Electrical Grid Integration Studies

Presented to Hawaii-BOEM Outer Continental Shelf Renewable Energy Task Force

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by University of Hawaii at Manoa – Hawaii Natural Energy Institute

OWITS and HSIS Funding Source

U.S Department of Energy

Office of Electricity Delivery and Energy Reliability

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Additional Funding Source for HSIS

HECO

UH-HNEI

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Study Team Participants

- Hawaii Electric Company (HECO)
- Maui Electric Company (MECO)
- University of Hawaii's Hawaii Natural Energy Institute (UH-HNEI)
- General Electric Company (GE)
- National Renewable Energy Laboratory (NREL)
- AWS Truepower (AWST)

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Oahu Wind Integration Study (OWITS)

- Status
  - ***OWITS is complete***; final report is publically available on the UH-HNEI website

" … Results of this study suggests that ***400 MW*** of off-island ***wind*** energy and ***100 MW*** of on-island ***wind*** energy **can be integrated** into the Oahu electrical system ***while maintaining*** system ***reliability***.

Integrating this wind energy, along with 100 MW of solar PV will eliminate the need to burn approximately ***2.8 million barrels of low sulfur fuel oil and 132,000 tons of coal each year*.**

The combined supply from the ***wind and solar plants*** will comprise just over ***25% of Oahu's projected electricity demand***…"

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http://www.hnei.hawaii.edu/sites/web41.its.hawaii.edu.www.hnei.hawaii.edu/files/story/2011/03/Oahu_Wind_Integration_Study.pdf

HSIS Study Objectives

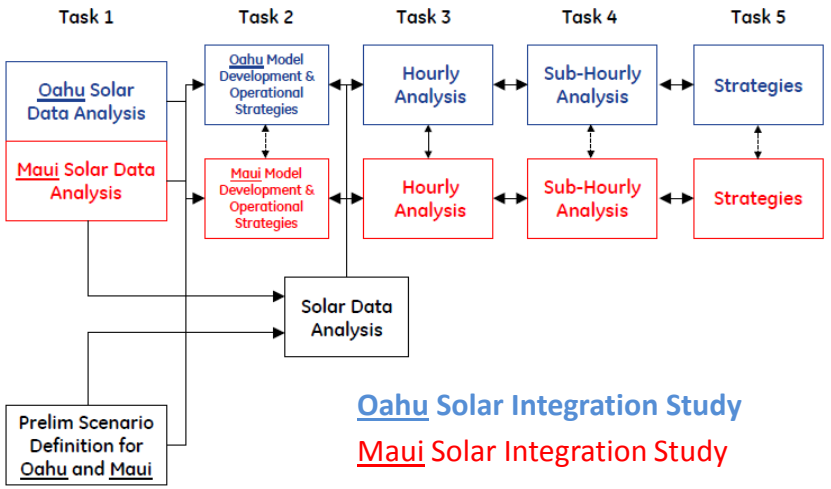
- ***Analyze performance*** of Oahu and Maui systems with ***high-penetration of wind and solar*** generation (e.g. Assess the levels of wind and solar energy delivered, curtailment, emissions, up and down reserves, and annual operating costs
- ***Develop rigorous analytic models*** of electrical system and ***data sets*** for each island to ***identify operational challenges*** (different resource mixes and different operating practices) and to ***develop mitigation strategies***
- ***Assess impact*** of each ***mitigation strategy*** across many time scales of system operation
- ***Recommend new technologies and requirements*** to enable higher-penetrations of wind and solar generation (e.g. advanced controls, demand management, forecasting, storage, …) and ensure reliable system operation

Study Team Process

- Assemble ***Study Team, Technical Review Committee*** (TRC) and ***stakeholders***
- ***Validate data sets*** from the base year – 2007
- Develop and ***validate data sets*** (e.g. distributed and centralized PV and Wind plants, and solar forecasting) to support modeling the simulation year – 2015
- Host ***TRC meetings*** – technical reviews and reporting
- Conduct Maui and Oahu ***studies in parallel***
- Define ***test scenarios***
- Deliver final technical report

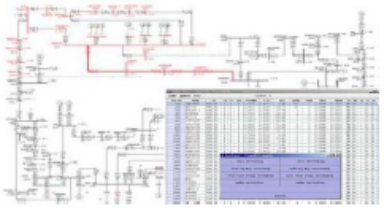
Scenario	Distributed PV (MW)	Centralized PV (MW)	Wind (MW)
Baseline	60	0	100
Scenario 1	60	100	100
Scenario 2	260	0	100
Scenario 3	260	100	100

