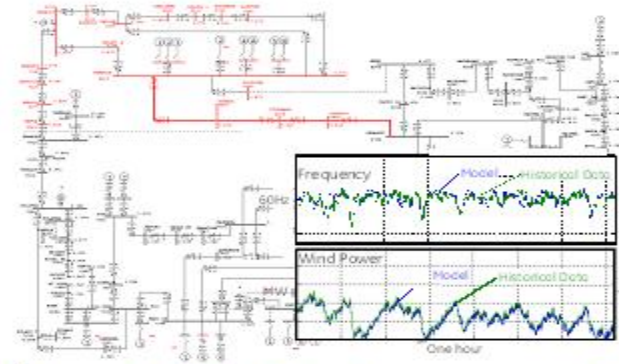
# GE tools used to Analyze High Penetration Renewables in HI Grids

## Transient Performance (PSLF™)

- Full network model, incorporating generator governors and AGC
- Transient Stability Simulation
- Long-Term Dynamic Simulation

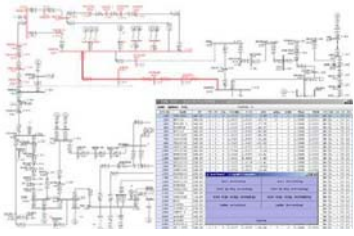
## Production Cost (MAPS™)

- Representation of dispatch and unit commitment rules
- Hour-by-hour simulation of grid operations for a full year

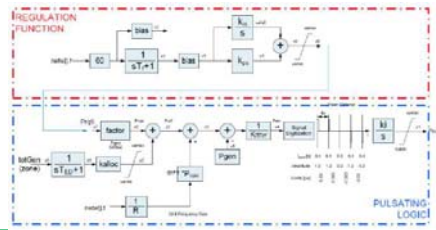


# GE Power Systems Analysis Tools

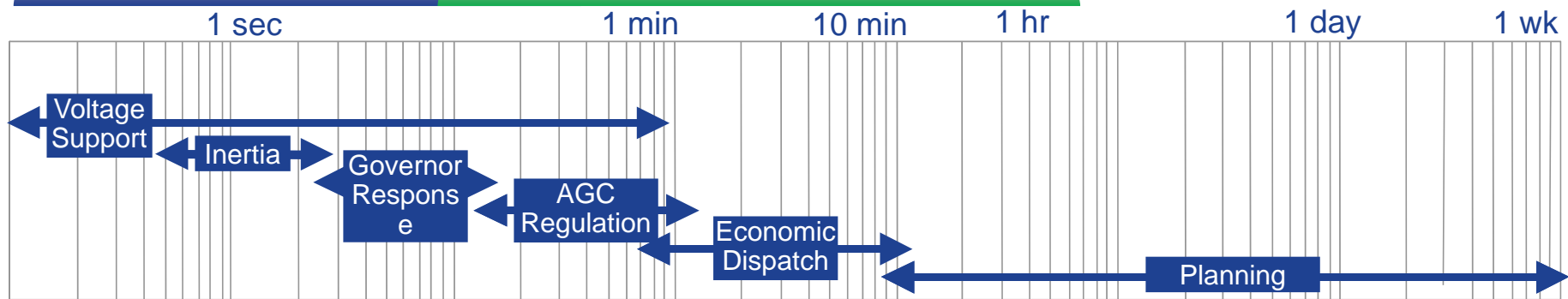
## Positive Sequence Load Flow (GE PSLF™)



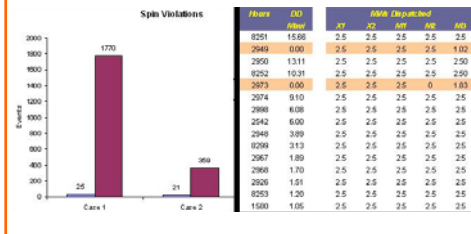
## Long-term Dynamic Simulations (GE PSLF™)



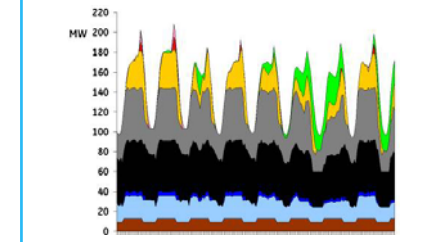
- Additional tools developed to analyze transient times between those of std tools
- Scenarios and results reviewed regularly by national technical review committee.



