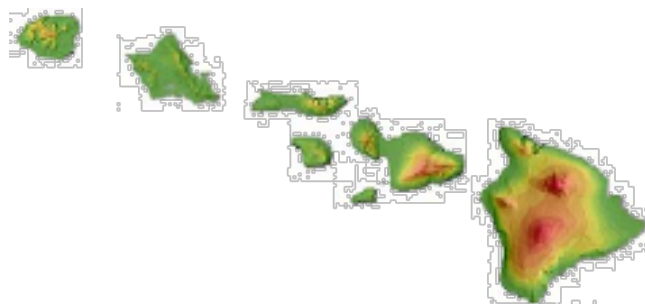


Update on SynchroVIEEU – High Penetration PV Utility



Dora Nakafuji (HECO); Jared Bestebreuer (SEL)

NASPI

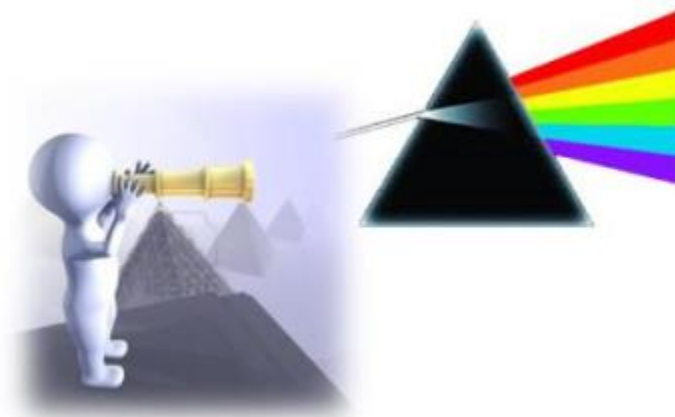
October, 15 2015



Hawaiian Electric
Maui Electric
Hawai'i Electric Light

Topics

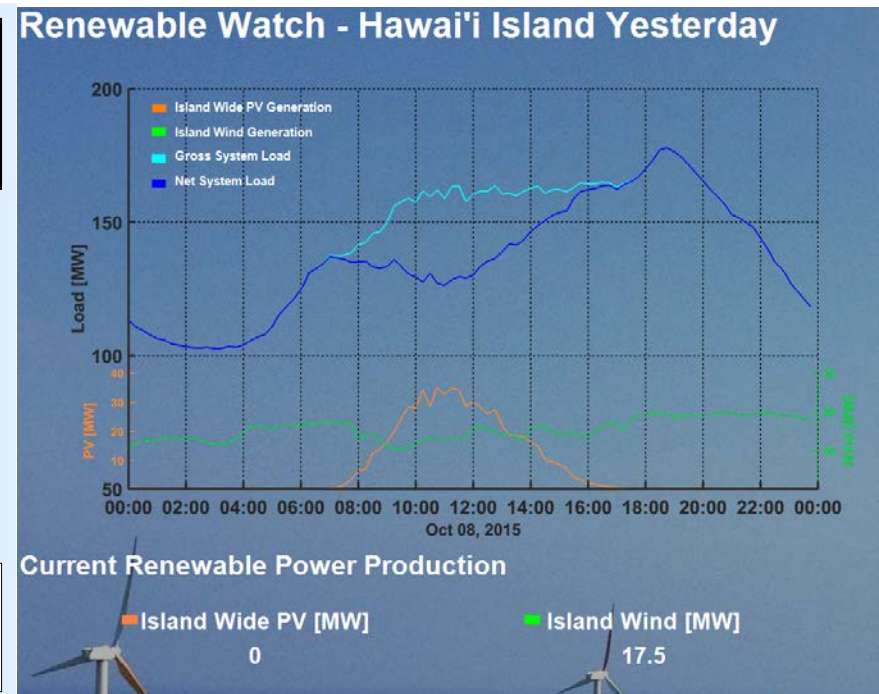
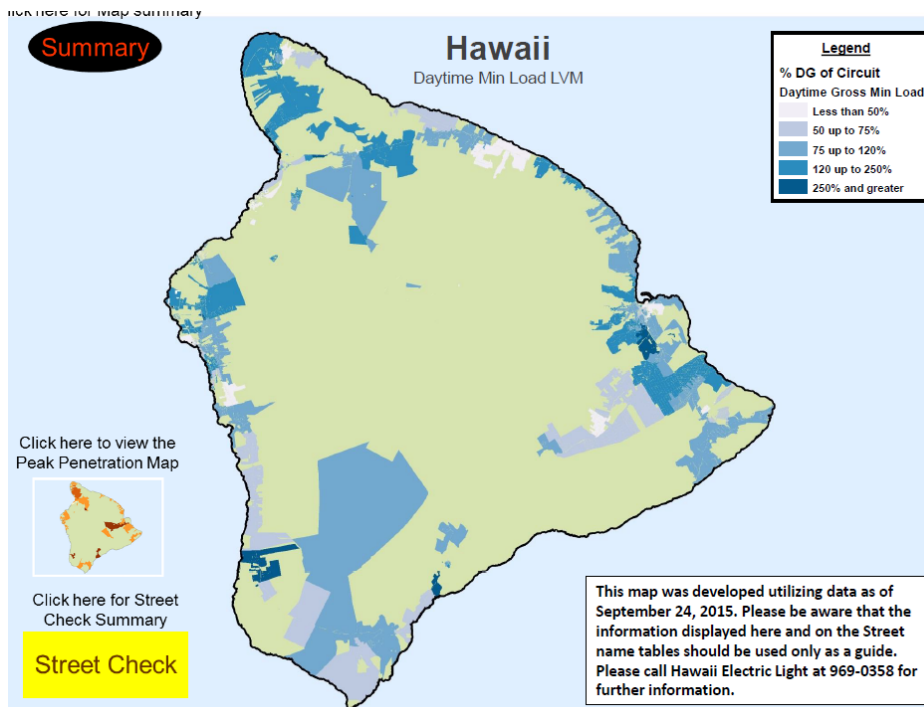
- ◆ Penetration Issues in Hawaii
- ◆ Quick Review of Project – Goals & Tasks
- ◆ Views from SynchroVIEEU on Events
- ◆ Q&A



