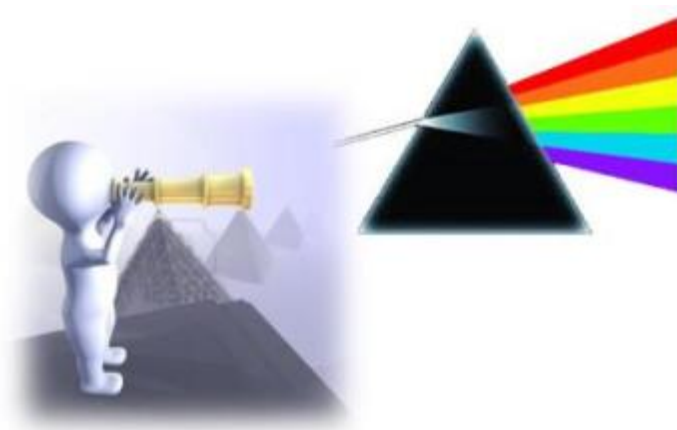# **Update on SynchroVIEEU – High Penetration PV Utility Experience**

Dora Nakafuji

NASPI, Seattle, WA

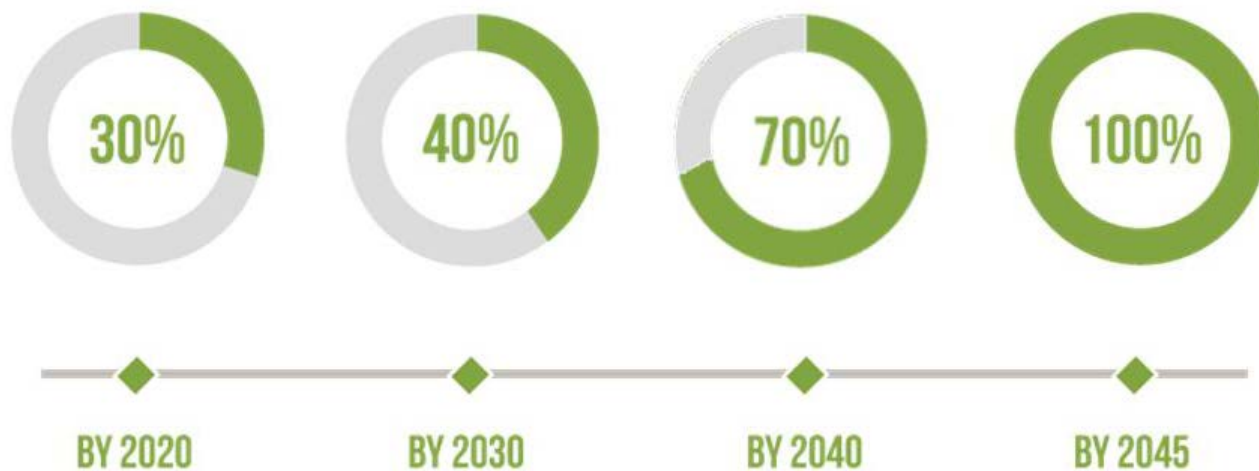October, 20 2016

Hawaiian Electric
Maui Electric
Hawaiʻi Electric Light

Topics

- ◆ Update on Hawaii
- ◆ Quick Review of Project – Goals & Tasks
- ◆ SynchroVIEEU Progress thus far…
- ◆ Next Steps
- ◆ Q&A

30% BY 2020 40% BY 2030 70% BY 2040 100% BY 2045

Hawaiian Electric
Maui Electric
Hawaiʻi Electric Light

Hawaii RPS – 100% renewables by 2045

Moving Beyond the Status Quo

◆ Contending with high penetrations of behind-the-meter PV, EV and Storage
◆ Implementing new technologies via utility-vendor-customer demonstrations that provide dual value for customer savings and a more reliable grid

Creatively Communicate
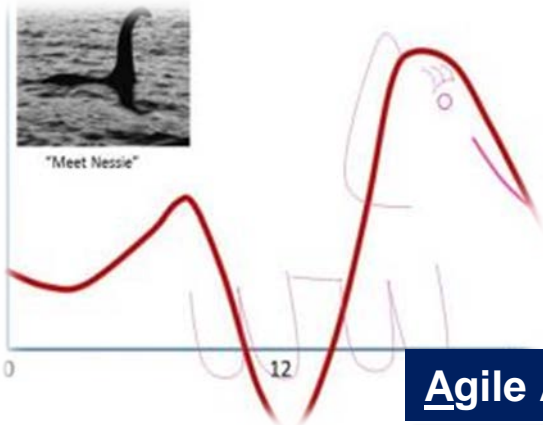
Resilient & Responsive Integration

Agile Awareness to Adapt

Engage & Enable Partners

Proactively develop portfolio of new data, tools and capabilities

Hawa [logo]
Maui Electric
Hawai'i Electric Light
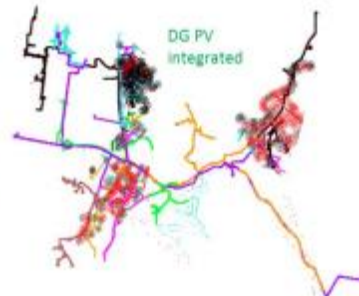
3

Project Summary

Synchrophasor Visual Integration and Event Evaluation for Utilities (SynchroVIEEU) with High Penetrations of Renewables
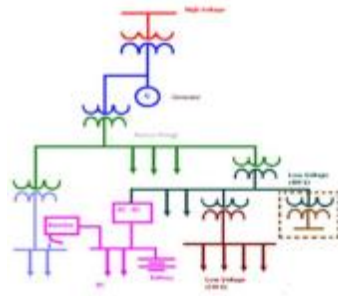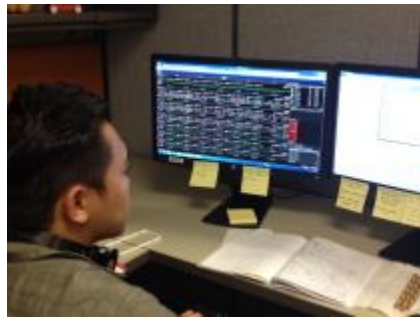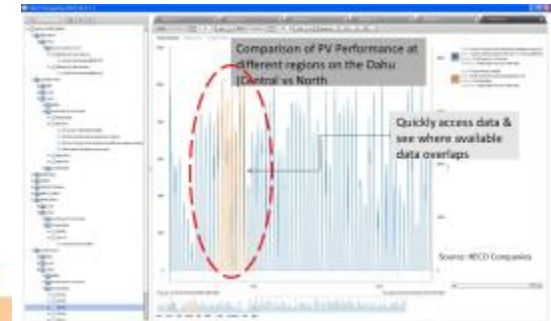

Before: Single Line View no geographic reference

After: Enhanced - Geographic orientation with DG PV (SynerGEE)

Goals :

- <u>Accelerate</u> the integration of synchrophasor information into data visualization and analysis platforms (Ops & Proactive Planning)
- <u>Leverage PMU capability</u> at substations – explore ways to tap resources and provide real-time visibility and real-time data
- Evaluate <u>synchrophasor data for</u> high penetrations renewable grids

Project Objectives & Status Review

✓ **Identify and evaluate recent "surprising" system events**
- Review of outage events (lighting strikes, hurricane outages, line and generator outage, wind storms)
- Uncovered significant <u>unexpected sympathetic load trips.</u> Where, how much and when are questions being asked. Distribution level and behind-the-meter DER assumed to be cause of change in system response.