## GE Interhour Screening Tool™

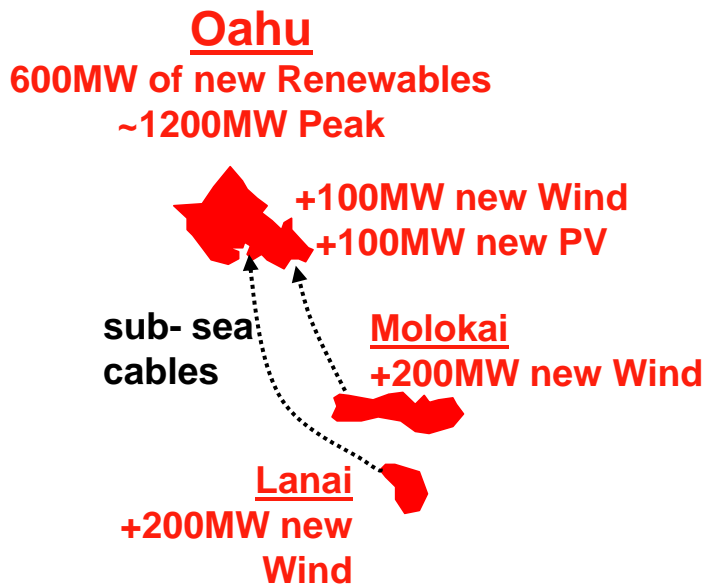


## Multi-Area Production Simulation (GE MAPS™)



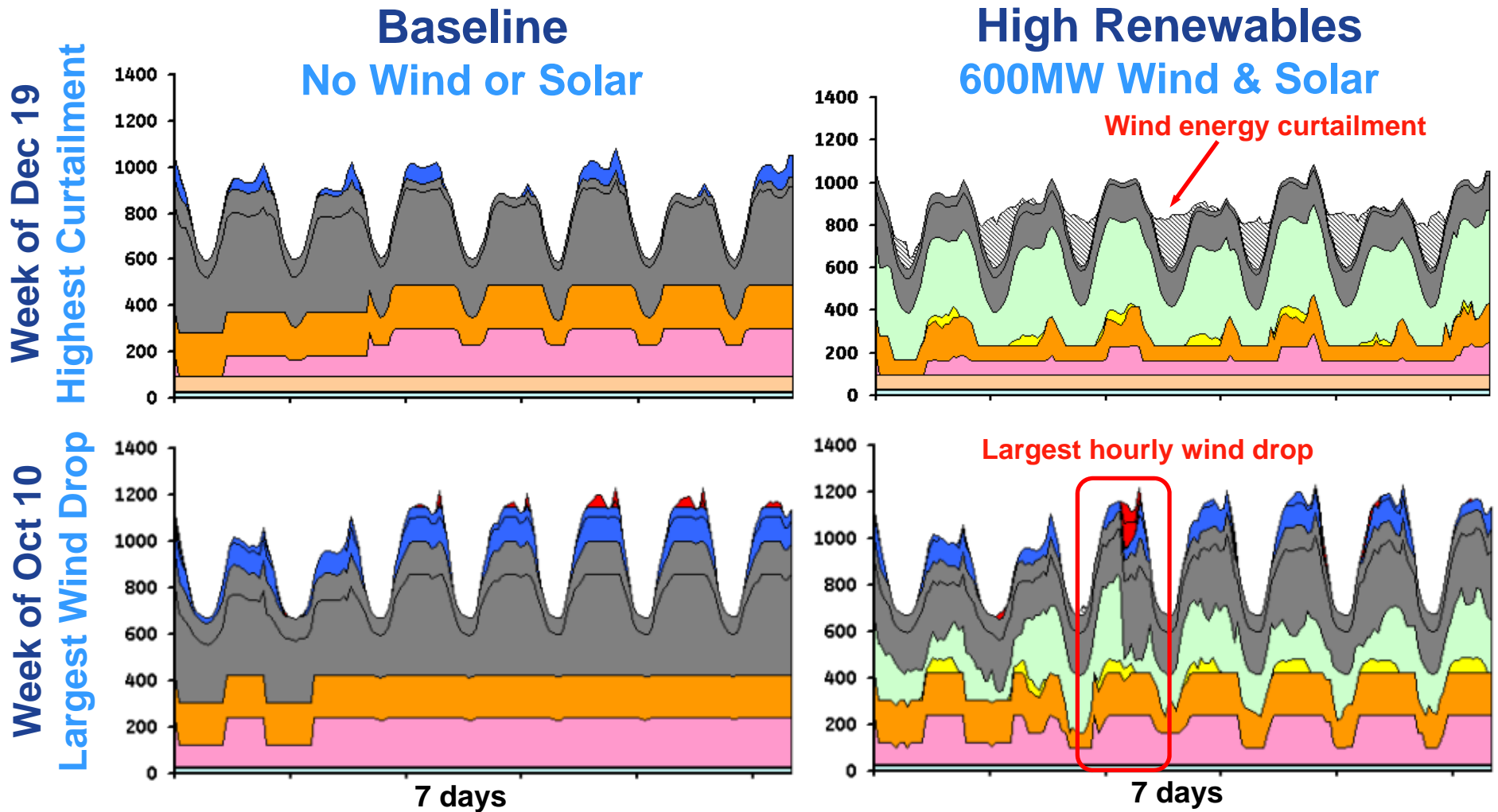
# Study Focused on Four Scenarios Increasing Wind and PV Power on Oahu

