



Hawaiian Electric
Maui Electric
Hawai'i Electric Light

Reliability For Our Customers Panel Discussion 8

*The Hawaiian Electric Companies'
Integrated Grid Planning Symposium*

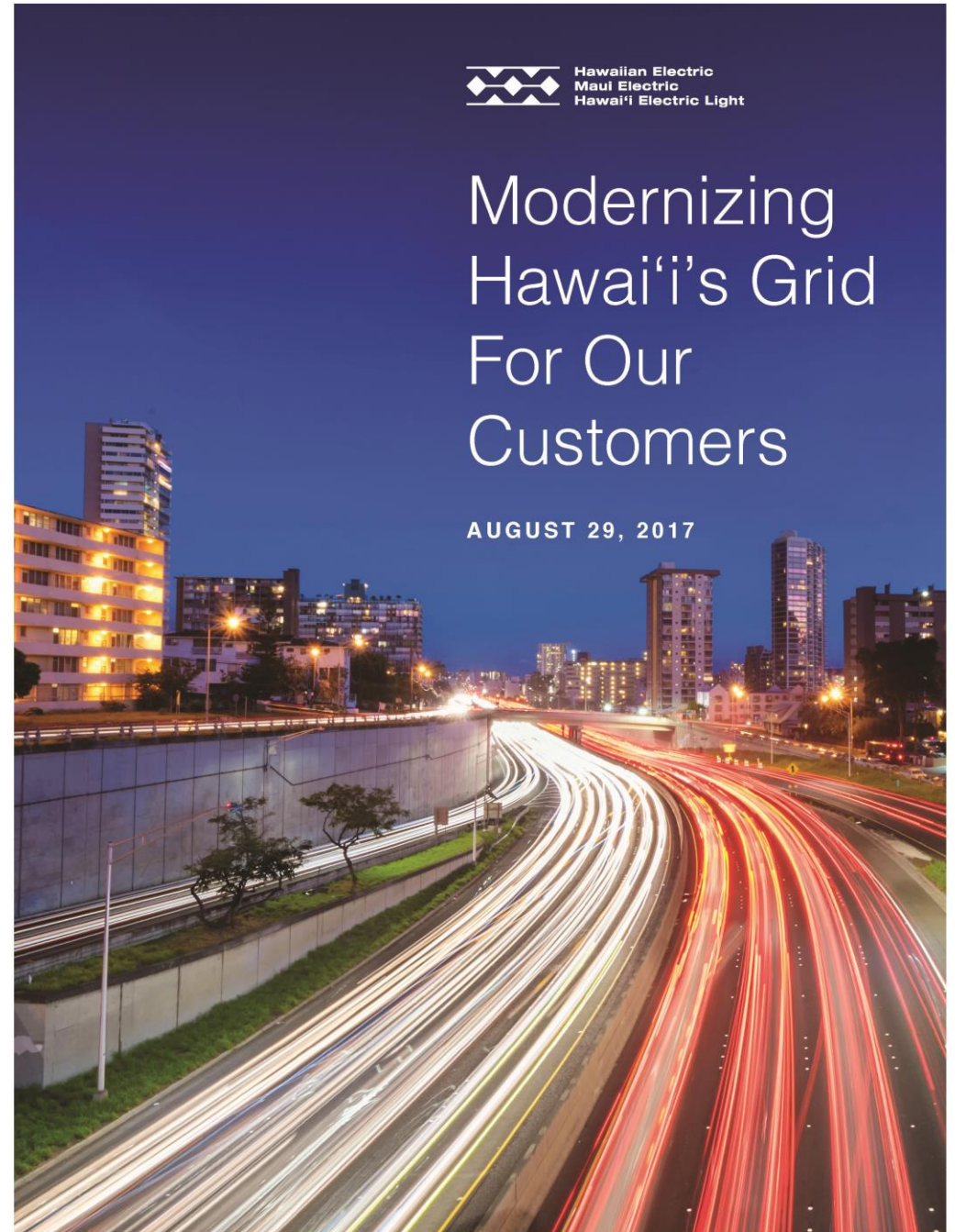
Dean Arakawa
Director, Transmission Planning