Hawaiian Electric
Maui Electric
Hawai'i Electric Light

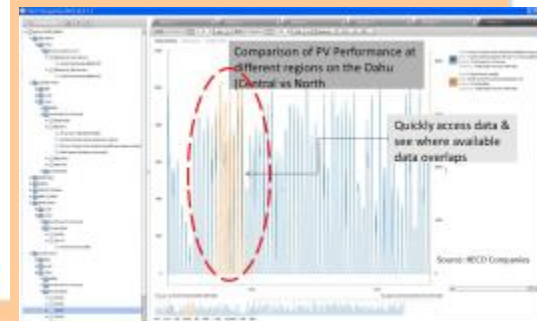
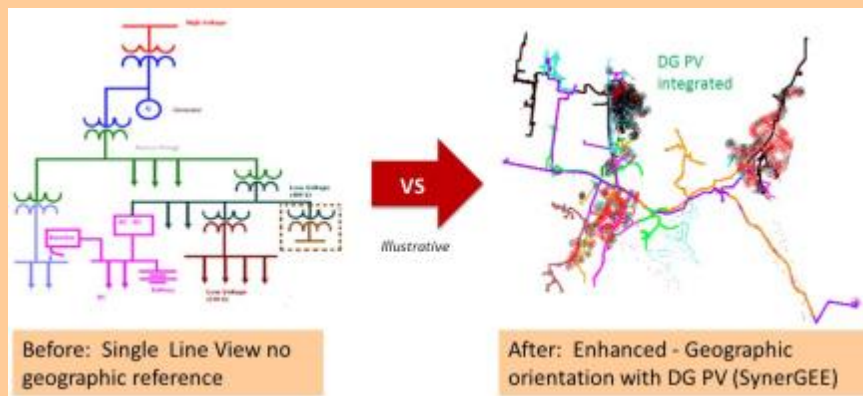
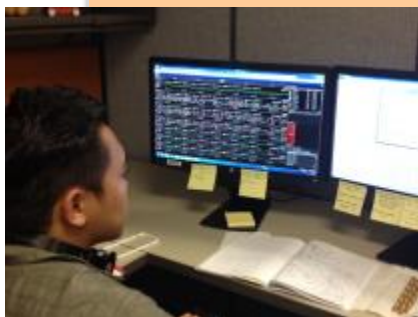
Hawaii at 100% RPS

- ◆ PUC ruling to replace NEM with Self-supply and Grid-supply & TOU
- ◆ Emergence of behind the meter storage for both customer use and grid response
- ◆ 100% RPS goals & distributed resource utilization
- ◆ Use of hosting capacity and % availability to evaluate DG impacts



Project Summary

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



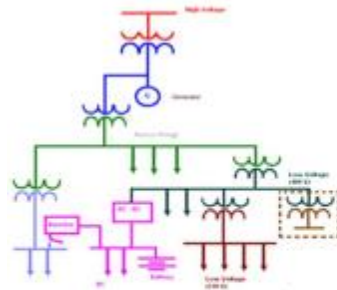
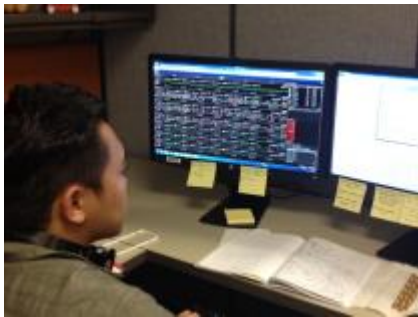
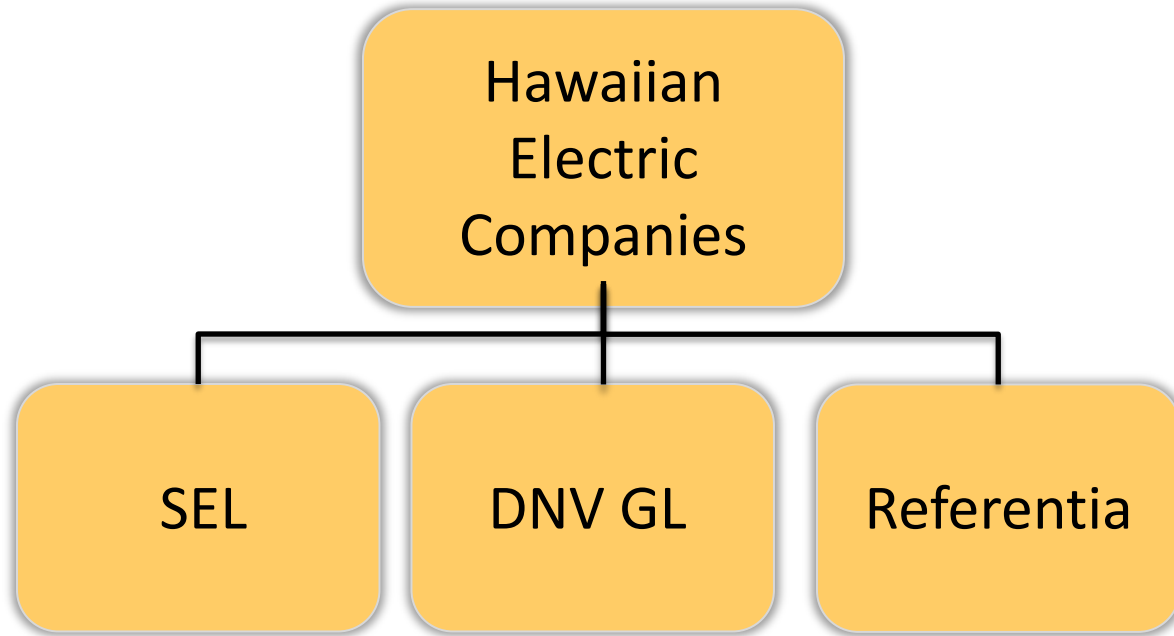
Goals :

