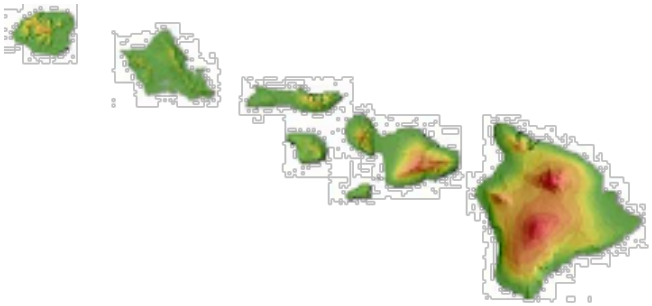
SynchroVIEEU for Utilities with High Penetration of Renewables



Dora Nakafuji

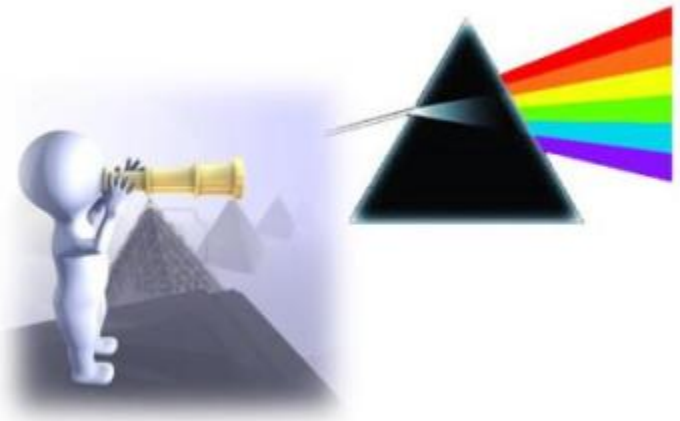
NASPI

March 23-34, 2015

Hawaiian Electric
Maui Electric
Hawai‘i Electric Light

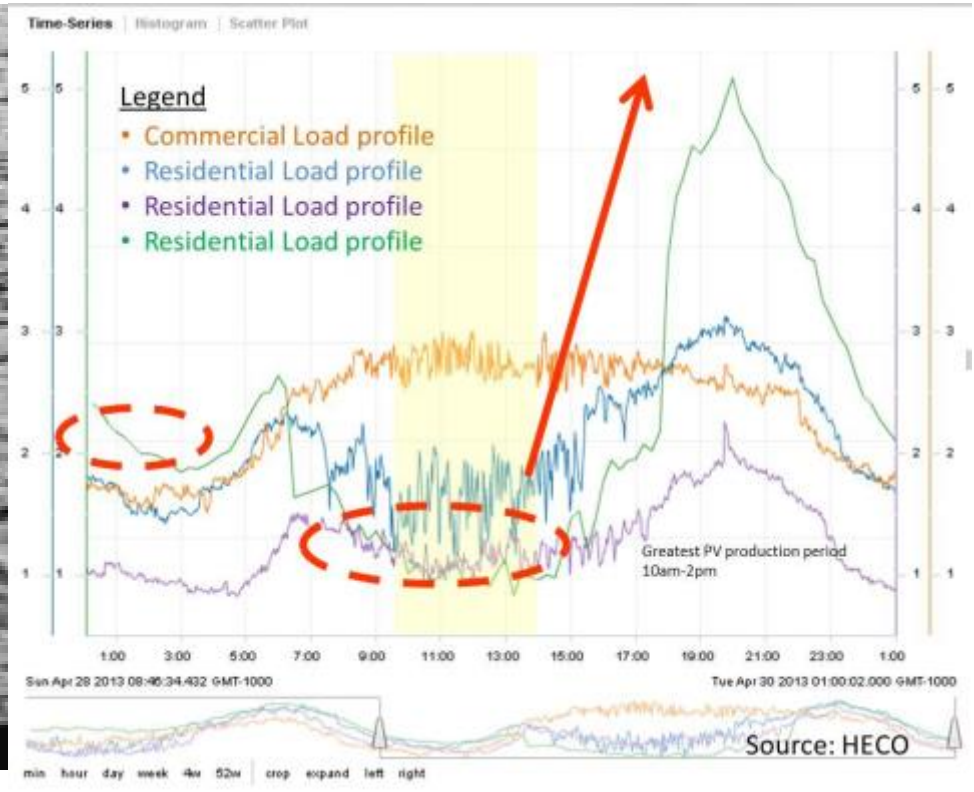
Topics

- Motivation – High Penetrations of DG
- SynchroVIEEU Goal
- Project Approach
- Team Members
- Q&A



State of the Grid – Meet Nessie

Midnight



12 noon

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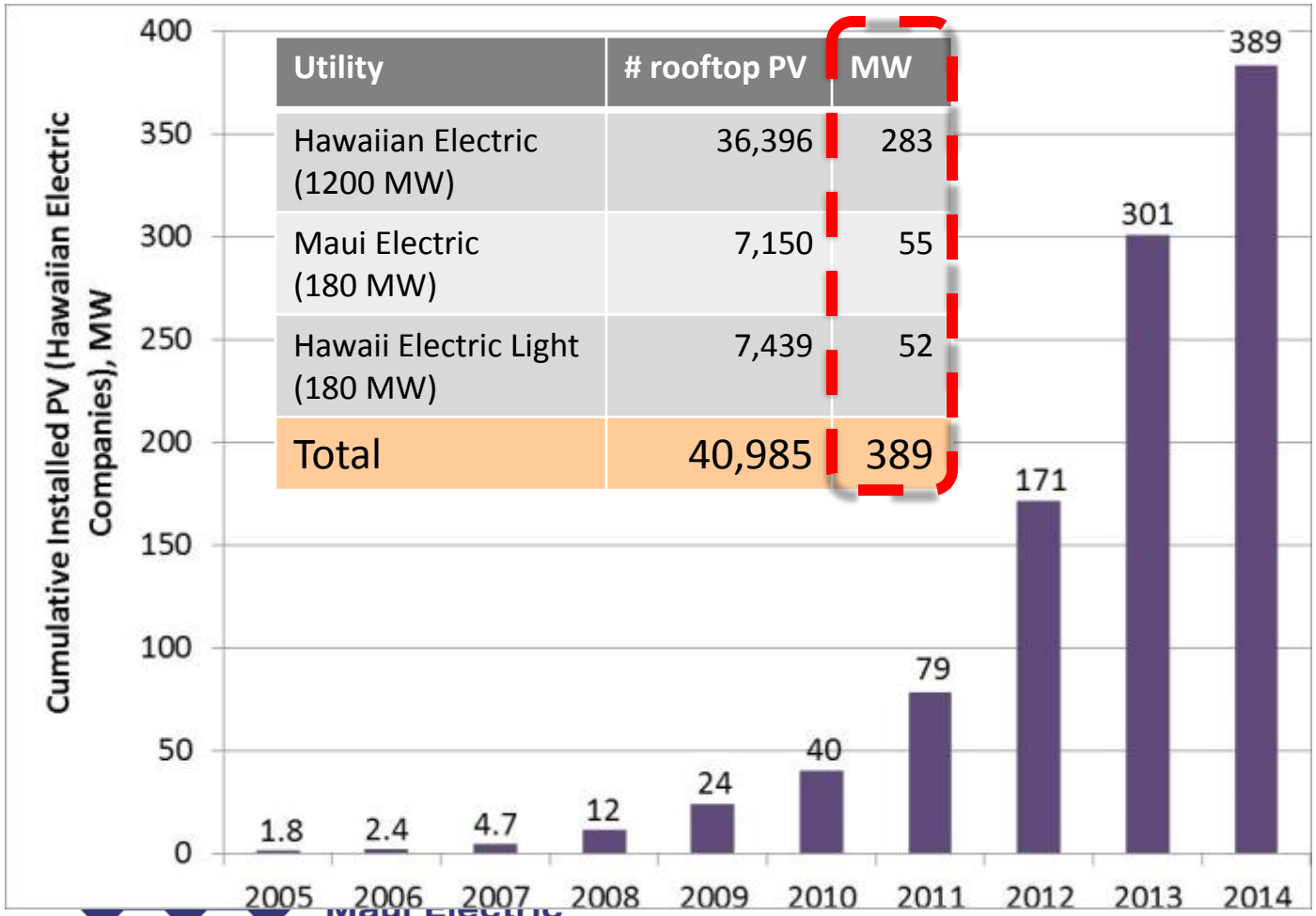
Tracking where we are Today in Hawaii