November 16, 2017



Modernizing Hawai'i's Grid For Our Customers

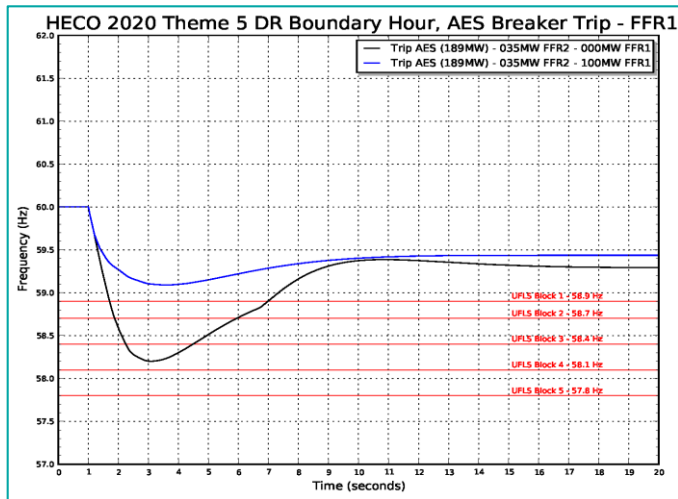
AUGUST 29, 2017



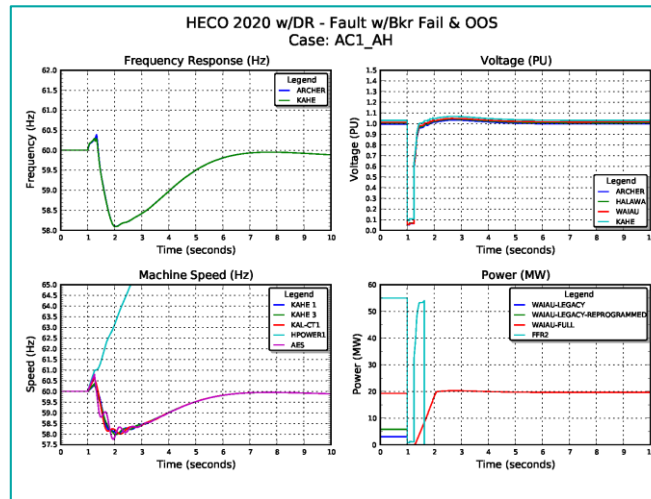
PSIP System Security Analysis

Analysis performed on resource plans to determine near-term requirements to support the reduction of on-line fossil generation. Frequency stability, voltage stability, and rotor angle stability were analyzed.