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

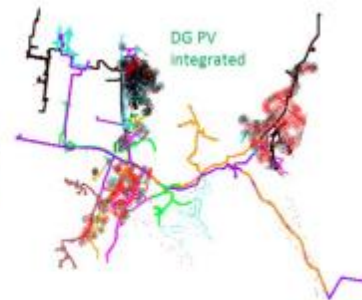
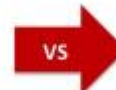


Hawaiian Electric
Maui Electric
Hawai'i Electric Light

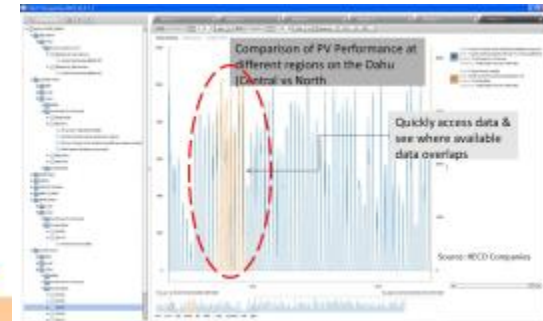
SynchroVIEEU Team



Before: Single Line View no geographic reference



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



Hawaiian Electric
Maui Electric
Hawai'i Electric Light



referentia



SCHWEITZER
ENGINEERING
LABORATORIES



DNV

Project Objectives & Status Review

- ✓ **Visualization: Make Actionable what the Tools are Providing Us**
 - SEL SynchroWAVE and TEAMS software training workshop (HELCO) for real-time view and access of event data (interpretation; data extract, system architecture at substation)
- ✓ **Identify and Evaluate System Events of Interest (in Progress)**
 - Review synchrophasor data from recent events (lighting strikes, hurricane outages, line and generator outage, wind storms) with relay, resource and other grid data
- ✓ **Contribute to national efforts, build collaborative utility-vendor partnerships and capabilities (in progress)**
 - NASPI 2015, California; Industry Venues: SEPA USC, SPI 2015, Asia Pacific Clean Energy Summit; Abstract submission; NASPI 2015 (Fall)
- ✓ **Disseminate lessons learned and add relevant capabilities to the field using commercial grade products (in progress)**



Event Analysis: Recent System Issues

Day, Date Time	Line	Fault Type	At Gen Sub Lowest Voltage (A/B/C phase)	Load Loss (MW)	High Freq Measured
Sun, 8/23 0055	67	2-Line-Gnd	0.28pu/0.26pu/0.79pu	17	60.68
Sun, 8/23 1455	75/93	3-phase	0.44pu/0.46pu/0.42pu	17	60.41
Sun, 8/23 1541	62	3-phase	0.45pu/0.45pu/0.45/pu	20	60.43
Thu, 9/3 1454	81/82	3-phase	0.41pu/0.43pu/0.41pu	18	60.41
Sun, 9/13 1641	71	3-phase	0.28pu/0.30pu/0.28pu	17	60.32
Tue, 9/15 1733	75/93	A-Gnd	0.26pu/0.68pu/0.66pu	20	60.5