✓ **Enable new visual capabilities and understanding**
- SEL SynchroWAVE and TEAM software providing <u>new real-time view and access of event data</u> (interpretation; data extract, system architecture at substation)
- Real-time AWS Truepower SWIFT forecasting tools enhanced to provide wind and solar forecasts and variability at the distribution substation level
- Implemented new data handling infrastructure using Referentia/In2lytics TREX and Perspective platform to support "big data" and advance time-series analysis capability

Hawaiian Electric
Maui Electric
Hawai'i Electric Light

Review of Event Using Synchrophasor Data
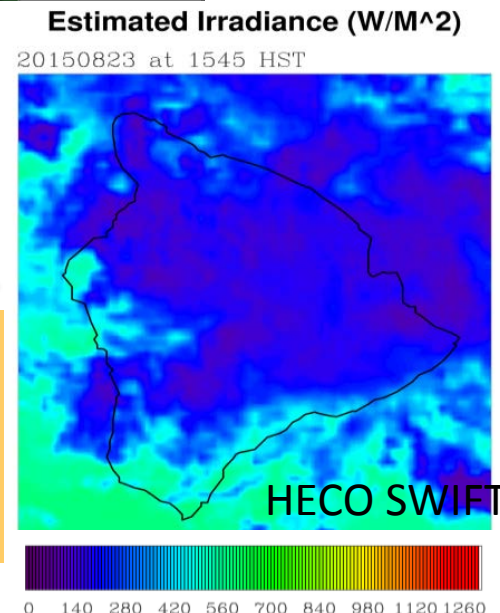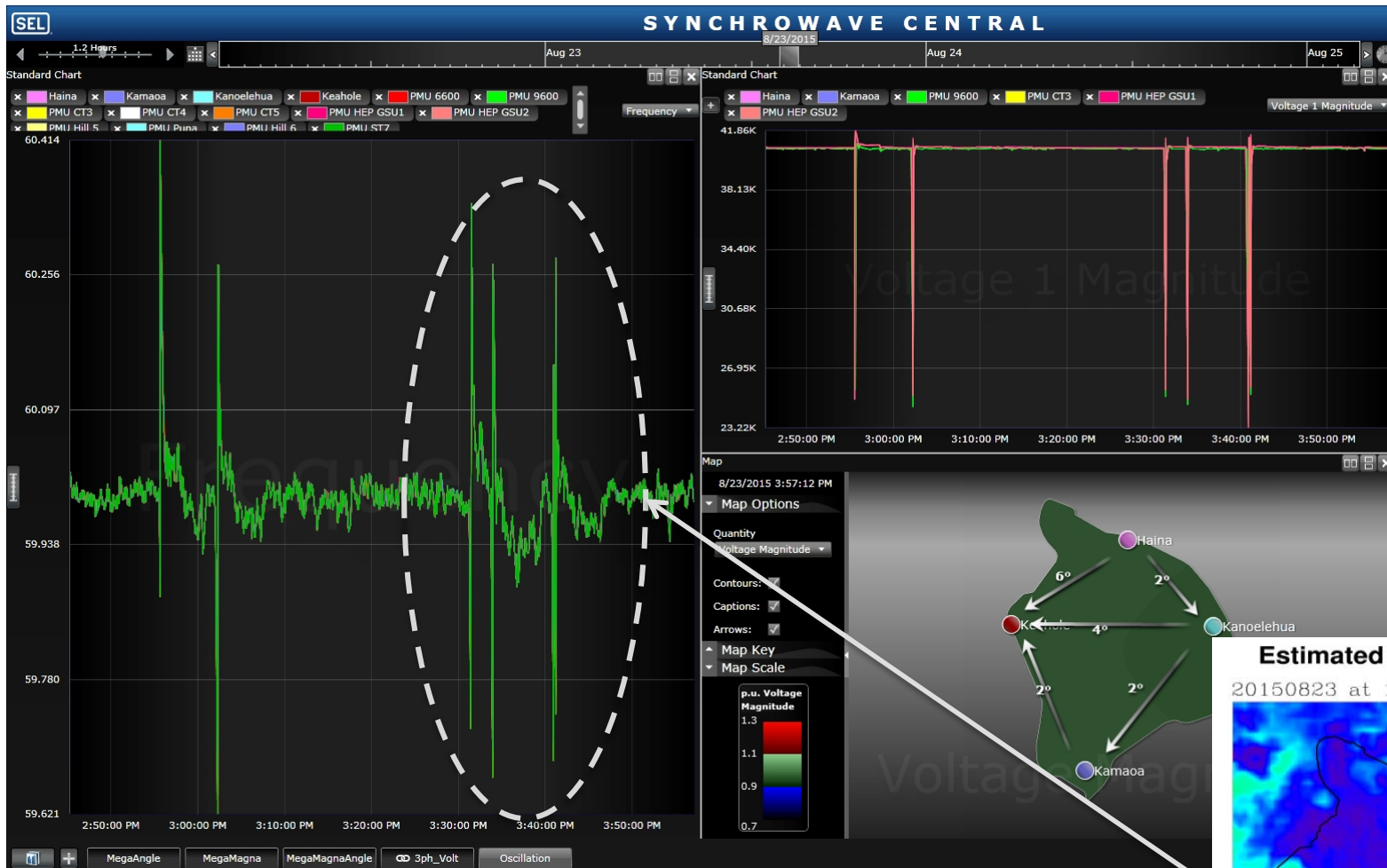
Real-time visual of solar and cloud conditons over Hawaii island during event on 8/23 at 3:45pm. Source: HECO SWIFT

# Project Objectives & Status Review

- ✓ **Utilizing & Making Actionable what Visuals are Providing Us**
  - – Utilize tools for managing conditions (hurricane monitoring)
  - – Using information to design and roll-out new monitoring devices (PMU, RTAC, IED) for more situational awareness of changing conditions
  - – Using post event reviews on the system to strategically develop new data sources for capturing distribution level issues
  - – Enhancing T&D models to be more predictive
  - – Facilitate development of more internal data analysis and review tools
  - – Development of new operating practices and settings in response

- ✓ **Disseminate lessons learned and contribute to national efforts (in progress)**
  - – Implemented new demonstration pilots
  - – Participate in various NASPI venues and Industry Venues
    - – Conferences: SEPA USC, SPI 2015, AWEA, StorageWeek, Distributech, IEEE, UVIG, EPRI
    - – Journals: T&D World, IEEE preceedings