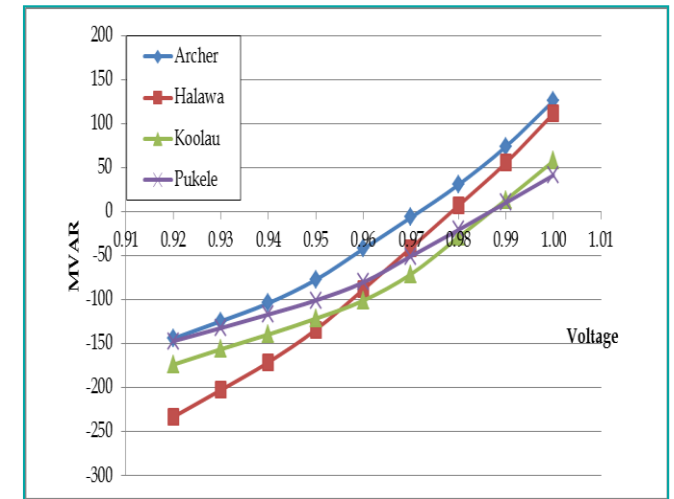
Loss of Generation



Transmission Fault



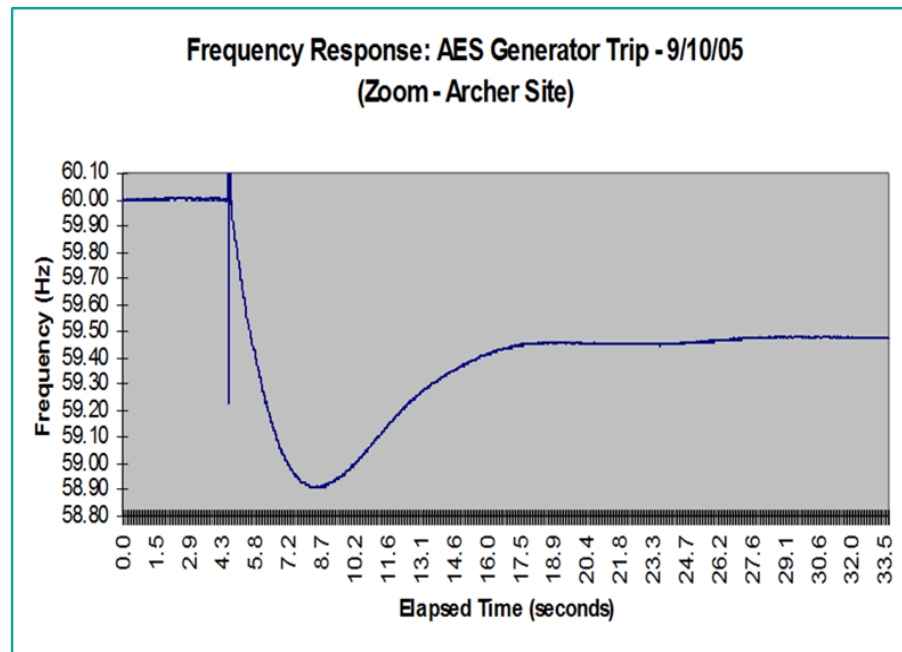
Voltage/Reactive Power



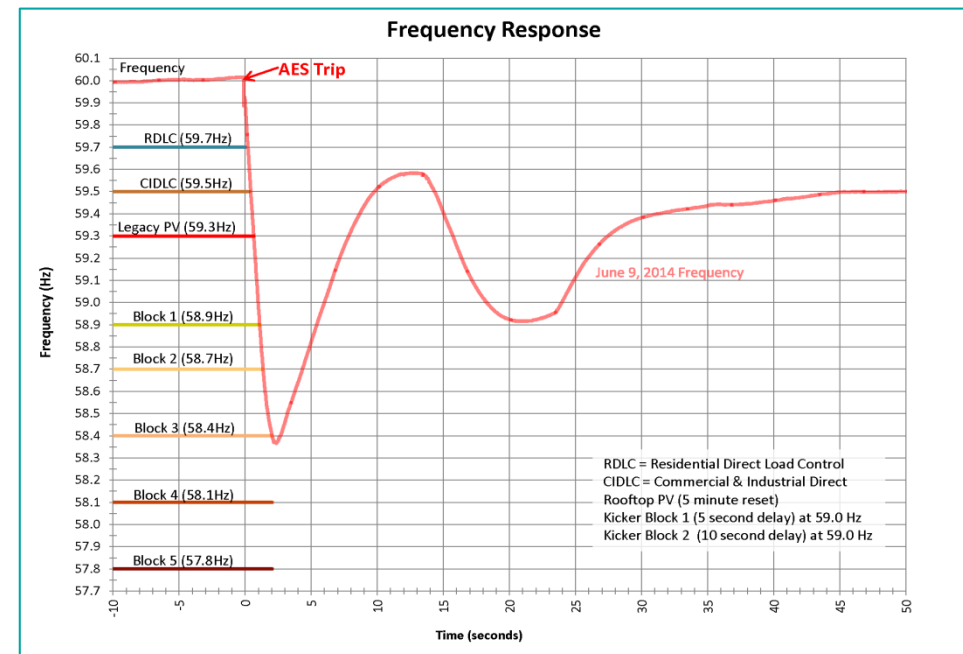
State of the System O'ahu

- Synchronous generators provide rotational inertia and short circuit current that are fundamental properties that determine grid reliability.
- Synchronous generators are being displaced by asynchronous generators, creating “weak grids”.
- Short circuit ratio (SCR) is a weak grid metric