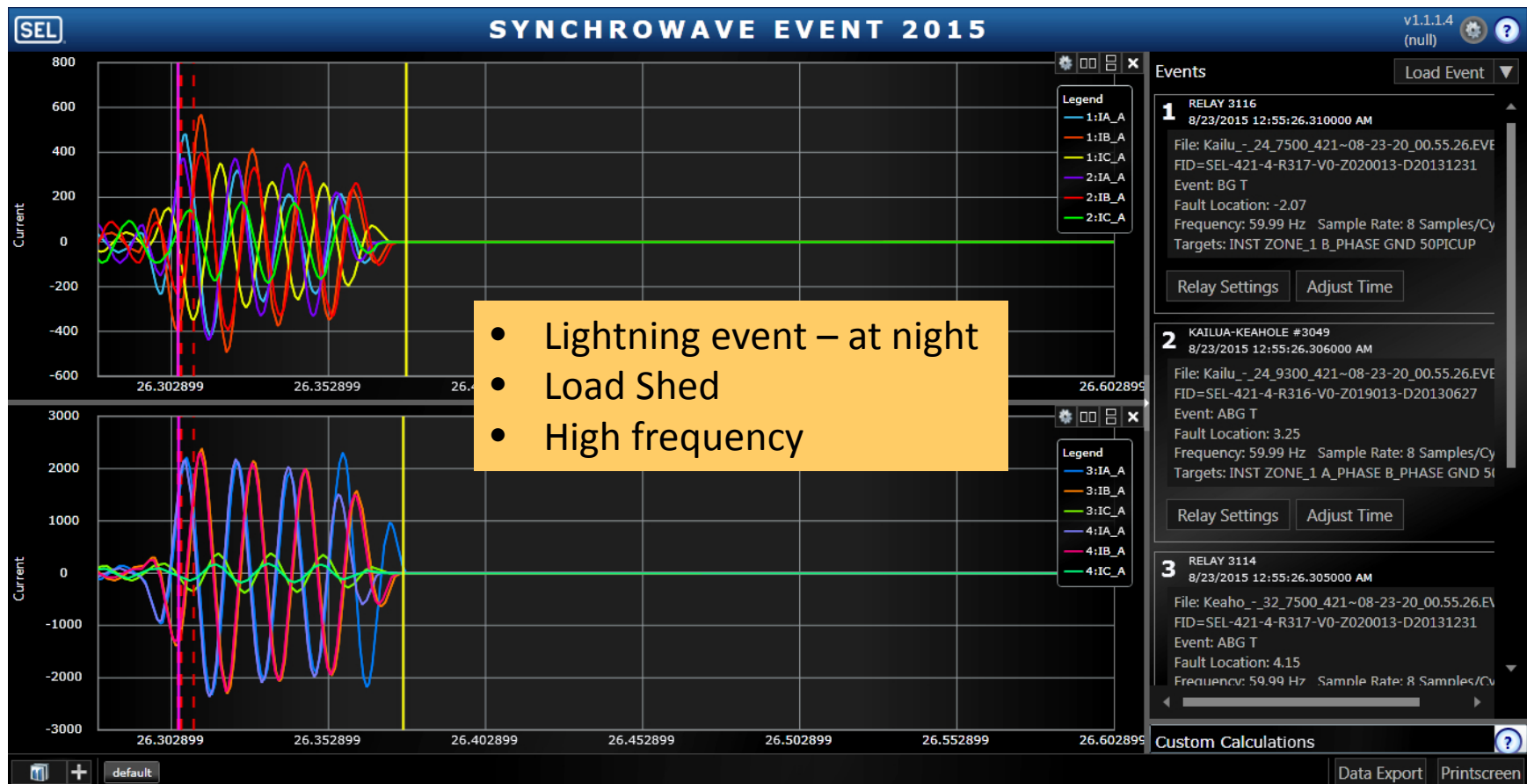


Hawaiian Electric
Maui Electric
Hawai'i Electric Light

Increasing load shed and loss of load during events are growing concerns and motivating the synchrophasor post-event analysis

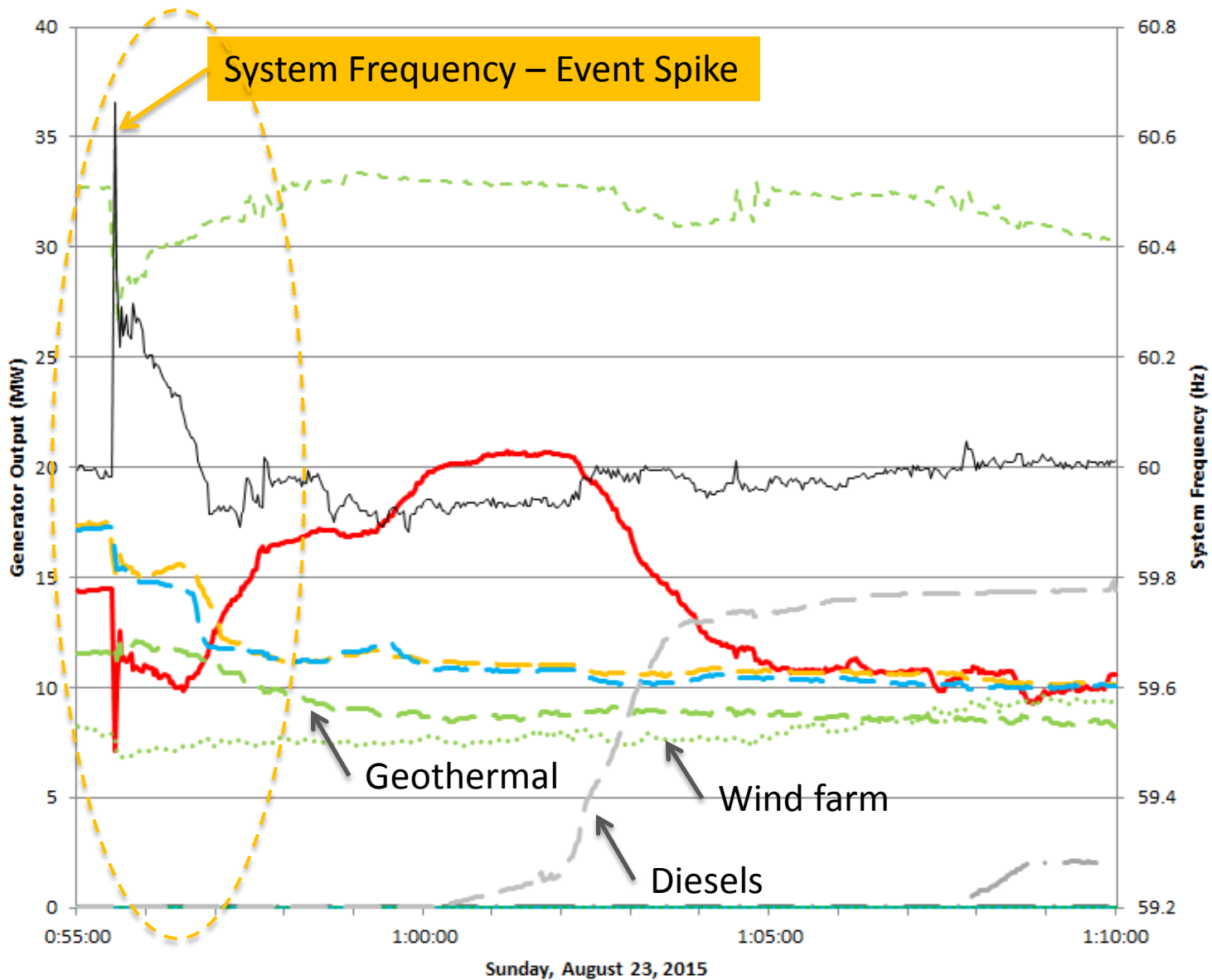
8/23 event – “Awesome Tool”