Aggregated behind-the-meter PV in 2014 as large as single utility generator

Utility	# rooftop PV	MW
Hawaiian Electric (1200 MW)	36,396	283
Maui Electric (180 MW)	7,150	55
Hawaii Electric Light (180 MW)	7,439	52
Total	40,985	389

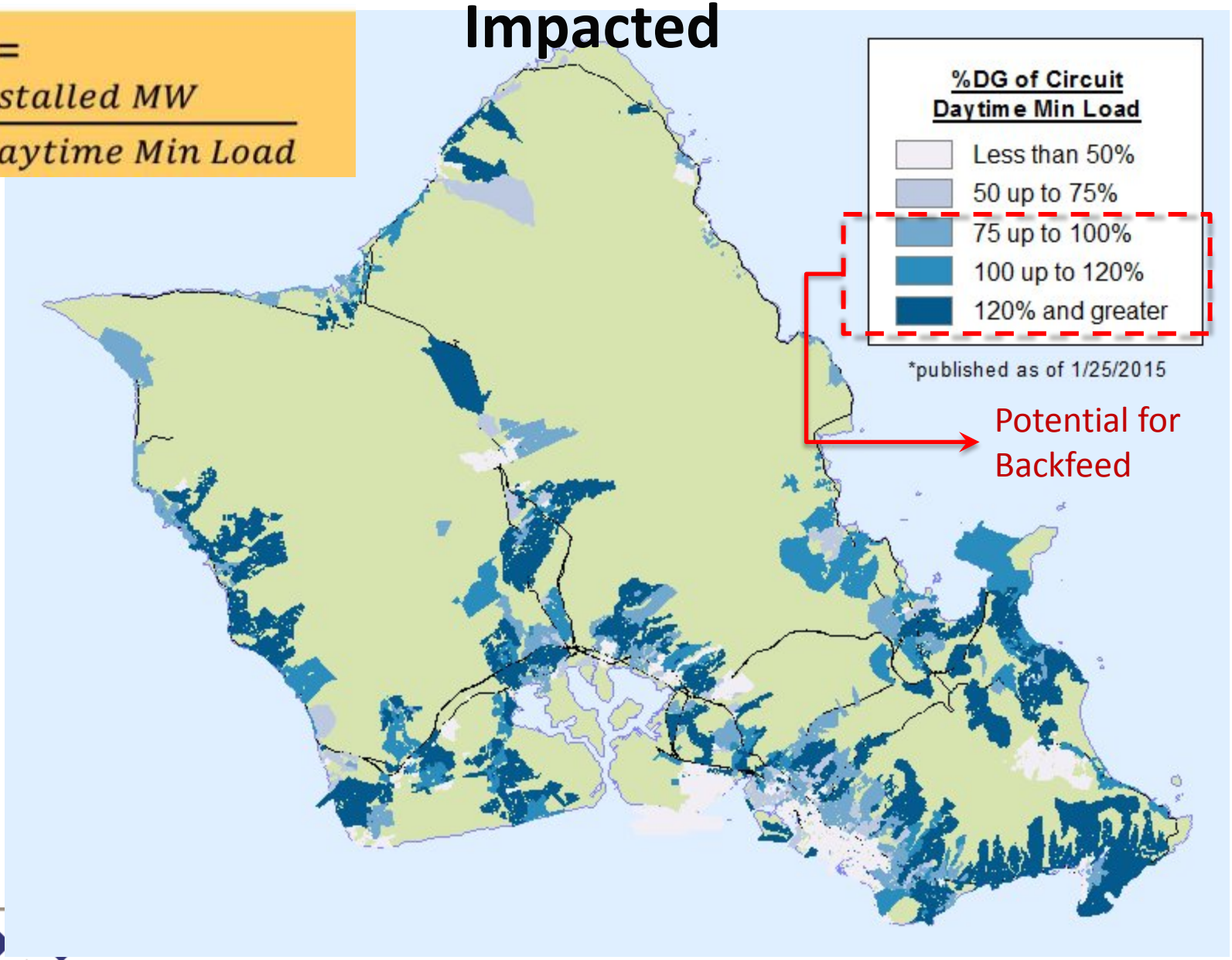


- RPS - 40% renewables generation, 70% total (includes transportation)
- Energy efficiency standard of 30% by 2030 (3,400 GWh)
- **Generation from RE Sources**
  Oahu – 12%,
  Maui – 29%
  Hawaii – 48%,

Maui Electric
Hawai'i Electric Light

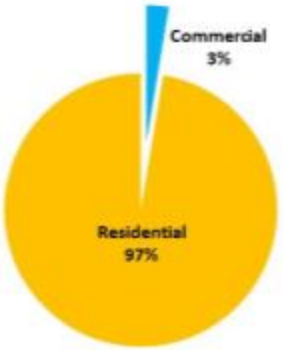
See Location & Types of Circuits & Load Types Impacted