Scenario	Title	Wind			Solar PV
		Oahu	Lanai	Molokai	Oahu
Baseline	2014 Baseline	-	-	-	-
Scenario #1	“Big Wind” Oahu only	100MW	-	-	100MW
Scenario #3	“Big Wind” Oahu + Lanai only	100MW	400MW	-	100MW
Scenario #5	“Big Wind” Oahu + Lanai + Molokai	100MW	200MW	200MW	100MW



Multiple scenarios were analyzed to determine the commitment/dispatch, identify new operating characteristics, and establish a new baseline to assess strategies to enhance operation with high penetrations of renewables

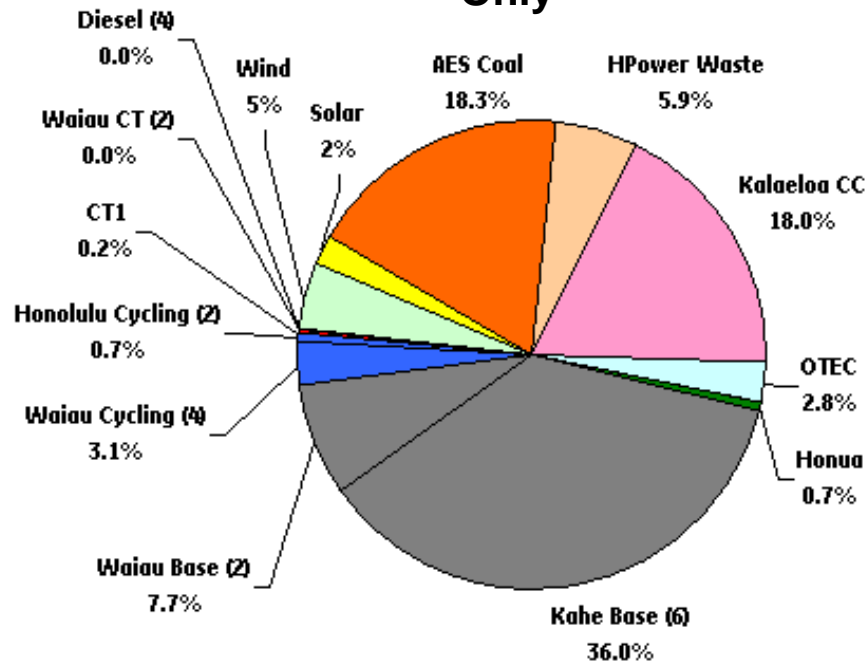