- Top shows one end of line and 2nd graph shows other end of major transmission line between 2 generators. Can see response time from 1st relay until breaker open = 71 ms

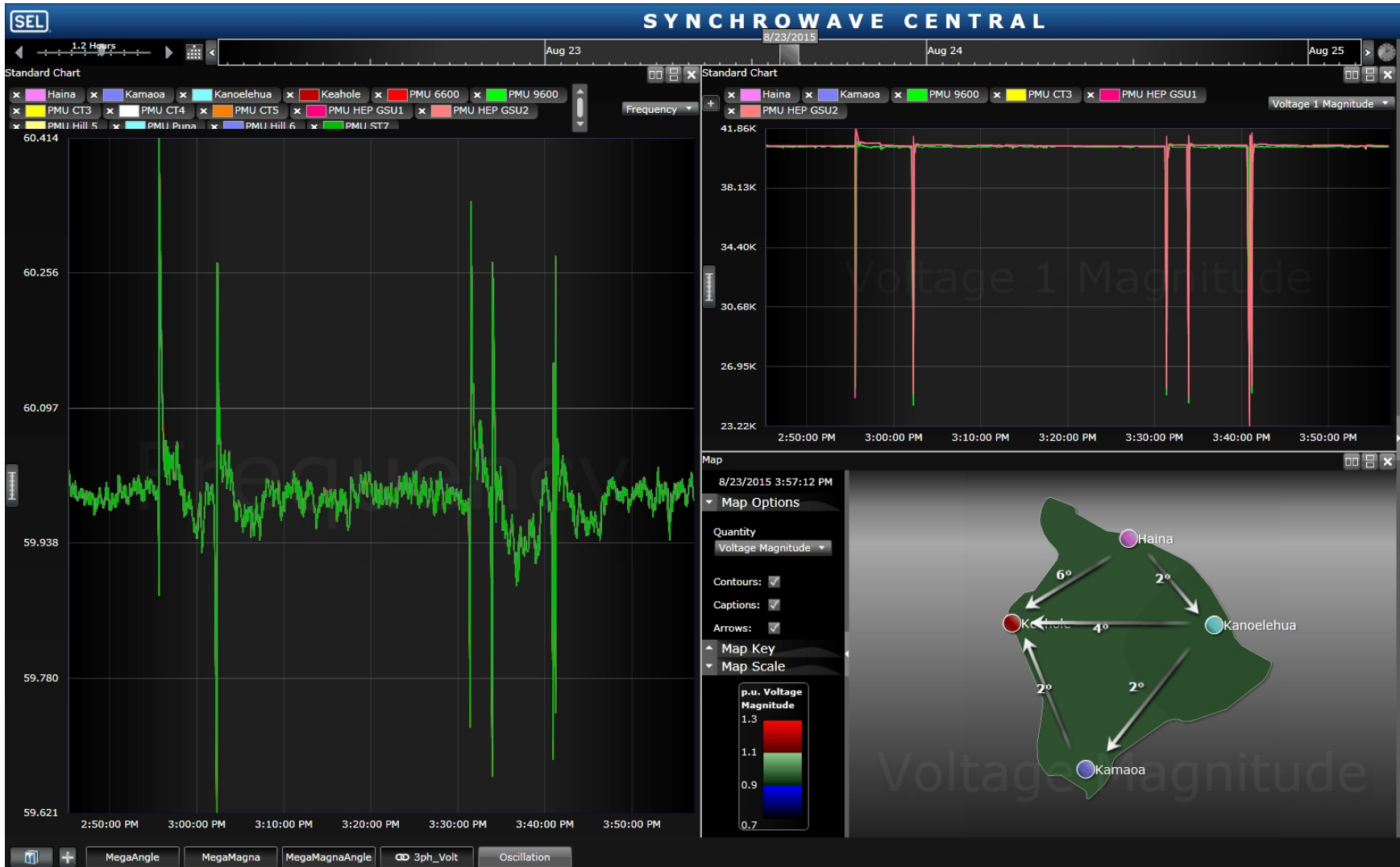


Hawaiian Electric
Maui Electric
Hawai'i Electric Light

System Response - Line Fault due to Lightning (high freq 60.68Hz condition)