Hawaiian Electric
Maui Electric
Hawai'i Electric Light

Enabled New Time-Series Data Handling Capabilities
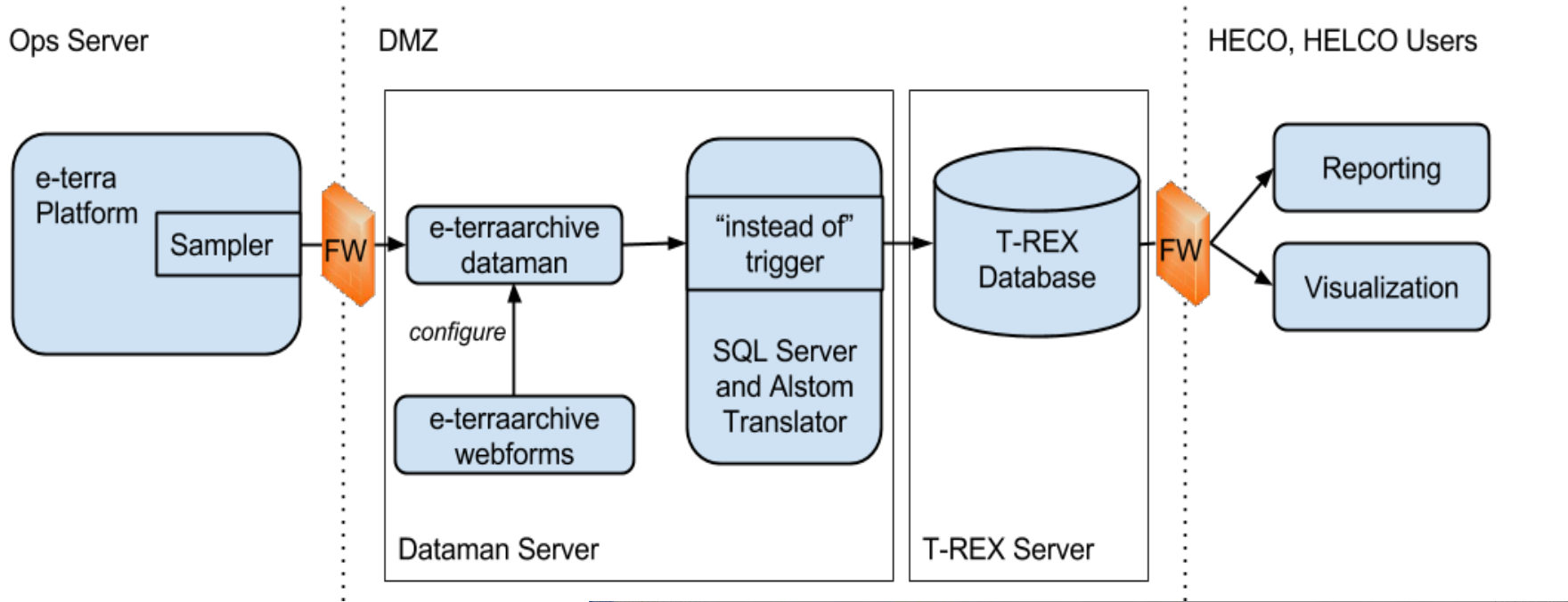
New Analysis Framework & Tools
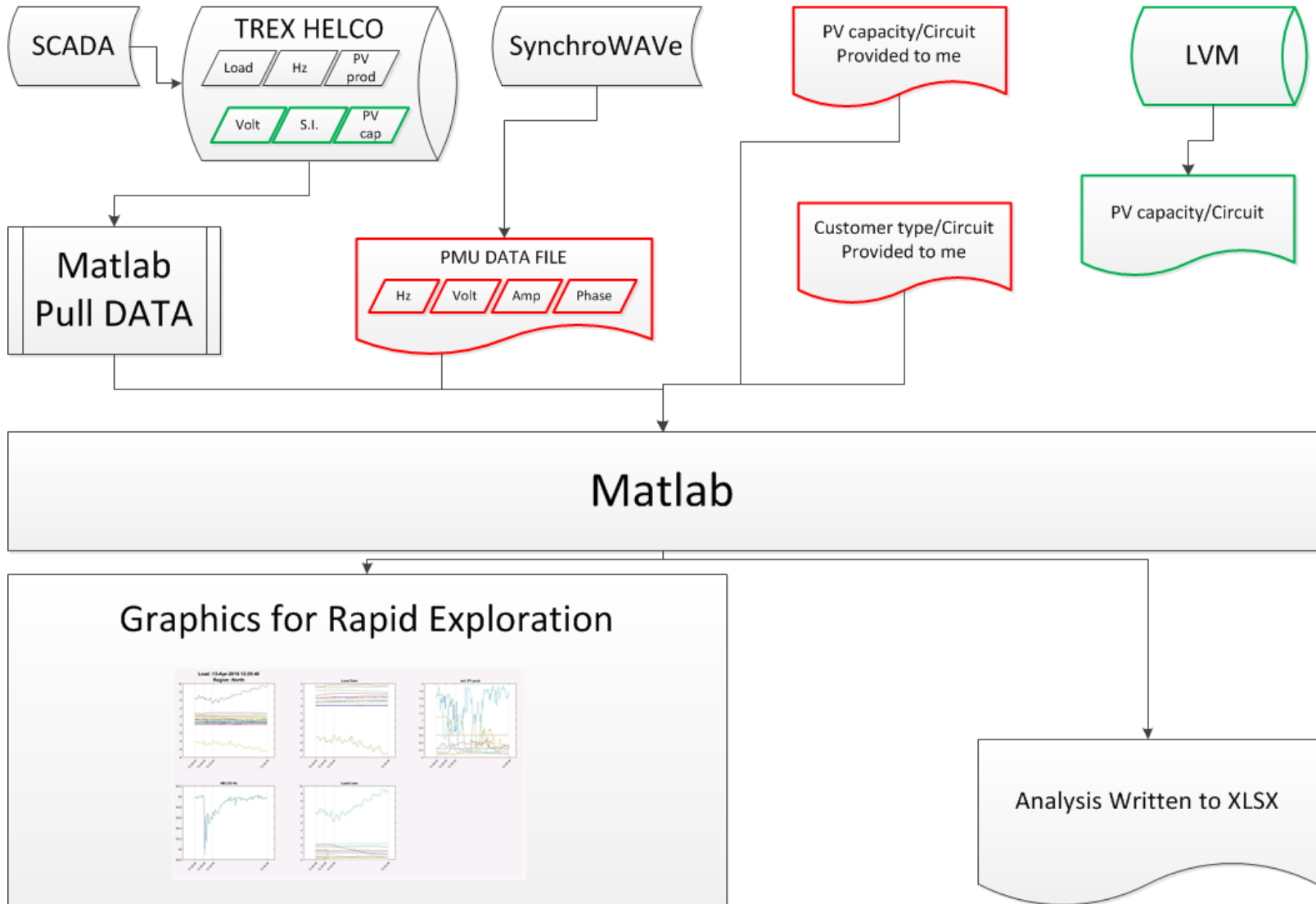
Faster Screening of Distribution Level Load Loss
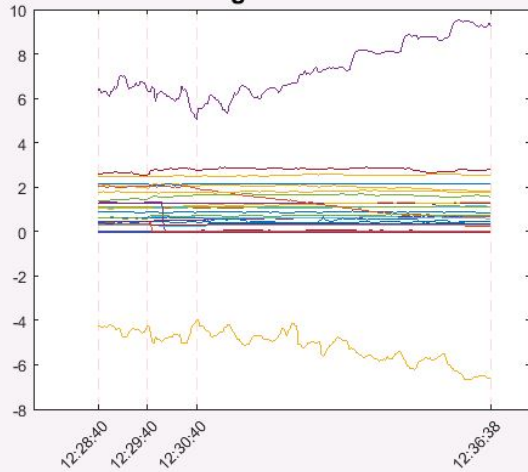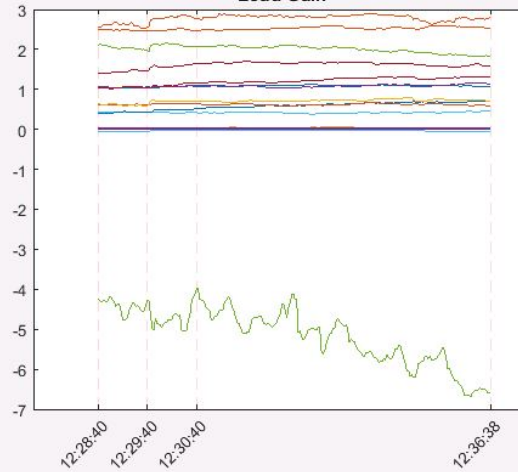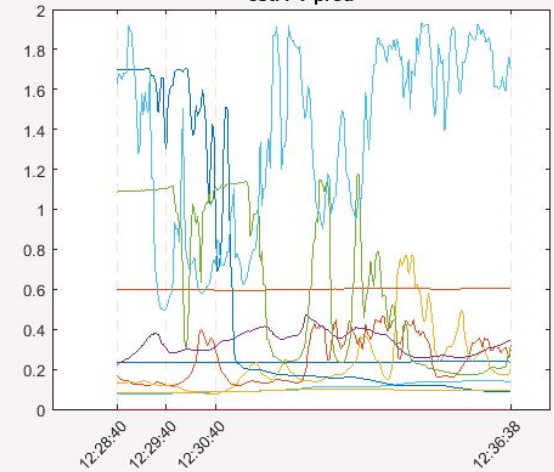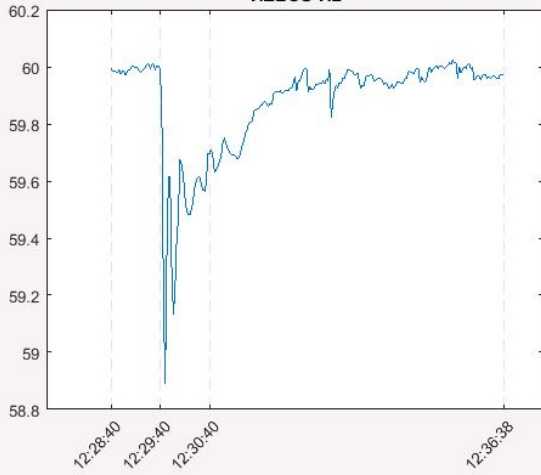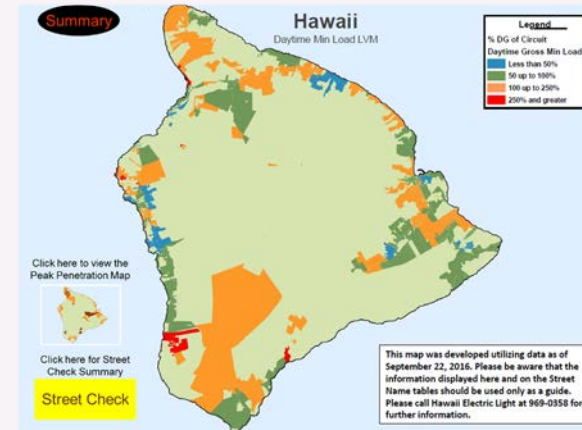
Locational Value Map