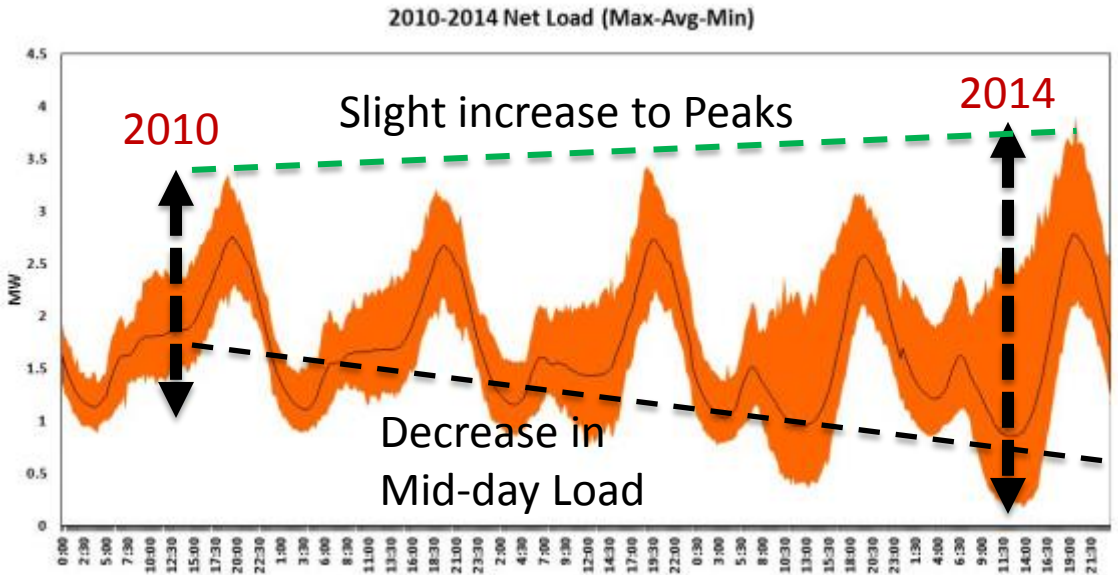
$$\%\ \text{Pen} = \frac{\textit{Installed MW}}{\textit{Gross Daytime Min Load}}$$



“Seeing” Load Variability: Change on Residential vs Commercial Circuits Due to PV

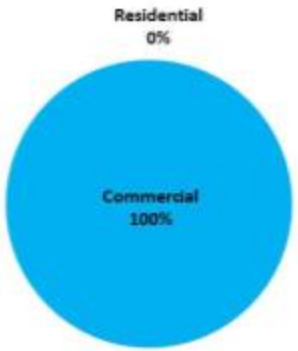
Percentage of Commercial & Residential Customers

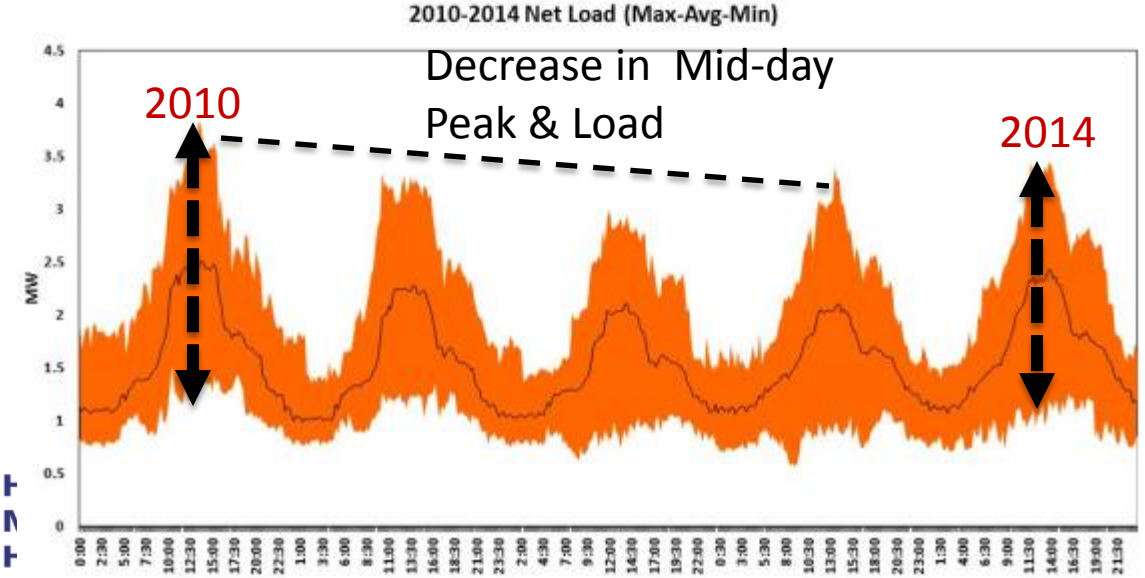




- Increase in Min to Peak variability
- Increase in evening peak
- Decrease in mid-day load

Percentage of Commercial & Residential Customers





- Circuit variability trends remain similar
- Peak load reduction in mid-day

Project Motivation

- Increasing levels of DG impact on system operations
- Lack of visibility to behind-the-meter PV
- Lack of control to distributed resources
- Need real-time capability to “see and manage” grid impacts
- Need insight on how best to use synchrophasor data
  - Event Driven (light loads, high penetration PV, high wind events and outage conditions)
  - Predictive analytics

Project Summary

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

Goals :

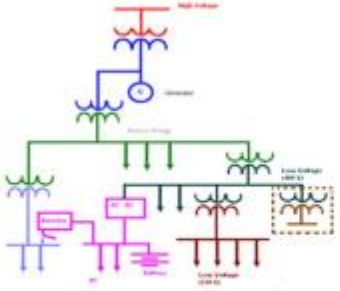
- Accelerate the integration of synchrophasor information into production grade data visualization and analysis platforms/models
- Leverage PMU capability at many substations – explore ways to tap resources and provide real-time visibility and real-time data
- Make synchrophasor data accessible for efficient and reliable operations of a modern grid in light of high penetrations of renewable resources

Objectives

- Visualization: Make Actionable
  - Facilitate access and review of existing synchrophasor data in combination with other utility information for system forensics, model validation and informing scenario planning needs
  - Investigate software tool development for a first-of-its-kind integrated visuals that incorporate synchrophasor data in combination with real-time forecasts and other DG data for real-time operational awareness
- Event Evaluation
  - Investigate use of synchrophasor data to inform Proactive Modeling of distributed generation and microgrid impacts on existing system operation, restoration and contingencies
- Contribute to national efforts, build collaborative utility-vendor partnerships and capabilities
- Disseminate lessons learned and add relevant capabilities to commercial grade products