Aug 23 Event – Daytime with PV



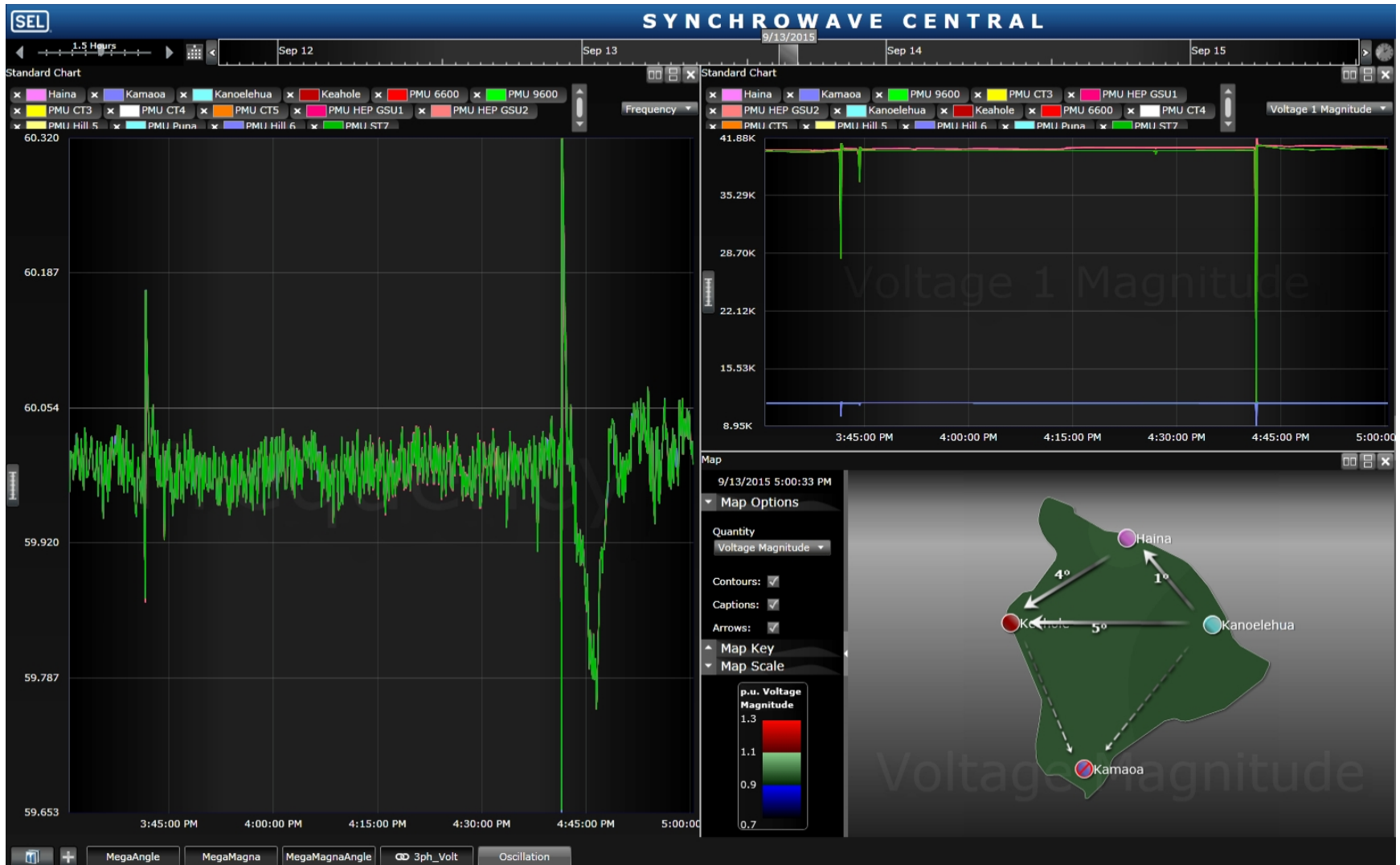
**Hawaiian Electric
Maui Electric
Hawai'i Electric Light**