Hawaiian Electric
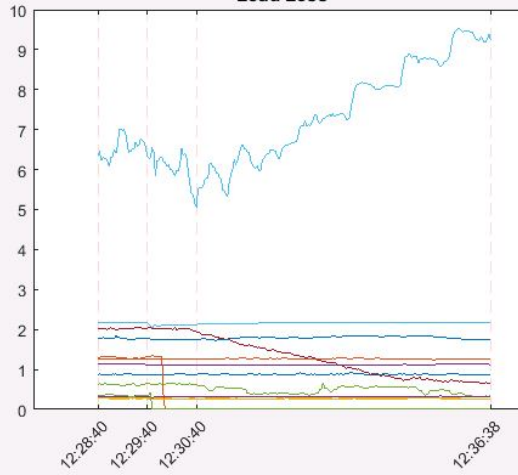**Maui Electric**
Hawai'i Electric Light

Simulation & Replication of Fault Event

Fault location

System Frequency

Freq rise due to 17 MW load drop
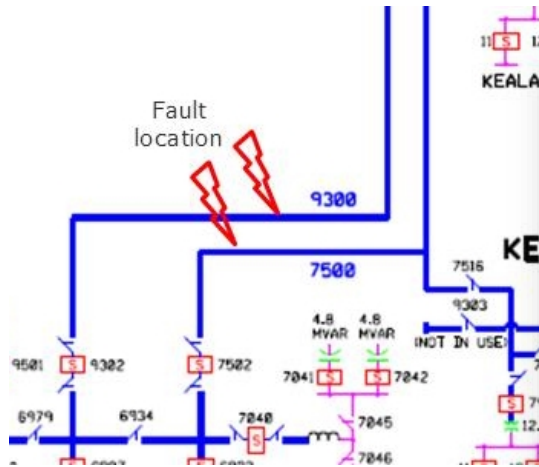
Comparison of Measured Frequency vs Analytical Result During Double Line Fault
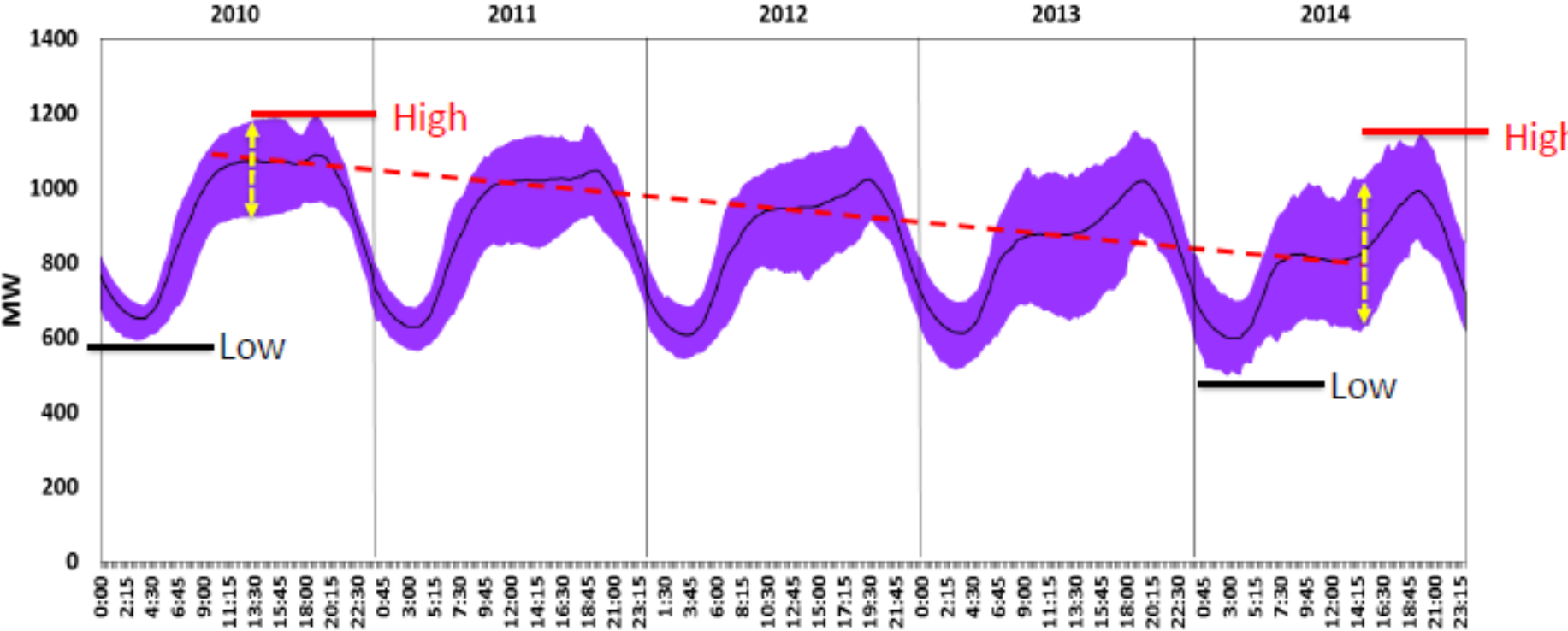
Measured · Analytical —
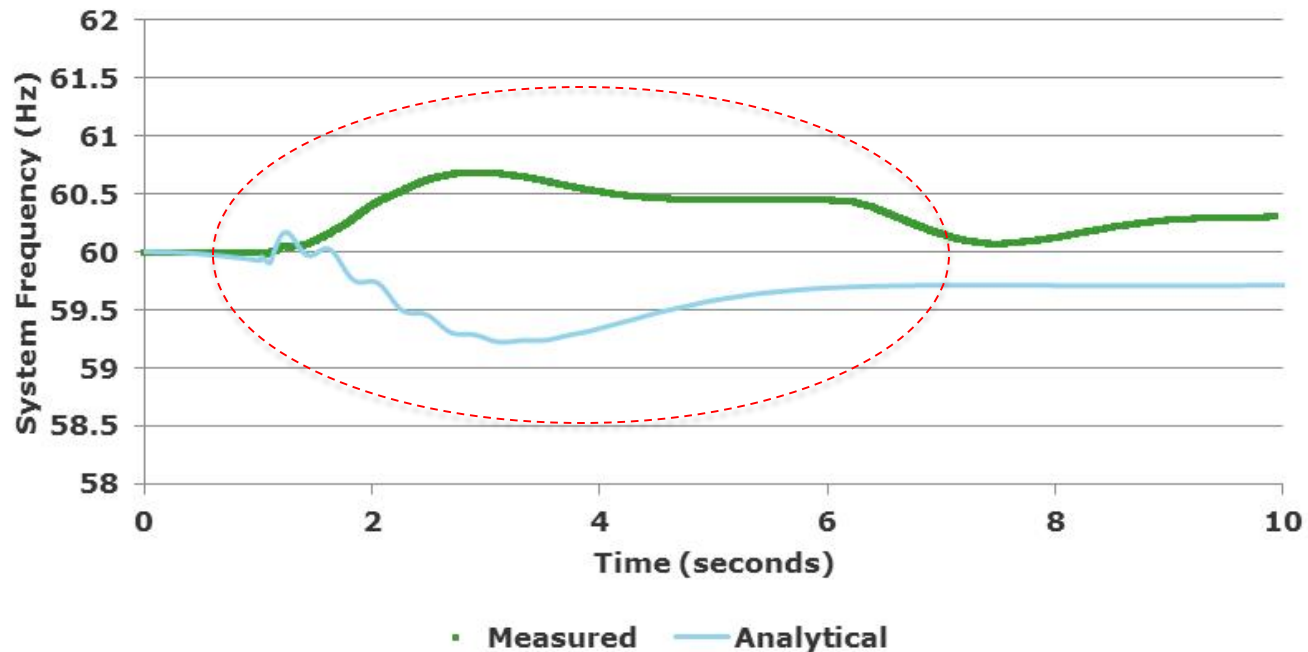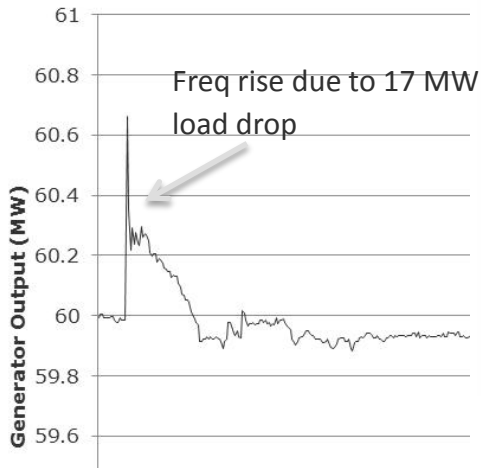
- The analysis of the fault event produced a different frequency profile than the measured data. No load was shed in the analysis.
- Review concluded that the protection and load characteristics need to be revised.