SynchroVIEEU Team

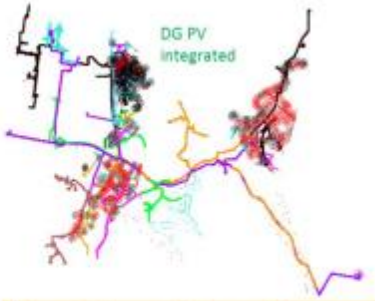
- Hawaiian Electric Companies
  - SEL
  - DNV GL
  - Referentia



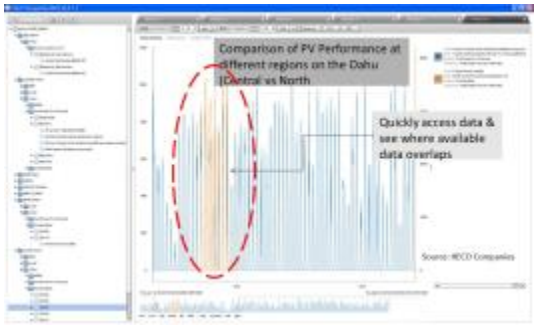
Before: Single Line View no geographic reference

VS

Illustrative



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



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SEL SCHWEITZER ENGINEERING LABORATORIES

DNV

Tasks & Schedule

- Task 1: Project Management Planning & Team Coordination
- Task 2: Synchrophasor Data Assessment and Review
- Task 3: Integrated Modeling and Visualization
- Task 4: Advancement of Synchrophasor Modeling Techniques
- Task 5: Technical Training & Outreach

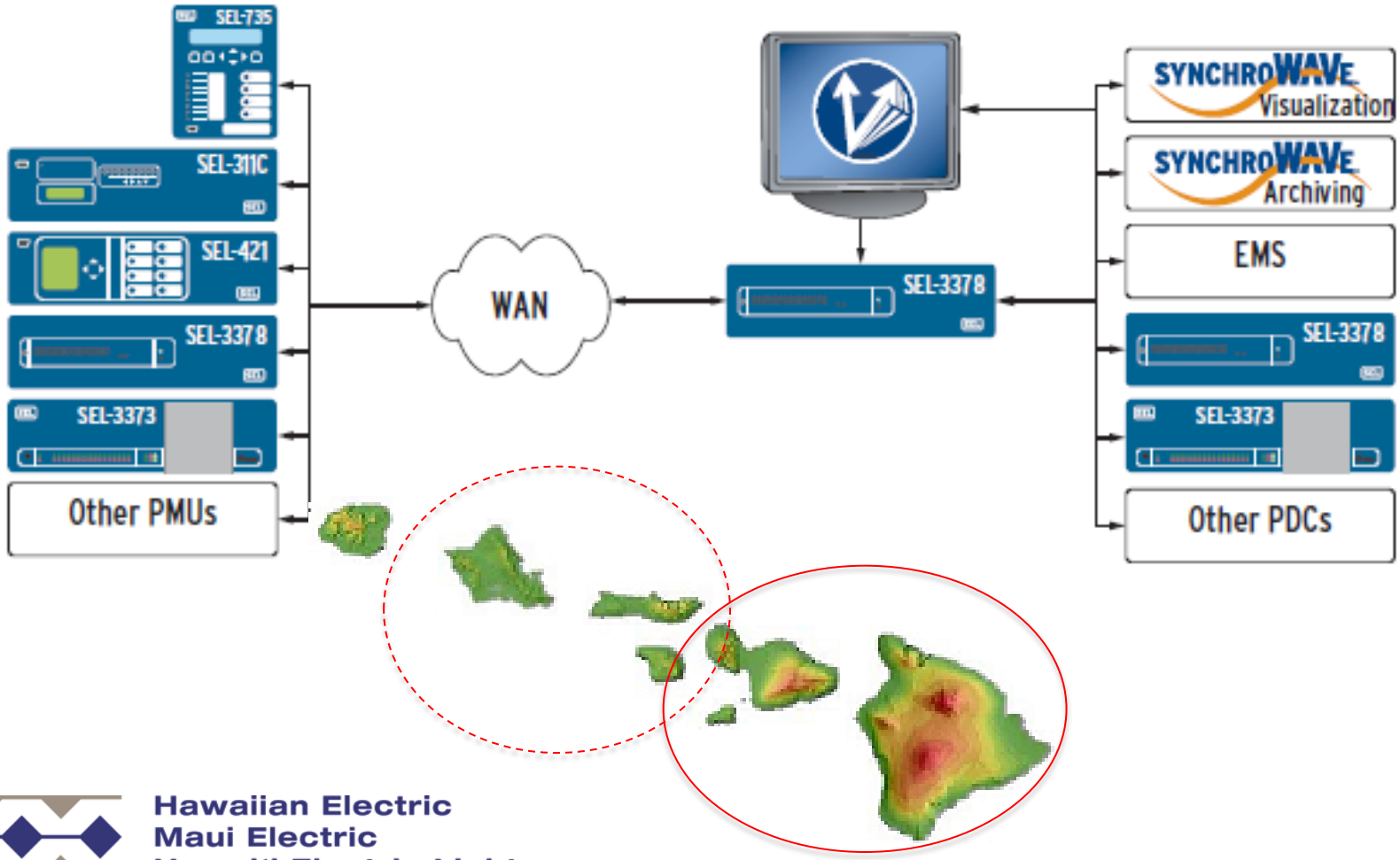
		Year 1				Year 2			
	Tasks/Period	3m	6m	9m	12m	15m	18m	21m	24m
1.0	**Project Management and Team Coordination**	■	■	■	■	■	■	■	■
2.0	**Synchrophasor Data Assessment & Review**	■	■	■	■	■			
	Subtask 2.1 User Engagement & Data Review								
	Subtask 2.2 Integration of Synchrophasor Data into Common Data Analysis Platform								
3.0	**Integrated Modeling and Visualization**	■	■	■	■	■	■	■	
	Subtask 3.1 Model Integration of Sychrophasor Data								
	Subtask 3.2 Informing Grid Modernization Strategies								
4.0	**Advancement of Synchrophasor Modeling Techniques**			■	■			■	■
5.0	**Technical Training, Outreach and Reporting**		■		■		■	■	■