Sample Only

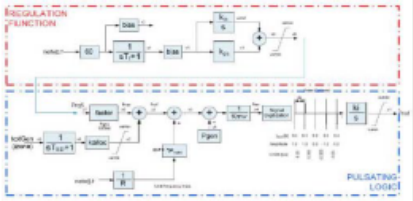


Modeling Tools

Positive Sequence Load Flow (GE PSLF)



Long-term Dynamic Simulations

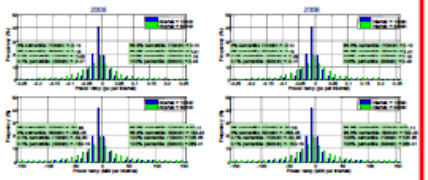


Tools are used together to assess the challenges & provide information needed for operations & planning.

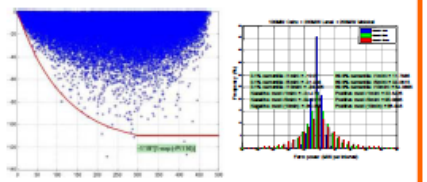
1 sec | 1 min | 10 min | 1 hr | 1 day | 1 wk

- Voltage Support
- Inertia
- Governor Response
- AGC Regulation
- Economic Dispatch
- Planning

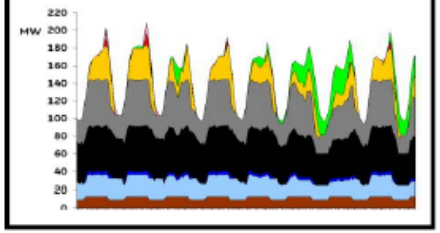
Statistical Wind/Solar Power Variability Assessments



GE Interhour Tool



Multi-Area Production Simulation (GE MAPS)



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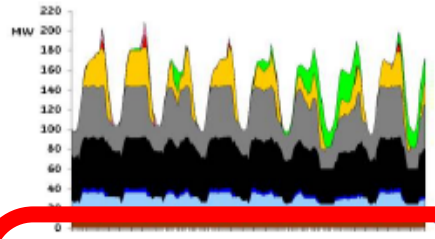
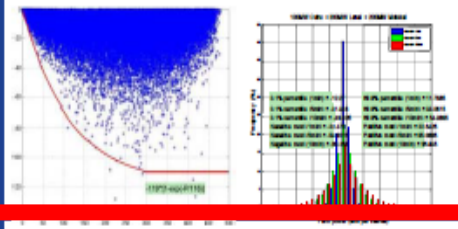
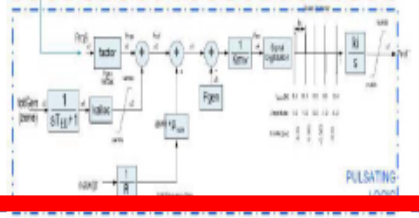
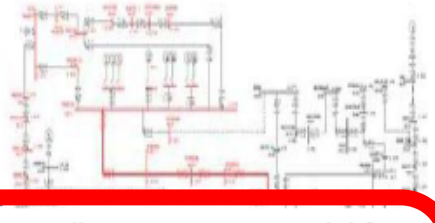
Mapping Tools to Requirements

GE MAPS Production Cost Simulations	GE Interhour Tool	GE Long-term Dynamic Simulations	GE Positive Sequence Load Flow (GE PSLF)
			
Unit-by-unit commitment/ dispatch, representing operating rules, benchmarked against system operation.	Sub-hourly wind/solar/load changes with respect to reserve, based on commitment and dispatch from GE MAPS.	Frequency analysis, including governors and AGC. Initialized from GE MAPS and driven by major wind/solar events.	Full Transmission model for voltage & stability performance, governor response, contingency analysis.
Hourly time steps	10-min time steps	1-sec time steps	1ms time steps
8760 hrs / yr	8760 hrs / yr	3600 s/hr (few hours)	60,000 ms/min (few events)
Quantify metrics for each unit.	Utilize hourly dispatch from GE MAPS.	Quantify frequency during challenging events.	Quantify stability during contingency events
Assess: • Wind/solar delivered • Variable cost, emissions	Assess: • Reserve adequacy • Ramp rate capability	Assess: • Unit maneuvering • Load shedding events	Assess: • Voltage/frequency • Congestion

Hawaii Solar integration Study (HSIS)

- Status
  - Hawaii Solar integration Study (HSIS) study is complete
  - Study team is preparing two Final Technical Reports; one for each island; both due out mid December
  - Report will be available on the UH-HNEI website

Mahalo Nui Loa