Normal Grid – O'ahu

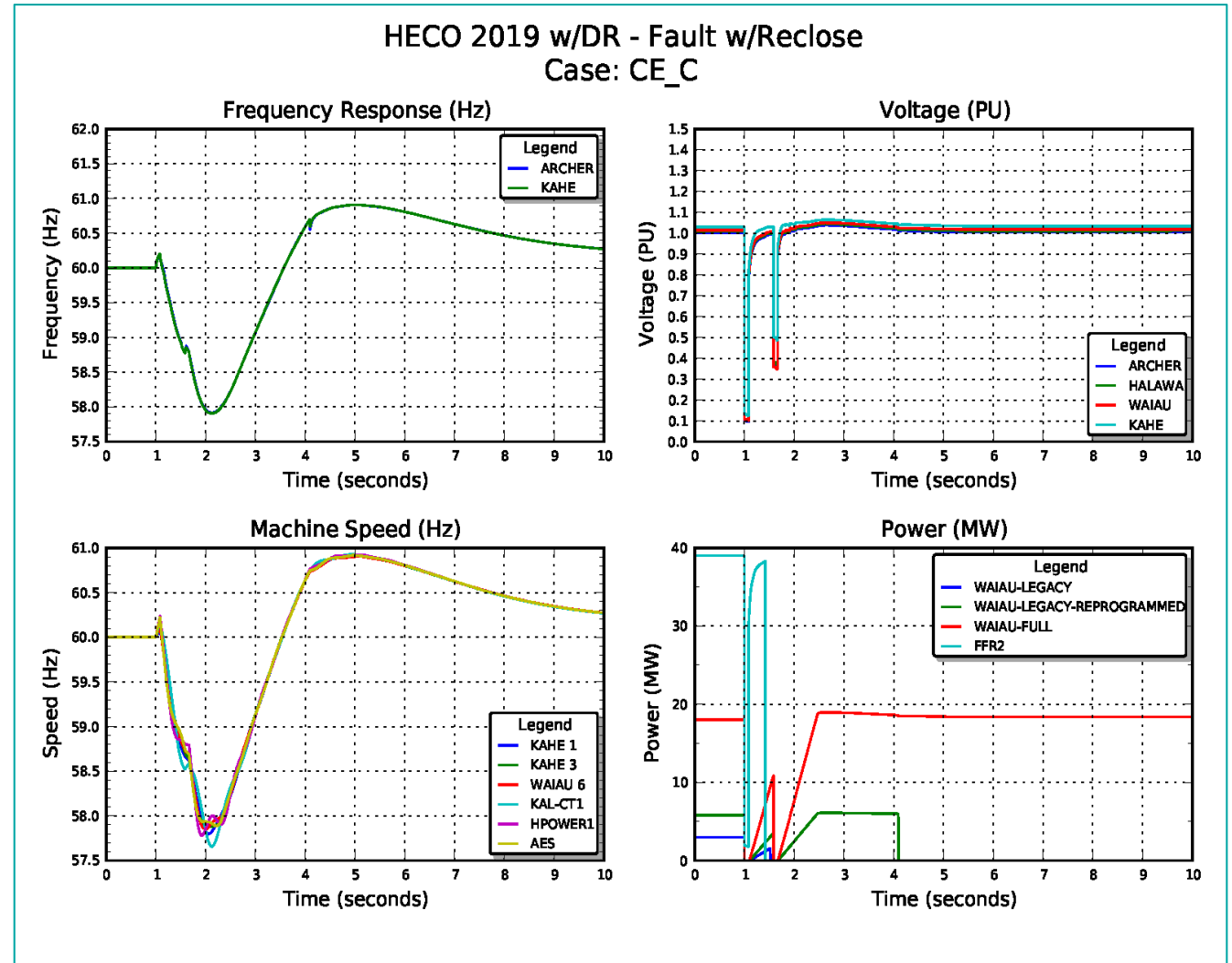


Weak Grid – O'ahu



State of the System O'ahu

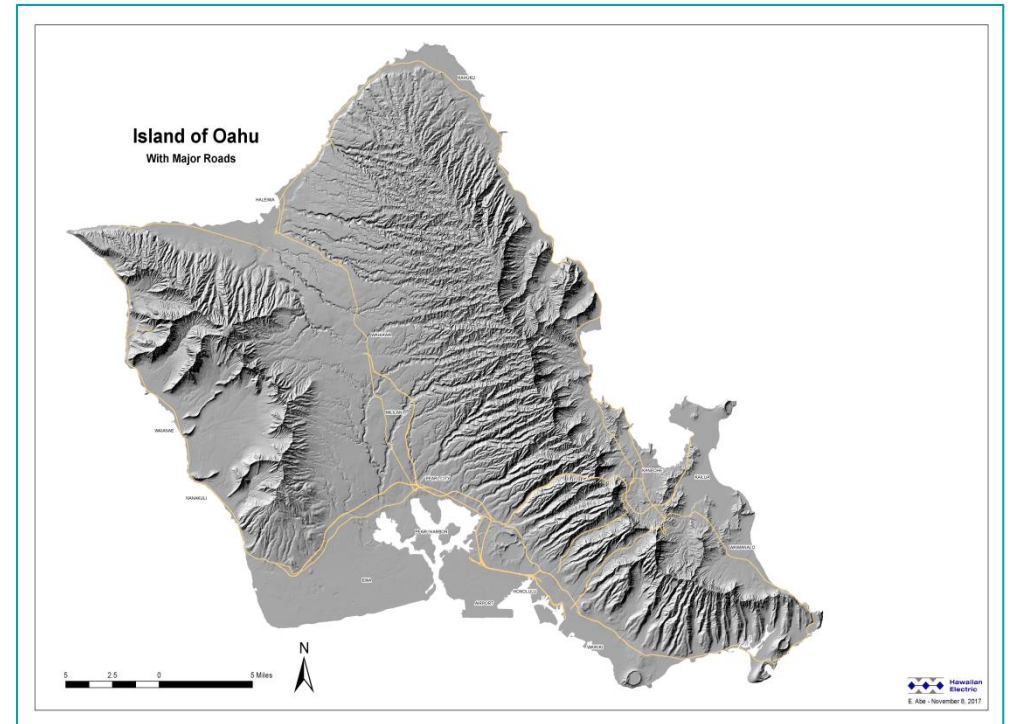
- Momentary cessation of DG-PV due to a transmission line fault
- Potential solution is to install synchronous condensers at busses with high penetrations of DG-PV
- Southern California experienced a similar disturbance on 8/16/2016 where 1200 MW of PV on the transmission system tripped on a 500 kV fault



O'ahu

Solutions:

- Fast Frequency Reserves (FFR) for loss of generation
- Synchronous condensers for short circuit current to ensure protective relay systems operate and to increase SCR
- Distribute synchronous condensers to mitigate momentary cessation
- Solutions apply to Maui and Hawai'i