# “Big Wind” on Oahu



Thermal units are backed down, wind energy is *sometimes* curtailed at light load, and wind power changes are managed by ramping the thermal units.

# System Impact of Big Wind Projects

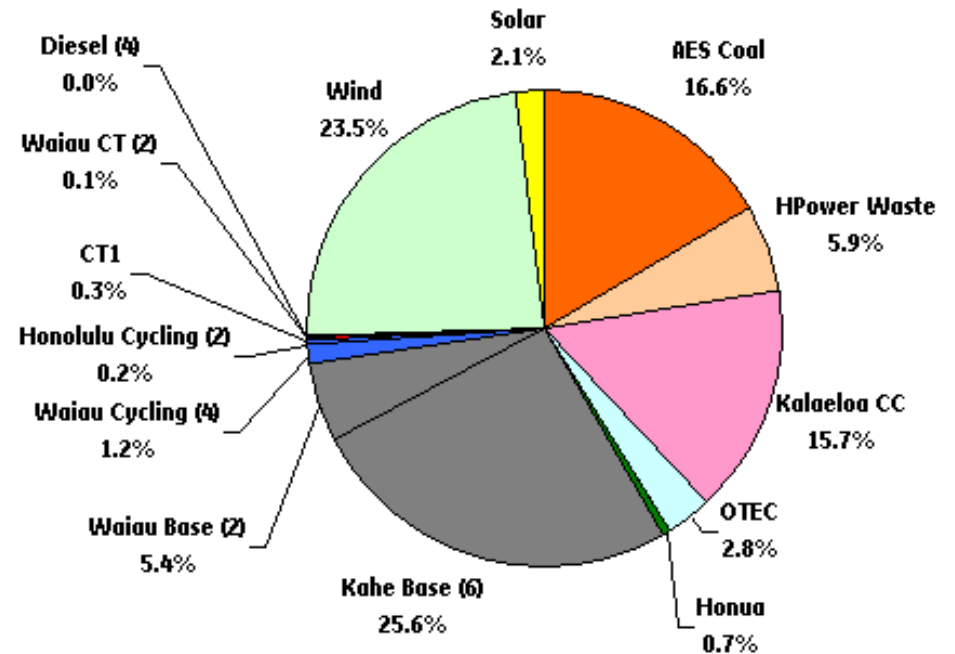
Oahu Wind Only



100 MW Oahu Wind = 5% Projected demand

100 MW Solar PV = 2% Projected demand

Oahu, Molokai, and Lanai Projects



100 MW Oahu Wind = 5% Projected demand

100 MW Solar PV = 2% Projected demand

400 MW Interisland wind = 19% Projected demand

About 2.8 million barrels of fuel oil and 132,000 tons of coal saved per year

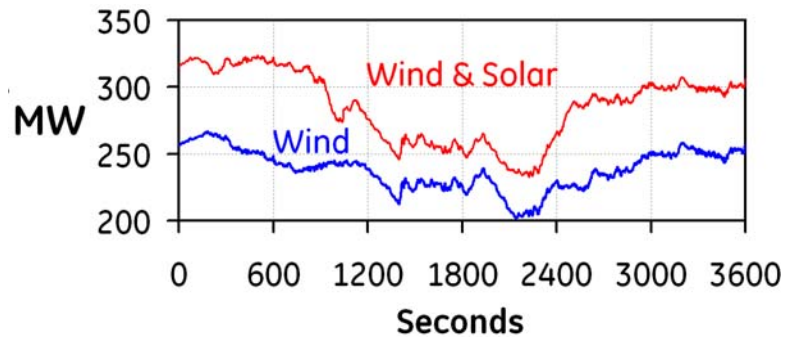
# Strategies considered to Enable “Big Wind”