Timely Decision Analytics – Size and Access to Data Matters

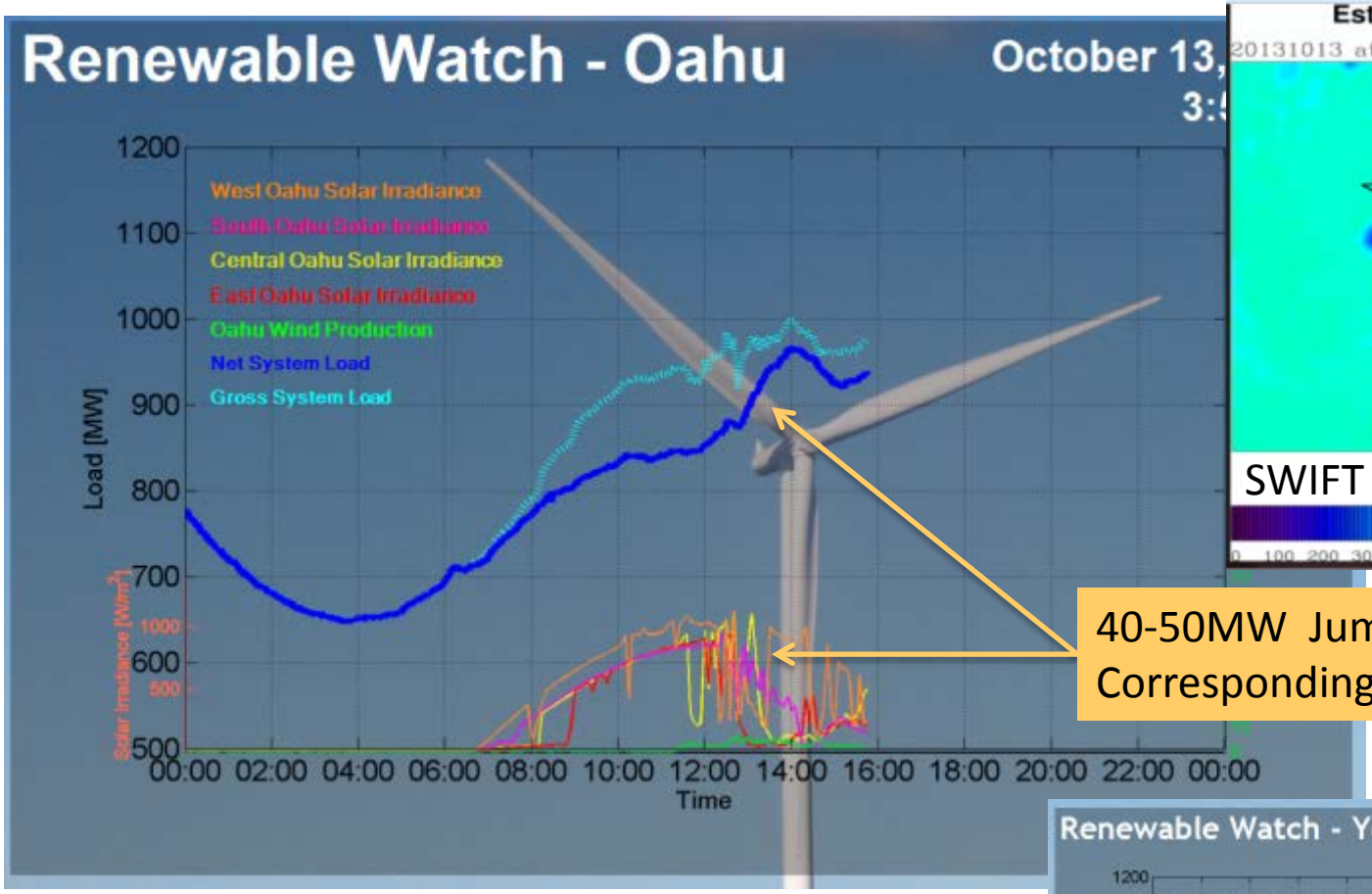
DATA Description	DATA SIZE
SCADA 3 days, 2sec, 1 point, uncompressed	8.56 MB
AMI Data 3 days, 15min, 5200 customers (compressed)	35.1 MB
AMI Data 3 days, 15min, 5200 customers (uncompressed	528 MB
PMU Data 3 days, 60 sample/sec	18 GB

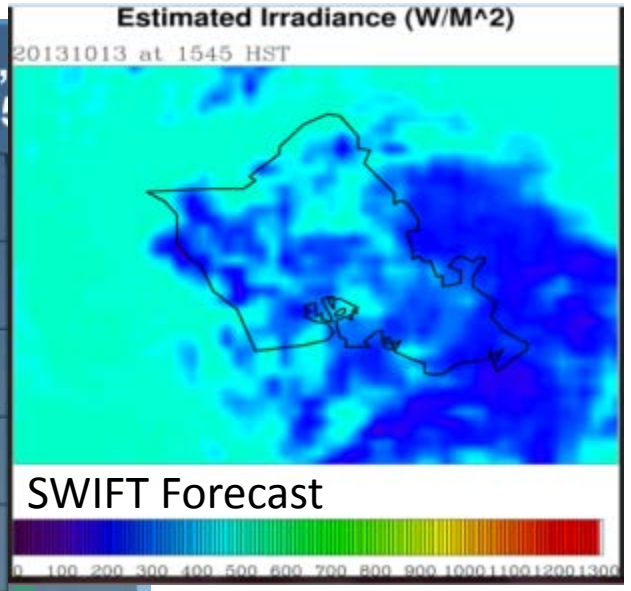
Architecture & Data – Where to Collect Data Matters

Acquire and Concentrate Synchrophasors From Remote Locations



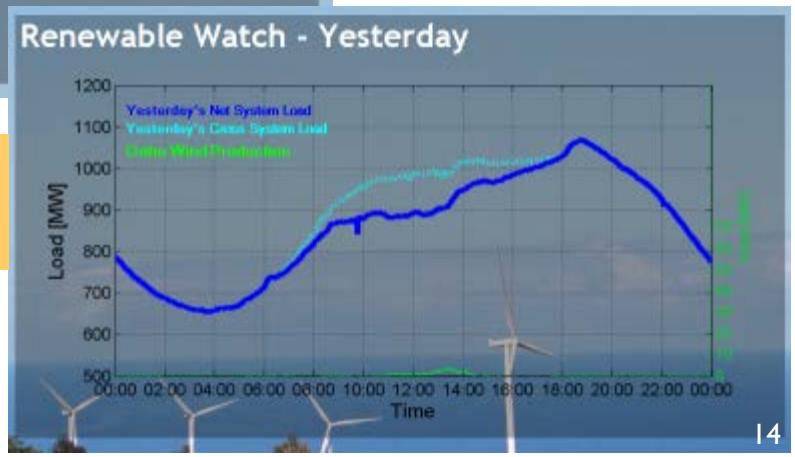
Event Driven Focus: “Seeing & Validating”