Hawaiian Electric
Maui Electric
Hawai'i Electric Light

11

Model Investigation - Next Steps

◆ Initial system model & conditions were set up correctly

◆ Dynamic model is stable

◆ The model produced different results for the fault event

- No load shedding occurred in the model, which resulted in a drop in frequency rather than a rise
- The cause of load shedding is to be identified
  - Not likely due to under-frequency
  - Could be due to under-voltage
- Utility to provide input on what load protection and conditions exists on the system (check loads)

**Hawaiian Electric
Maui Electric
Hawaiʻi Electric Light**

1
2

Change in Net System Load Trend over 4 Years

Oahu – Net System Load 7/2010 – 7/2014

System Dynamics – Day to Day

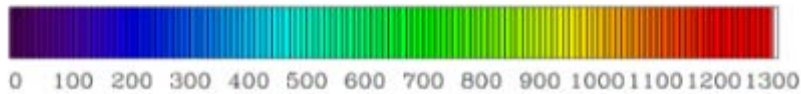20151104 at 1500 HST

Source: HECO SWIFT

3:00pm

November 4

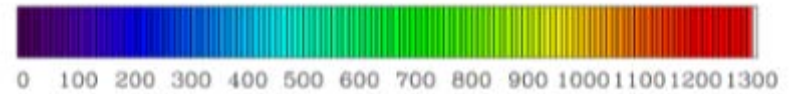Solar irradiance W/m²

0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300

20151107 at 1500 HST

3:00pm

November 7

Solar irradiance W/m²

0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300

Clear, Moderate Production Day

Cloudy Low Day

Nov4-7_CentralRegion_GD1
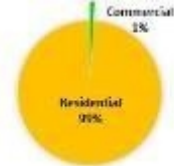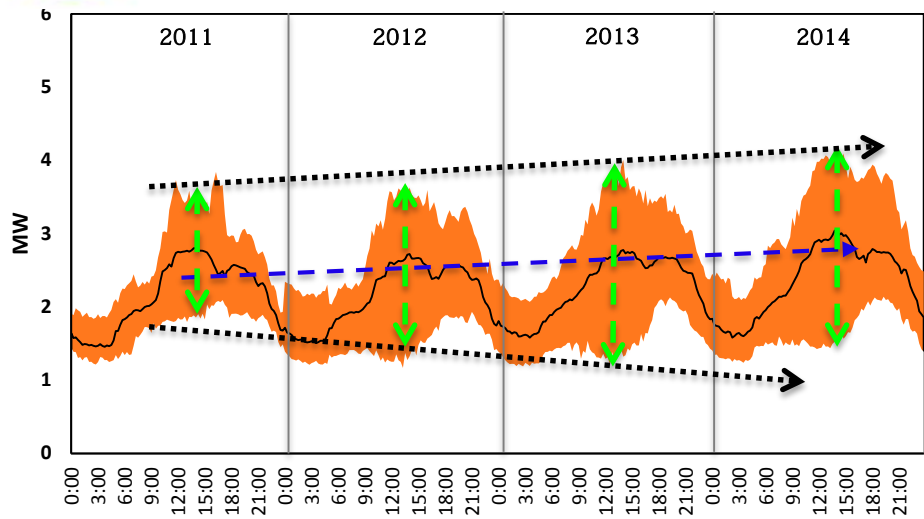Nov4-7_CentralRegion_GD2
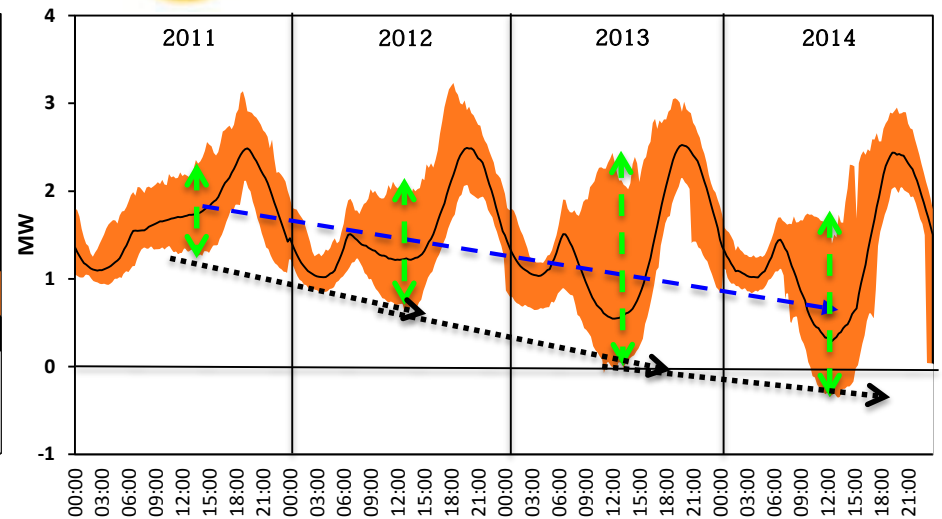
Solar Irradiance (W/m²)