9/3 Event – Daytime with PV



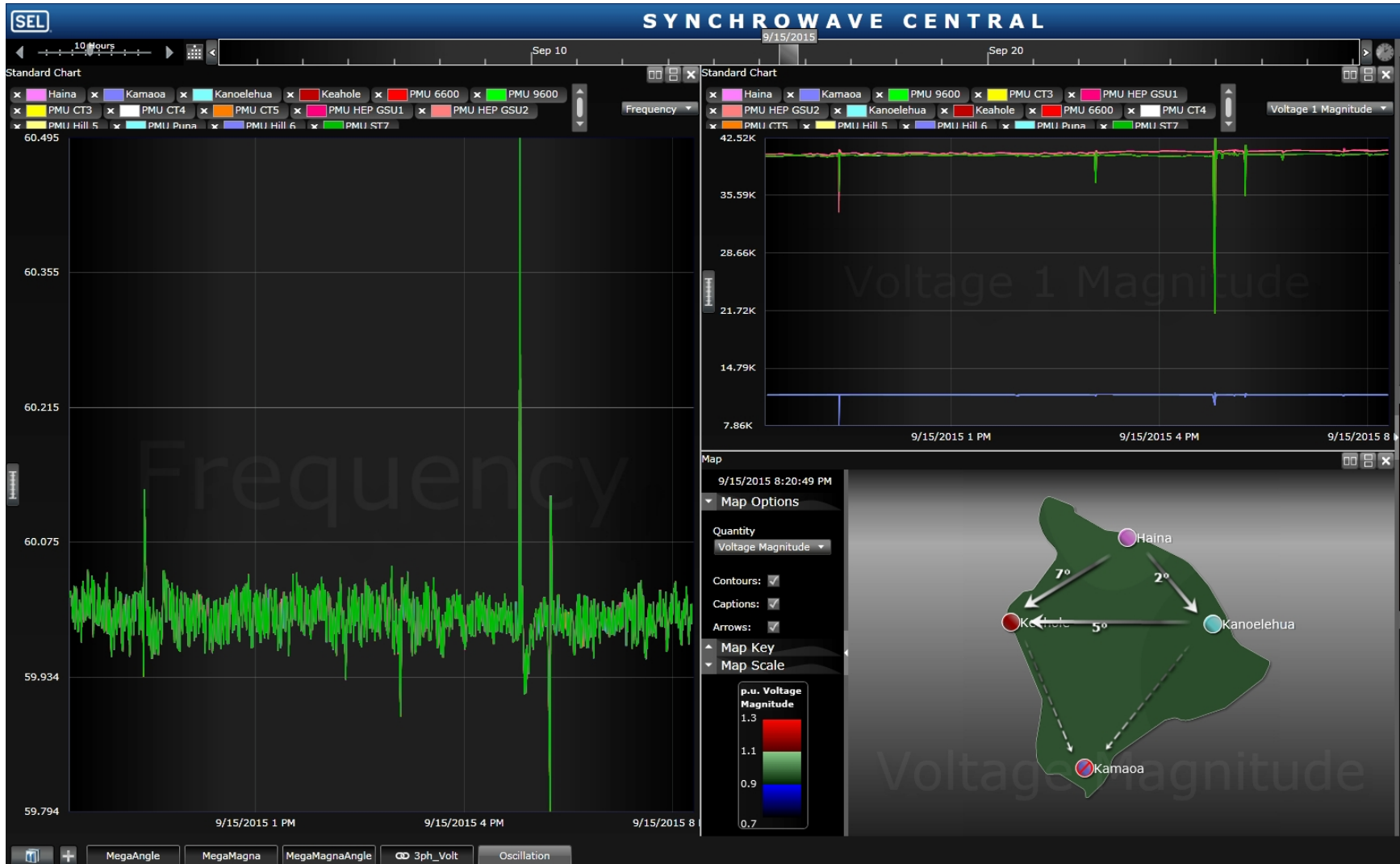
Hawaiian Electric
Maui Electric
Hawai'i Electric Light