40-50MW Jump in Load
Corresponding drop in PV

Yesterday is not a good predictor of Today anymore



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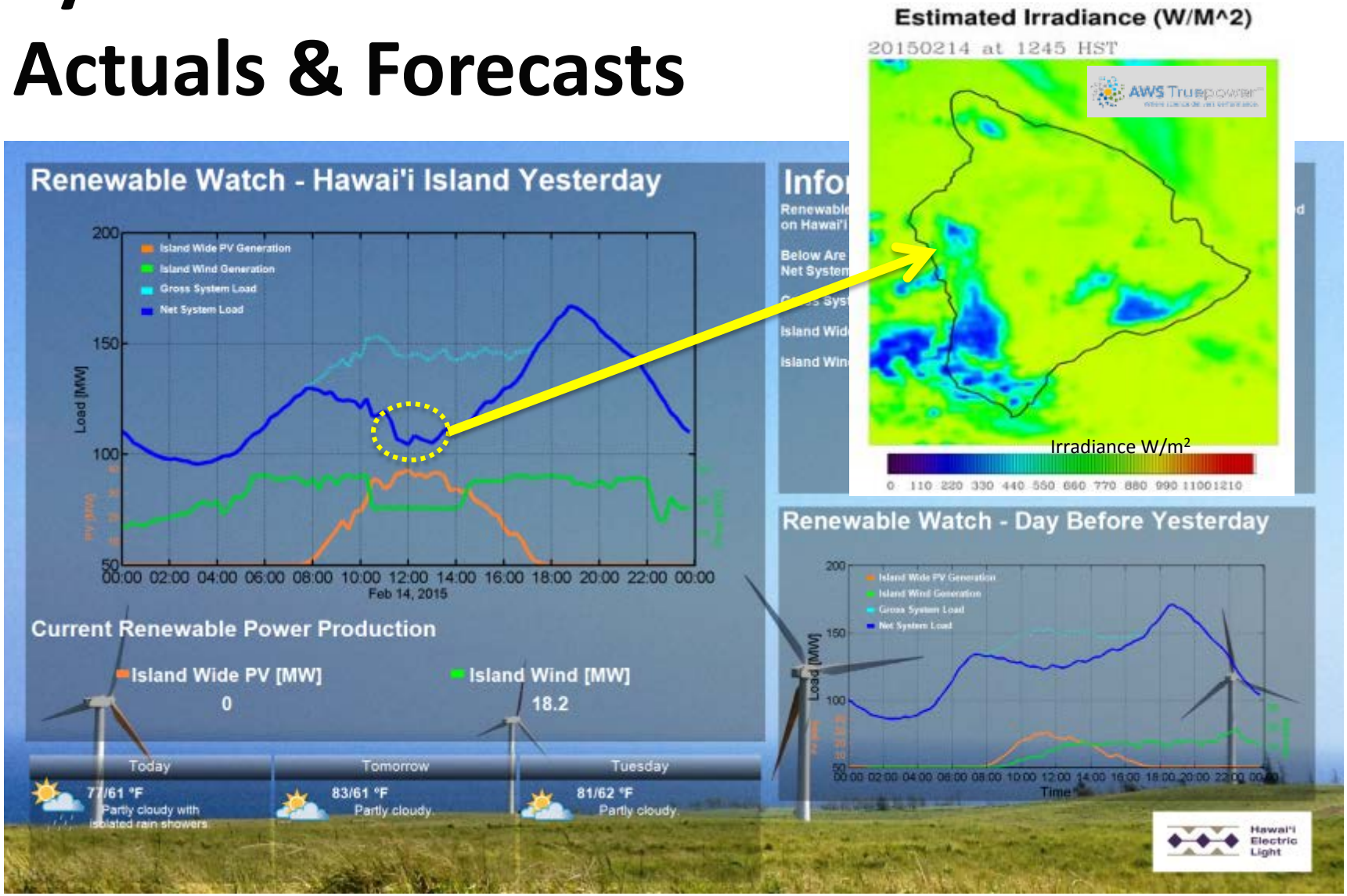
System Lows - "See & Validate" Actuals & Forecasts



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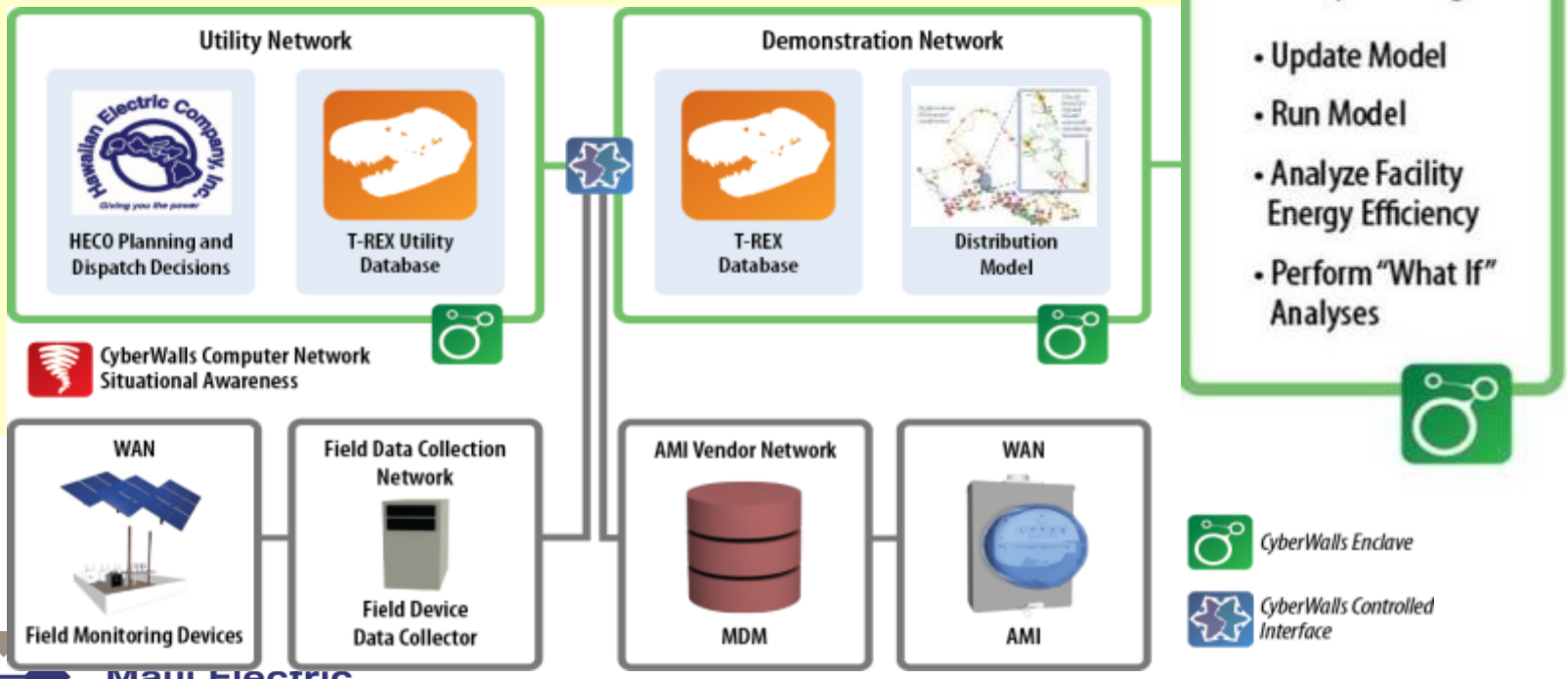
Island Wide View – Support Predictive Analytics for Operations & Planning