- Wind power forecasting
- Refining up reserve requirements (function of wind power)
- Reduce minimum power of baseload units
- Reduce reserve requirement (fast-start units / load control)
- Increase thermal ramp rate capability & enhance droop
- Consider advanced wind turbine technologies to provide “grid support” (e.g., inertia, frequency control)

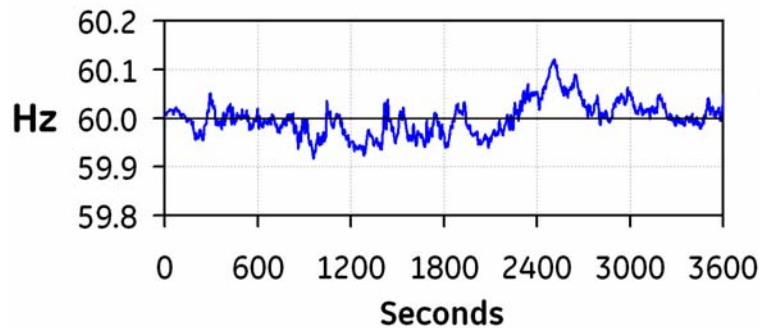


# Frequency Maintained During Wind Events

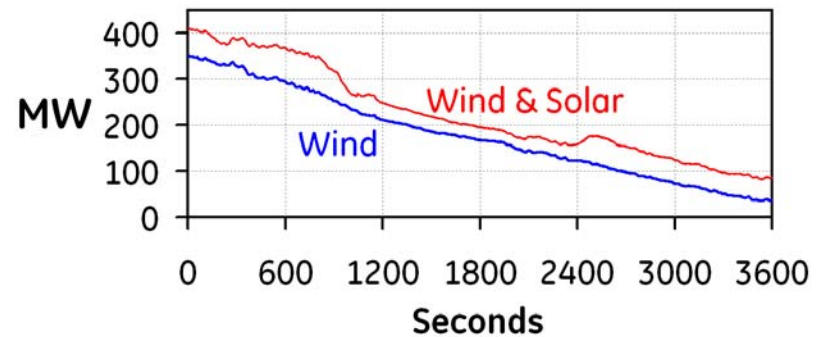
## Fast Wind Power Variability Aug 30<sup>th</sup> 10am (995MW Load)



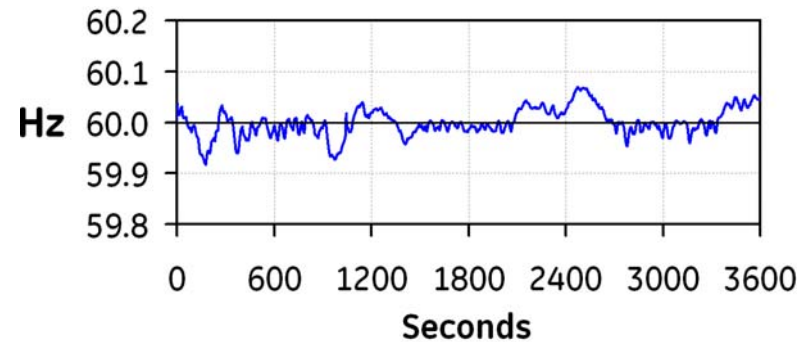
Large and fast-wind power variability over the 5-10min timeframe in both directions



## Sustained Wind Power Drop Oct 13<sup>th</sup> 2pm (1160MW Load)



Largest wind forecast error. Largest hourly wind drop (311MW; 27% of gen).  
All fast-start units dispatched



**Proposed future thermal unit ramp rates and droop helped maintain system frequency during these events**

# Key Conclusions

Oahu can reliably accept 25% of its energy from Wind/PV provided the following system modifications are considered:

- Incorporate wind power forecasting,
- Increase ramp rates and modify droop characteristics of thermal units,
- Reducing minimum power of thermal units,
- Refine reserve requirement (function of wind power forecast),
- Incorporate other resources for reserves (load control, fast-start units),
- Consider advanced wind turbines (inertia, frequency, curtailment).