Time
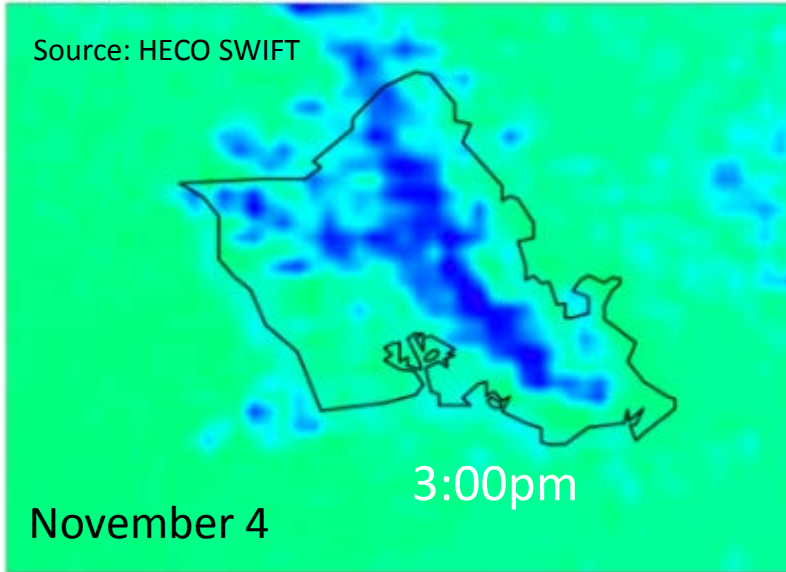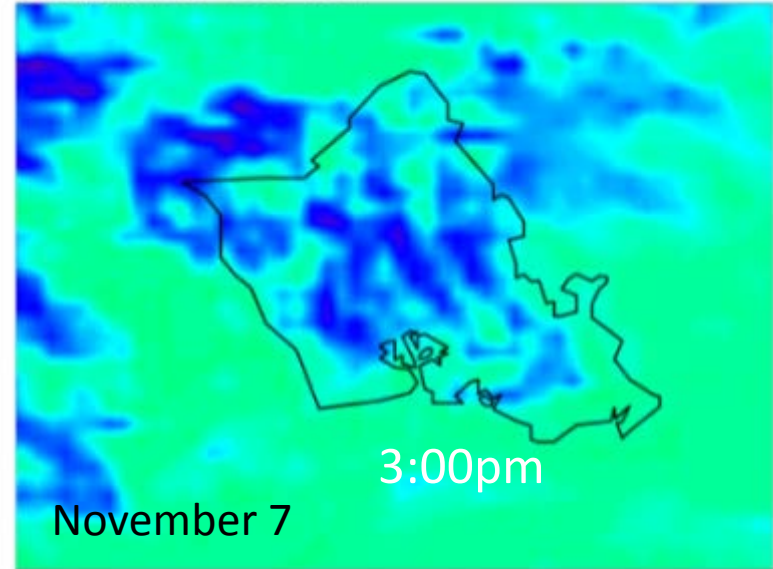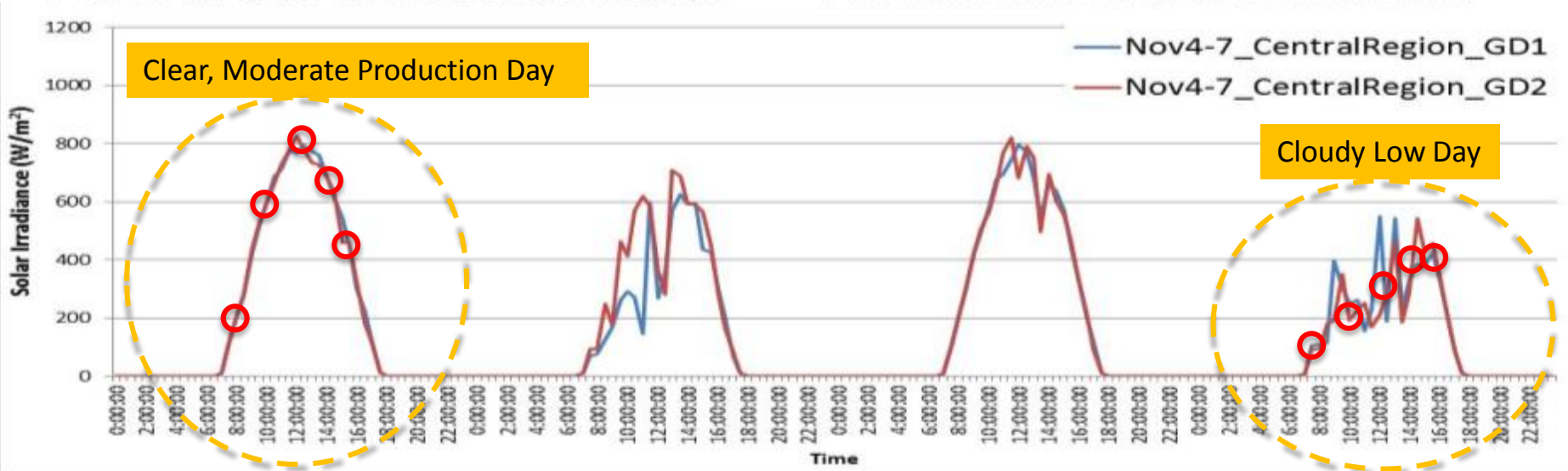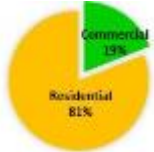
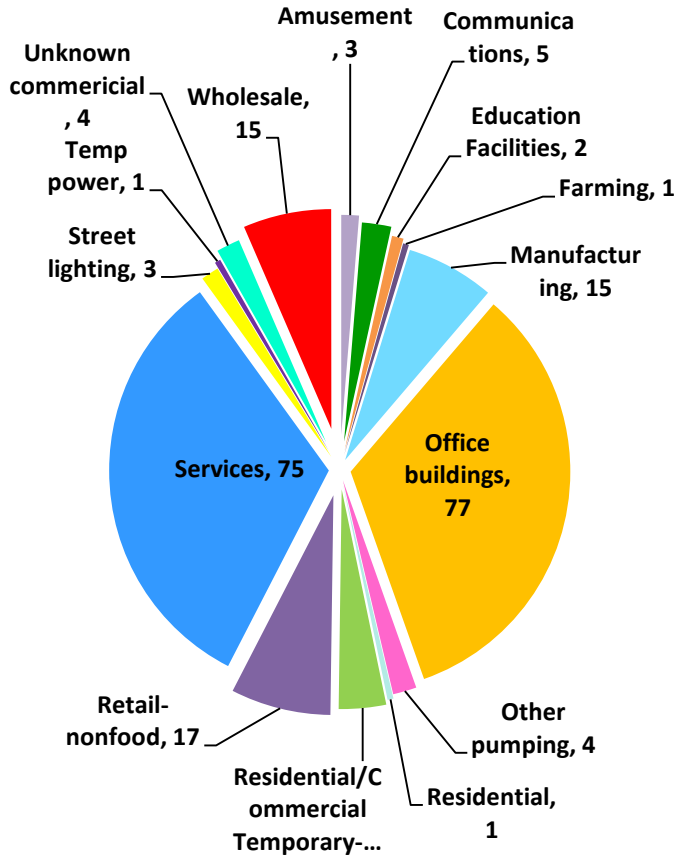Annual Circuit Net Load
(80%Commercial/ 20% Residential Circuit)

Annual Circuit Net Load
(99% Residential Circuit)