Vision Forward: GRID-IE Decision Framework for Utilities

- **Distribution network modeling and simulation**
  - Innovation: Validated network model with rooftop PV resolution
- **T-REX: Sensor data management and analytics platform**
  - Innovation: Lossless, instant access to data from diverse sources
- **CyberWalls: Cyber-secure information exchange**
  - Innovation: Establish, monitor, and manage network enclaves

referentia

Source: Referentia & HECO Companies



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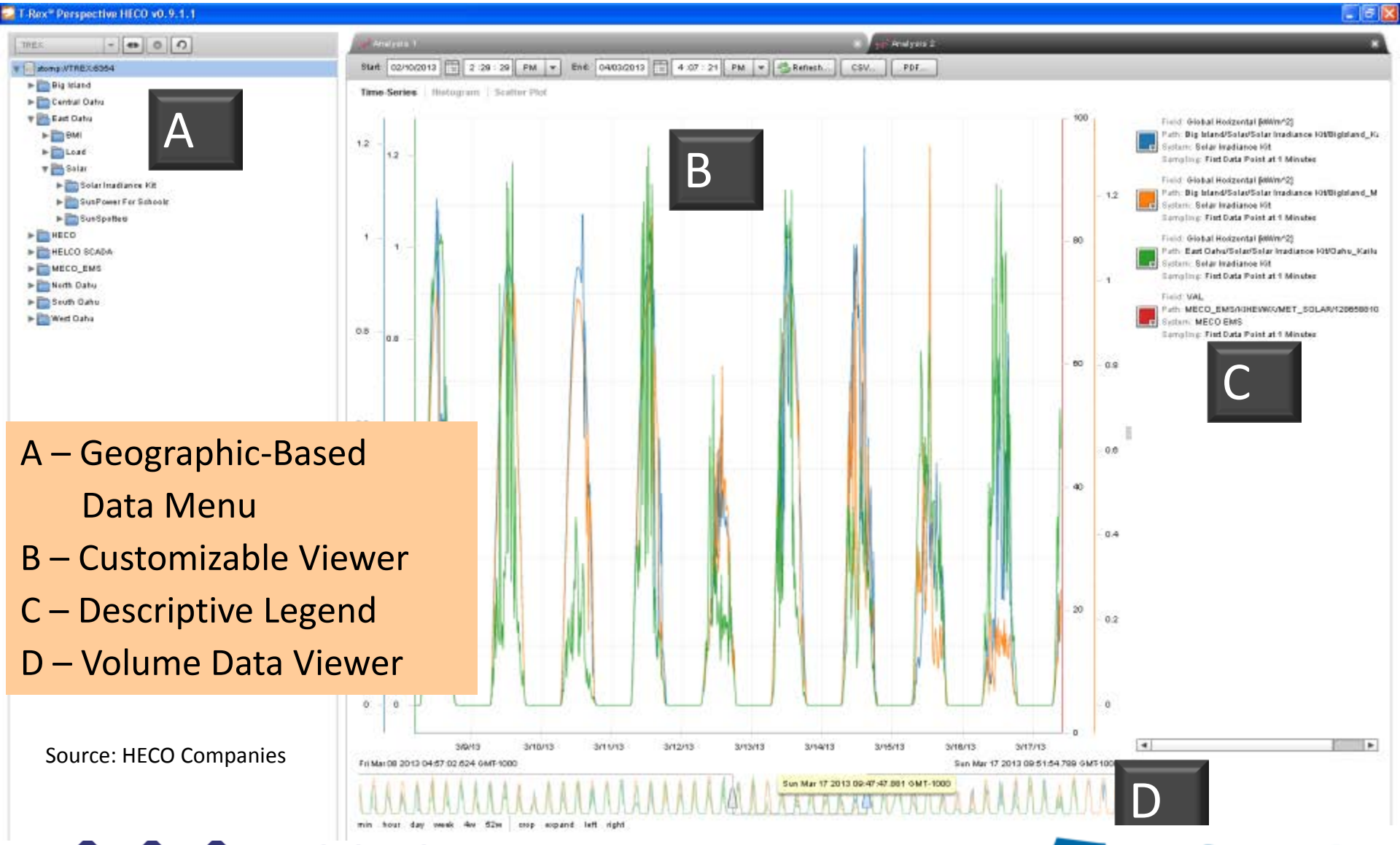
TREX *Perspective* Time-Series Capability