**Combined wind and solar power would displace approximately 2.8 million barrels of fuel oil and 132,000 tons of coal per year**



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# Oahu and Maui Solar Integration Studies

**Enhance existing GE models of the Oahu and Maui power systems, and leverage state-of-the-art solar data from the project team to:**

- 1. Assess the levels of wind/solar energy delivered, emissions, and annual operating costs for specific distributed/centralized PV plant projects**
- 2. Identify the operating characteristics (commitment/dispatch) of a system with high penetrations of solar power**
- 3. Assess the dynamic performance of the systems with high contents of wind and solar power**
- 4. Identify the challenges associated with reliable operation of a system with a very high content of wind and solar power**
- 5. Identify operational strategies & new technologies that could help enable high penetrations of wind and solar power**
- 6. Assess the impact of each approach across many timescales**
- 7. Recommend strategies and requirements to increase wind and solar energy delivered, reduce adverse impacts on the thermal units and help ensure reliable system operation**



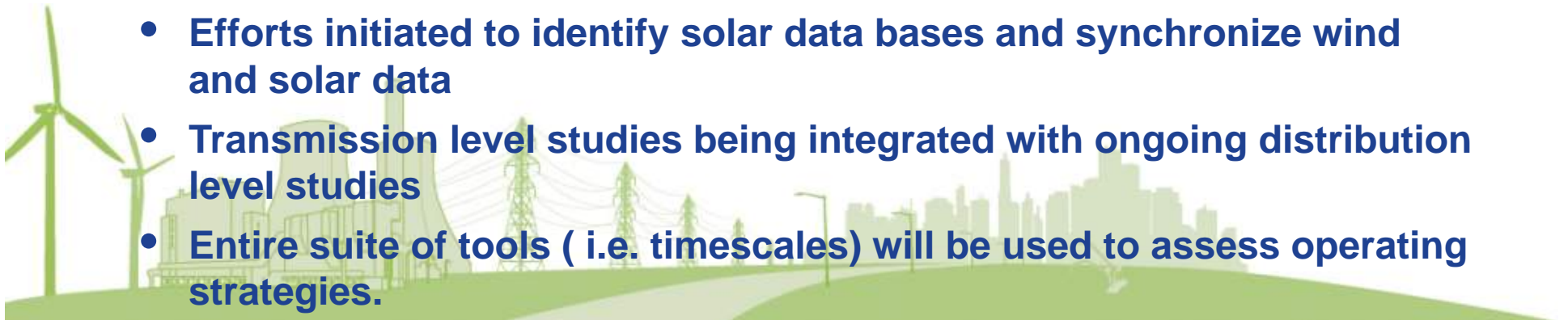
# Oahu and Maui Solar Integration Studies

## Desired Study Outcomes

- Identify the operating characteristics across many timescales and the key challenges associated with high levels of solar on the Oahu and Maui grids
- Assess and quantify impact of alternate solutions to enable high penetration of wind and solar power
- Recommend strategies to help enable high levels of wind and solar power on the Oahu and Maui systems.

## Progress/Status

- Funding identified for studies on both islands
- Technical review committee meeting to define scenarios and study details
- Initial scenarios are high penetration solar and wind without island interconnection
- Efforts initiated to identify solar data bases and synchronize wind and solar data
- Transmission level studies being integrated with ongoing distribution level studies
- Entire suite of tools ( i.e. timescales) will be used to assess operating strategies.



# Questions?

You can find full report at:

[www.hnei.hawaii.edu](http://www.hnei.hawaii.edu)

Further questions please contact Jay Griffin at:

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