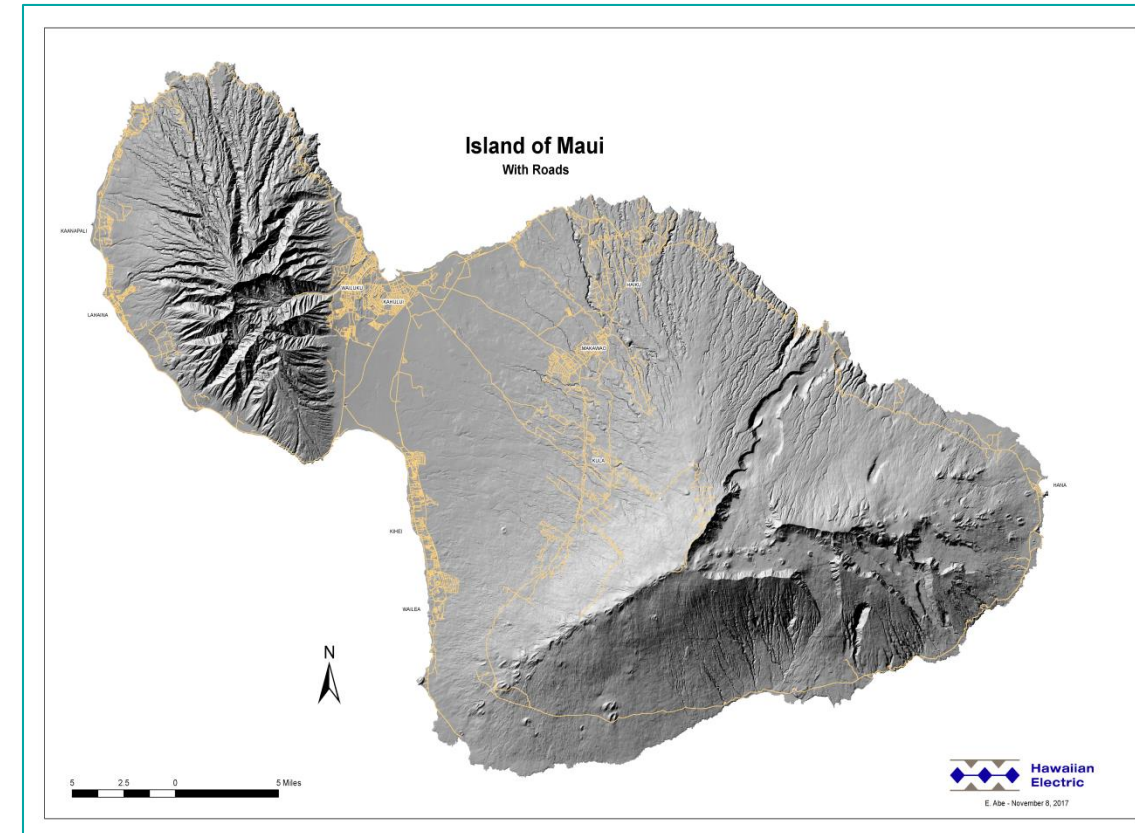
Maui

State of the System:

- Deactivation of Kahului Power Plant will leave one synchronous generating unit online. Loss of this unit will leave the system with no online synchronous generation.

Solution:

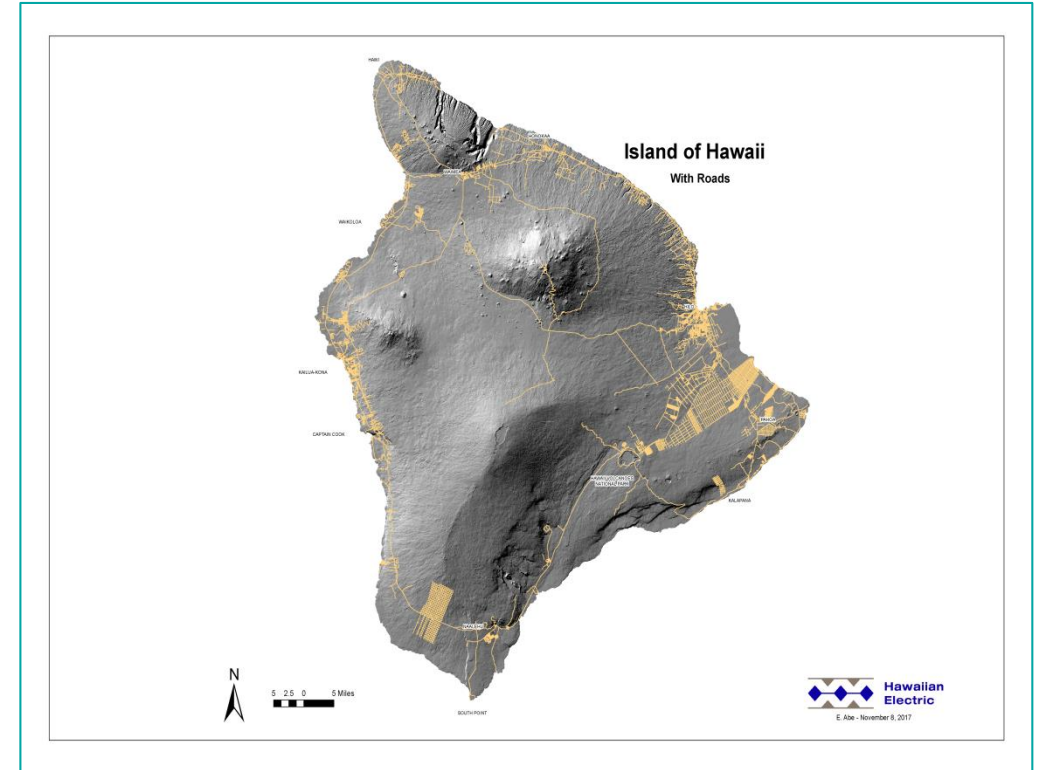
- Flywheels can add inertia to the system
- New tools like PowerFactory are being evaluated to analyze a future system with no synchronous generation



Hawai'i

State of the System:

- Large territory with over 600 miles of transmission lines at 69 kV
- Hawai'i Island has a new biomass unit under construction
- System security analysis is being performed with this new generating unit



Summary

**Grid
reliability
is critical
for our
customers**



Fast Frequency Response can mitigate the loss of generation

- Must reduce RoCoF
- Demand response
- Energy storage



Synchronous Condensers will strengthen the grid

- Provides short circuit current
- Provides voltage stability
- Provides some inertia



Hawaiian Electric
Maui Electric
Hawai'i Electric Light