Need Better Understand of Customer Load Changes on the Circuit

By Customer Count

By Energy Use

| Rate Schedule	BSC	Count
1_CO_OWNED		1
	Other pumping	1
1_G		168
	Amusement	2
	Communications	4
	Farming	1
	Manufacturing	8
	Office buildings	70
	Other pumping	2
	Residential	1
	Residential/Commercial Temporary-Straight	4
	Retail-nonfood	12
	Services	51
	Street lighting	3
	Temp power	1
	Unknown commericial	3
	Wholesale	6
1_J		59
	Amusement	1
	Communications	1
	Education Facilities	2
	Manufacturing	6
	Office buildings	7
	Other pumping	1
	Residential/Commercial Temporary-Straight	4
	Retail-nonfood	5
	Services	24
	Wholesale	8
1_P		1
	Wholesale	1
C_FIT		2
	Manufacturing	1
	Unknown commericial	1
Grand Total		231
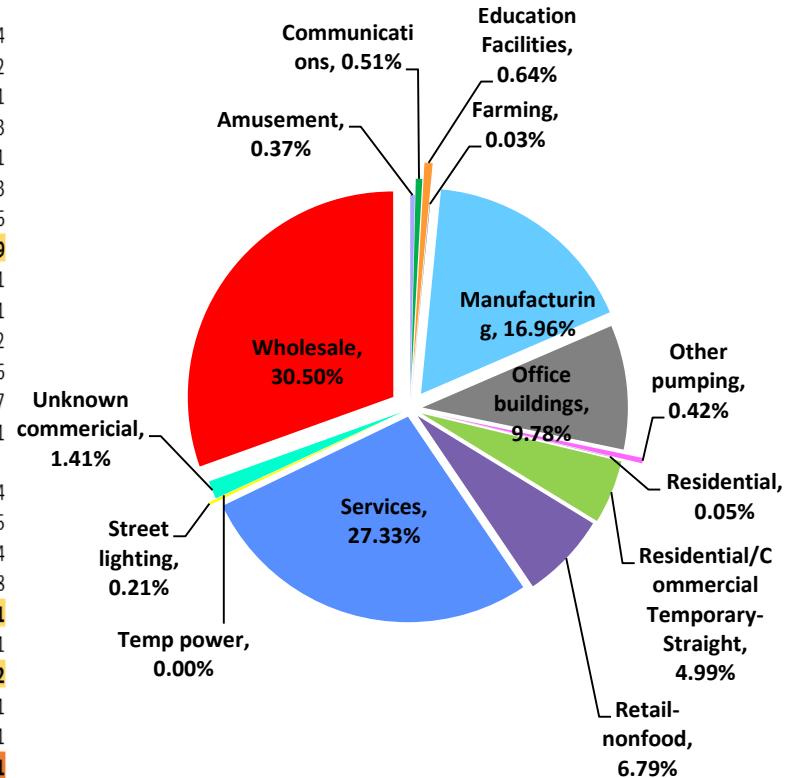
Feedback During Hurricanes Madeline & Lester
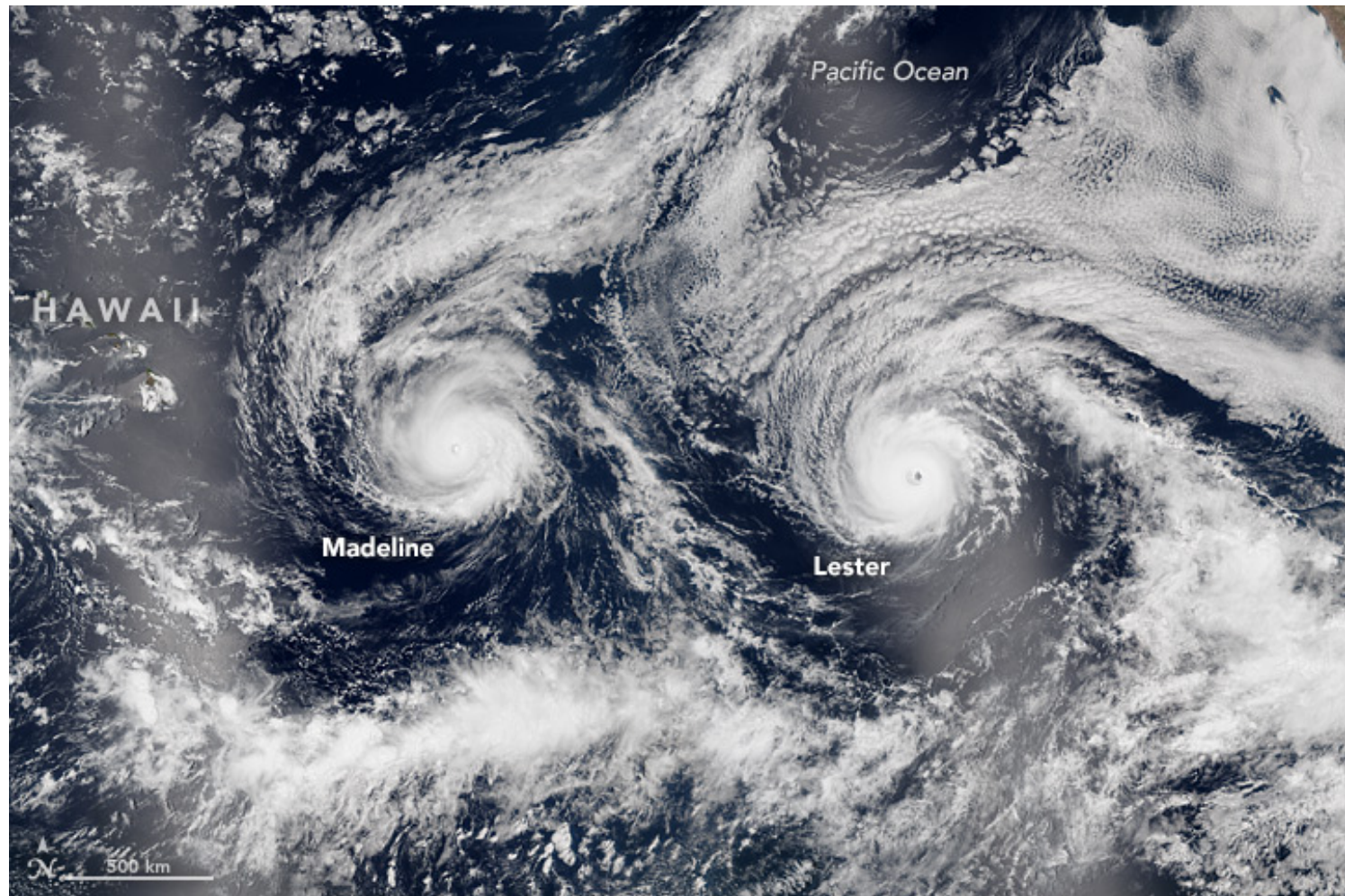
80 Meter Wind Speed AGL (m/s) — Updated: Aug-31-2016 at 14:00 HST
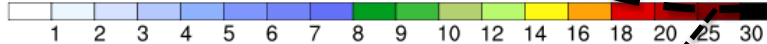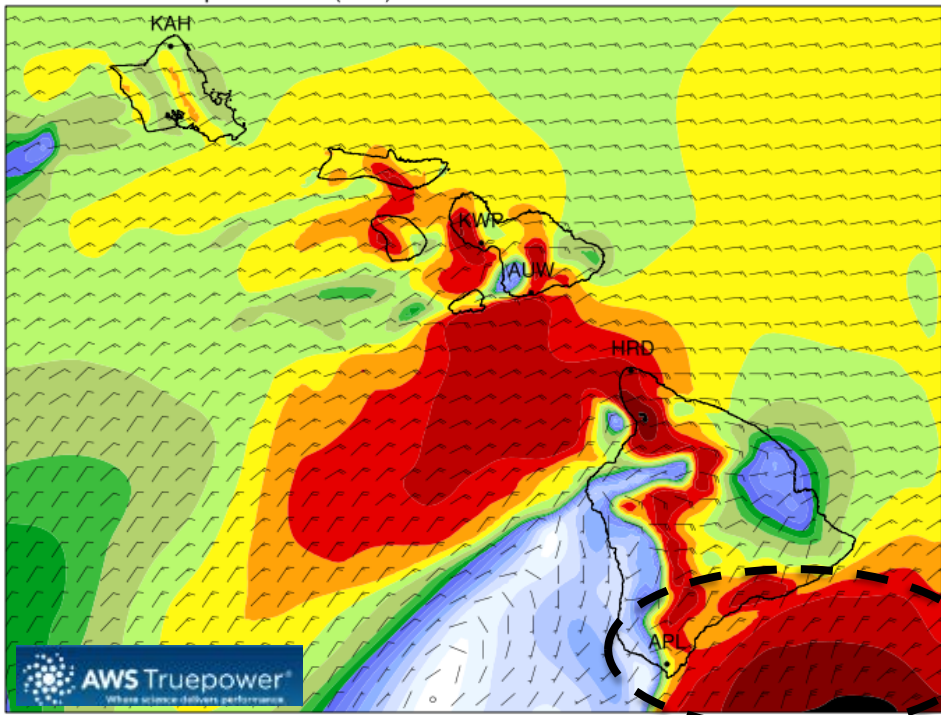
80 Meter Wind Speed AGL (m/s) — Updated: Sep-03-2016 at 10:00 HST
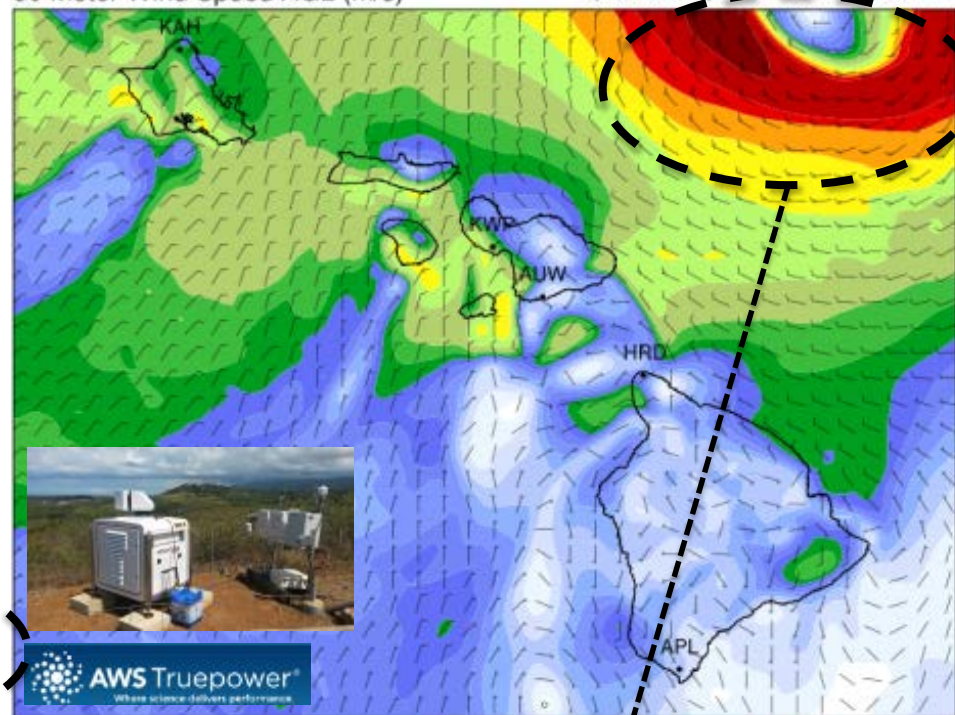
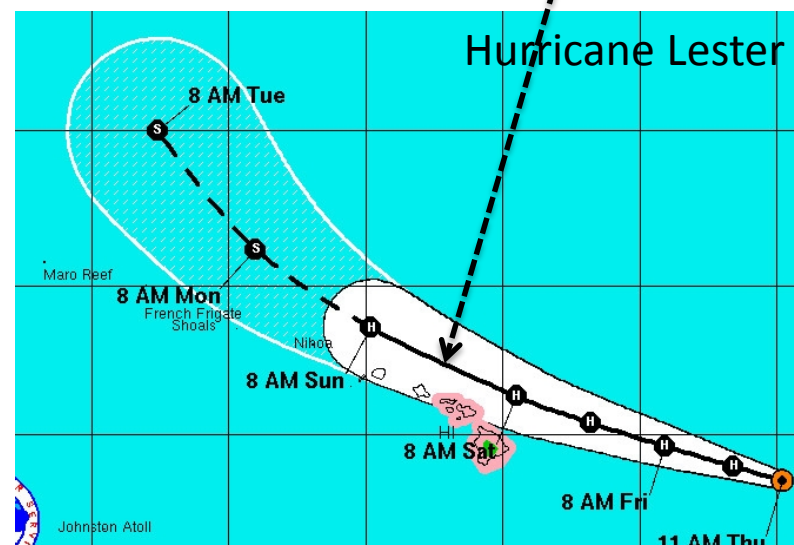Hurricane Madeline