9/13 Event – Daytime with PV

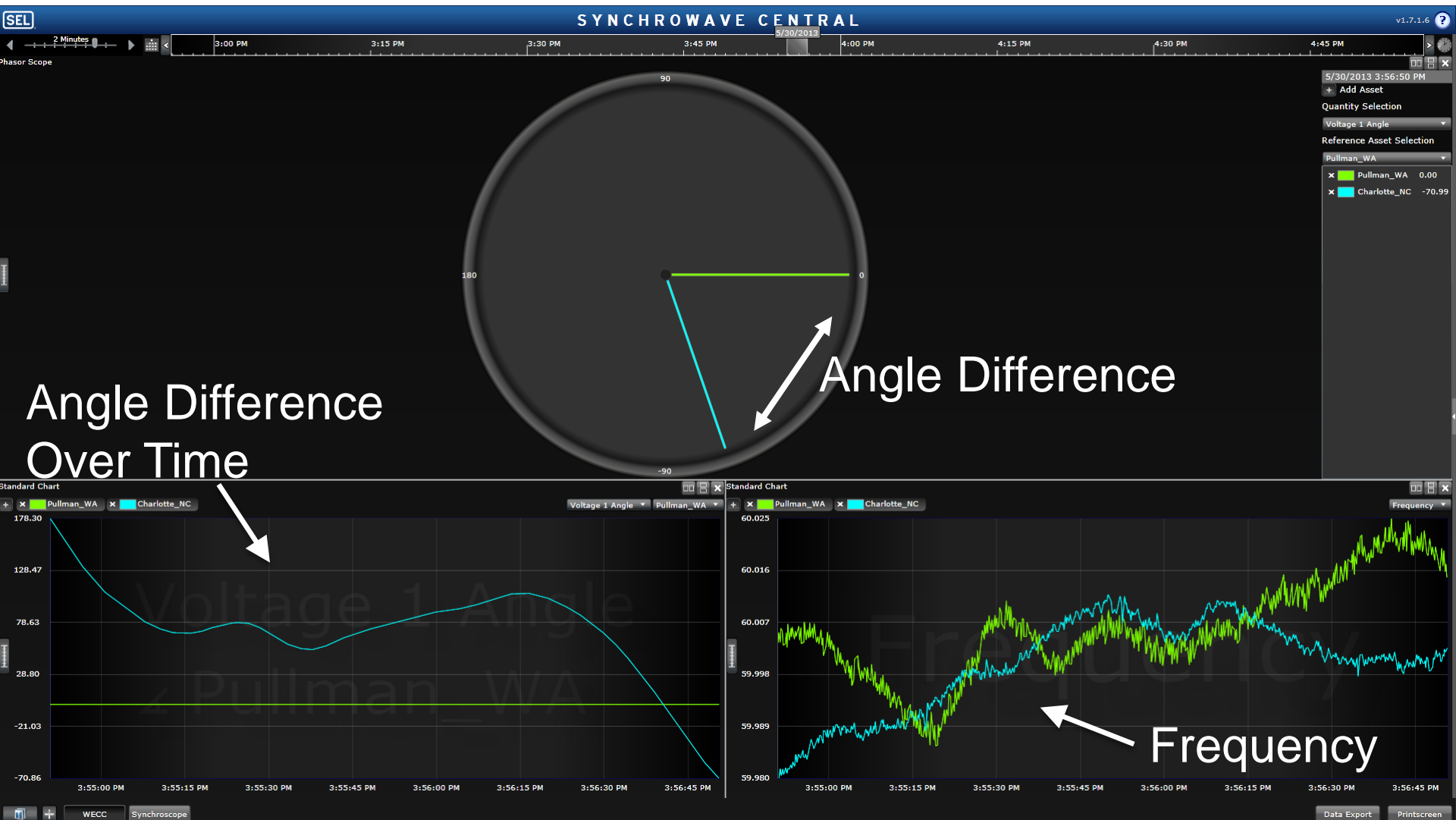


Hawaiian Electric
Maui Electric
Hawai'i Electric Light

9/15 Event – Daytime with PV



Next Steps – Hi-Pen PV Early Predictors?



Angle Difference
Over Time

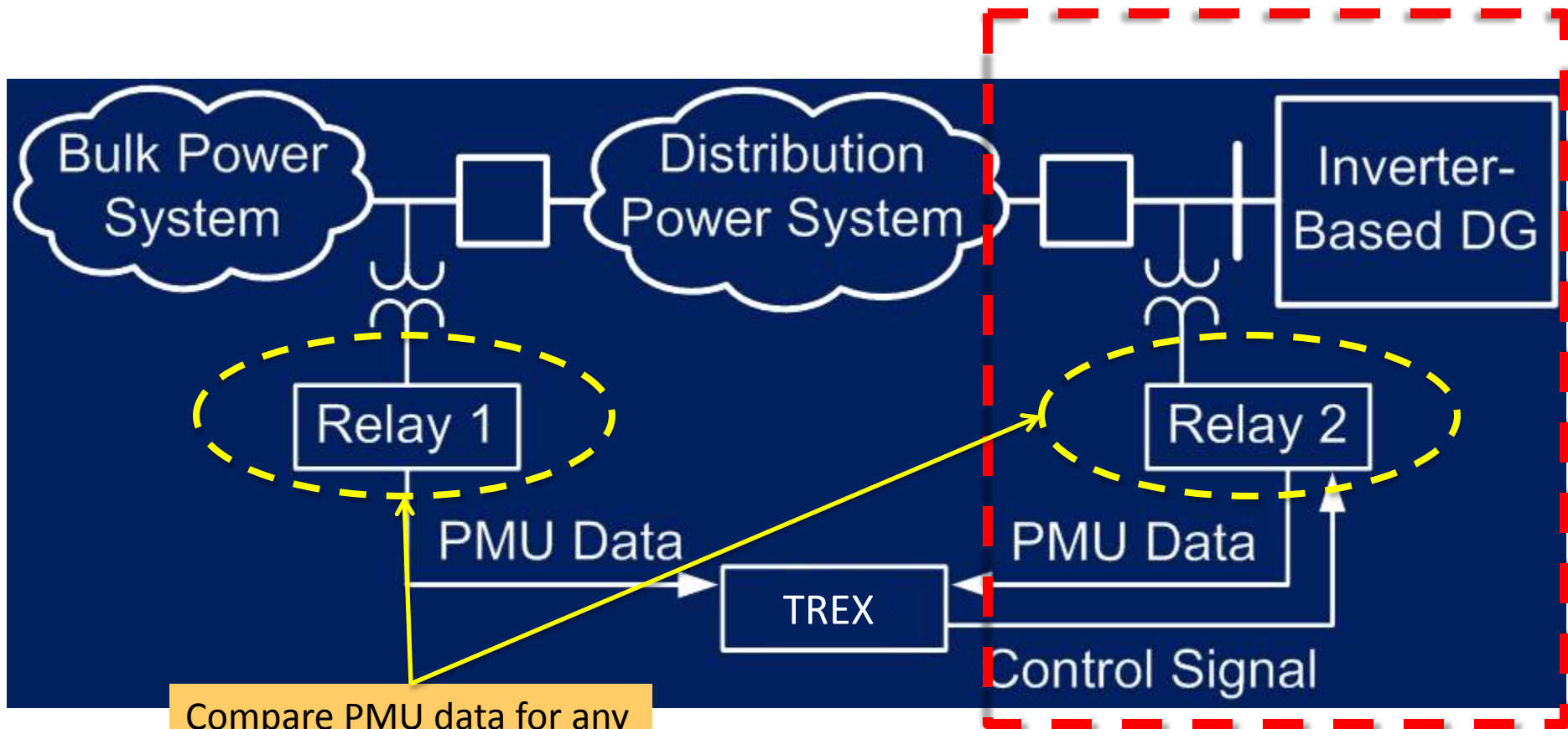
Angle Difference

Frequency



Hawaiian Electric
Maui Electric
Hawai'i Electric Light

Synchrophasor-Based DG Predictor Scheme with RTAC at Substations



Compare PMU data for any predictor signals resulting from DG-side (Relay 2)

Evaluating HELCO system for deployment of additional PMU/RTAC devices at substations closer to DG areas with high PV

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