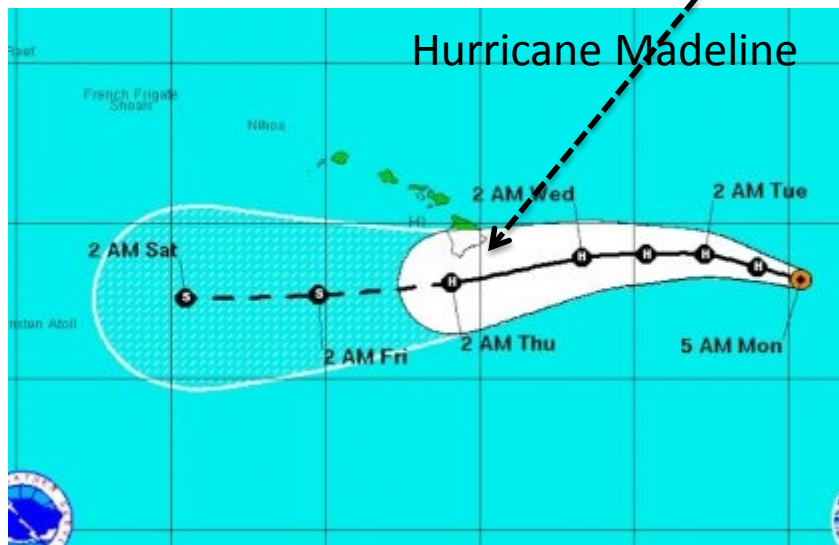
Hurricane Lester

Enhancing Operational Awareness with Data-Driven Tools

"Show me
- Where,
How much
and
When?"

Next Steps

- ◆ Implement Predictive Analysis & Visualization Tools
  - ➤ Situational awareness of real-time monitoring
  - ➤ Understanding of distribution impacts and sources
  - ➤ Provide new measured data for verification and confidence building
- ◆ Modeling Enhancements
  - ➤ Incorporating synchrophasor data into transmission model analysis to improve understanding of load shed conditions
  - ➤ Evaluate enhancement model needs to provide early prediction capability
- ◆ Equipment Deployment & Verification
  - o Provide new measured data at strategic locations for verification and confidence building
- ◆ Complete project - September 2017 with tools implemented

Hawaiian Electric
Maui Electric
Hawai'i Electric Light

Questions/Comments??

Mahalo

For more information please contact:

Dora Nakafuji, PhD
dora.nakafuji@heco.com

Director of Renewable Energy Planning
Hawaiian Electric Company

Hawaiian Electric
Maui Electric
Hawai'i Electric Light