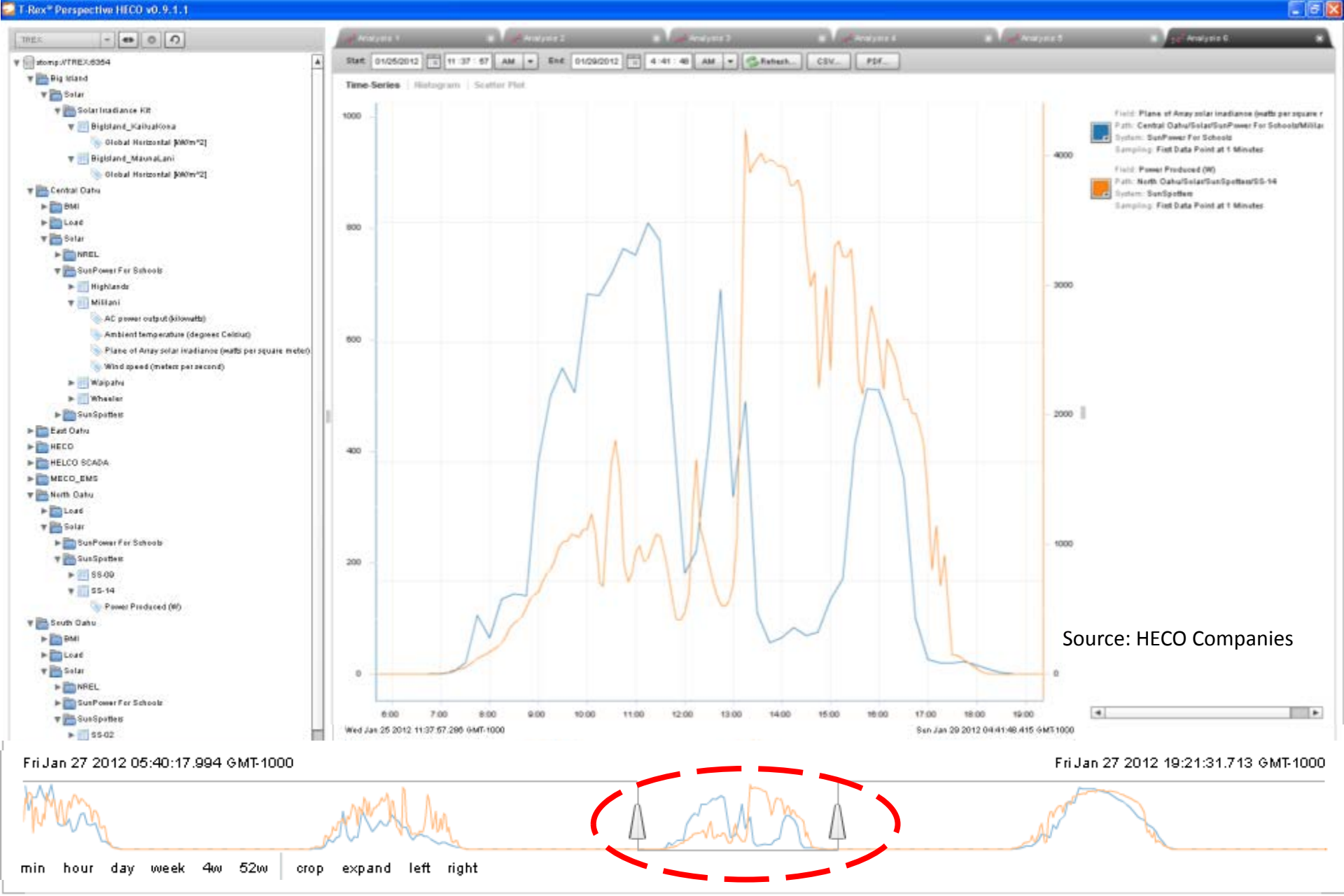
A – Geographic-Based Data Menu

B – Customizable Viewer

C – Descriptive Legend

D – Volume Data Viewer

Source: HECO Companies



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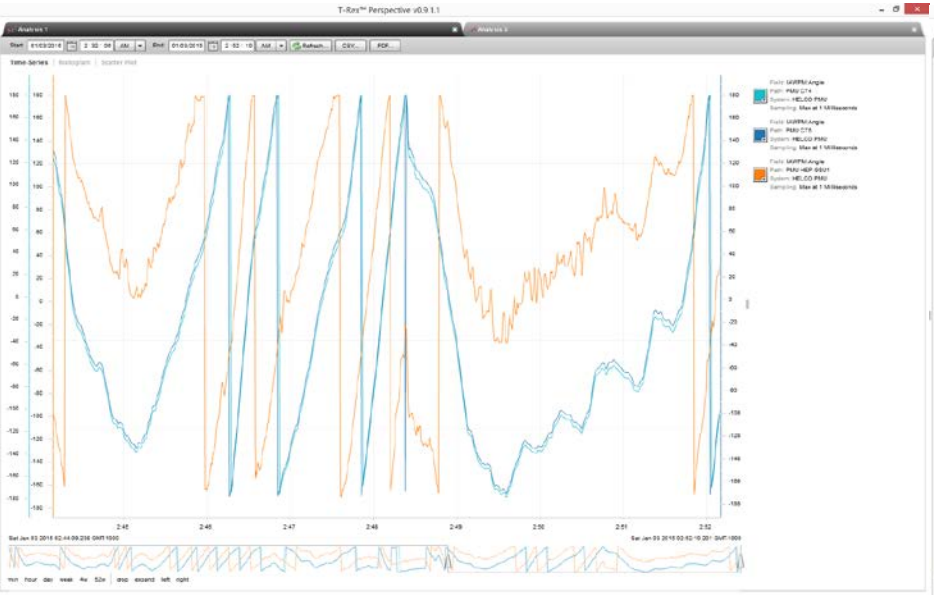
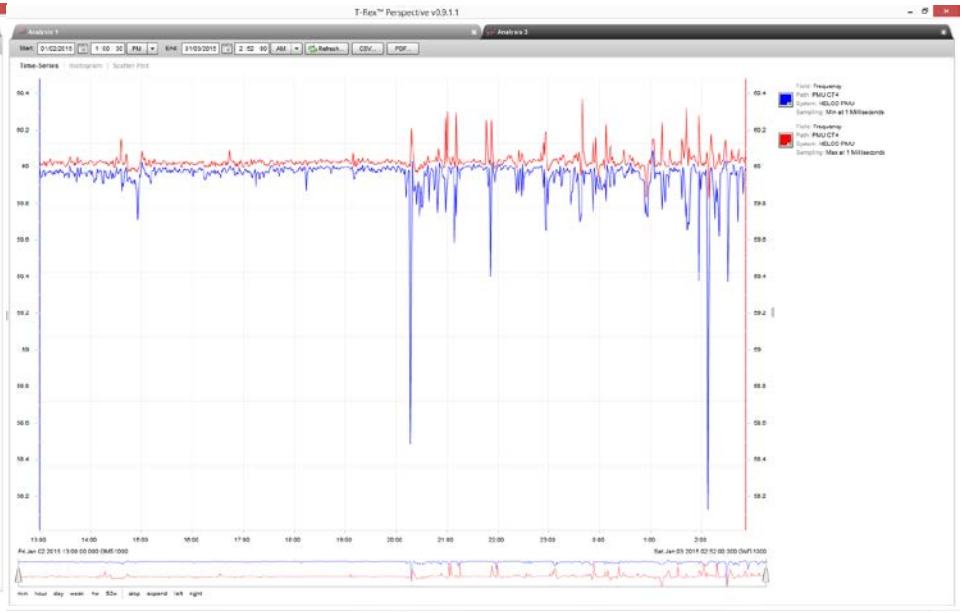
Synchrophasor Data Accessible on TREX





- Phase angle measurement at three different PMUs over about 8 minutes
- Orange tracks the other two very closely during some time periods, but is separated here

- Frequency over 14 hours
- Each charted value is an aggregate
- Blue series is the minimum freq value in the bin's time range
- Red series is the maximum freq value in the bin's time range

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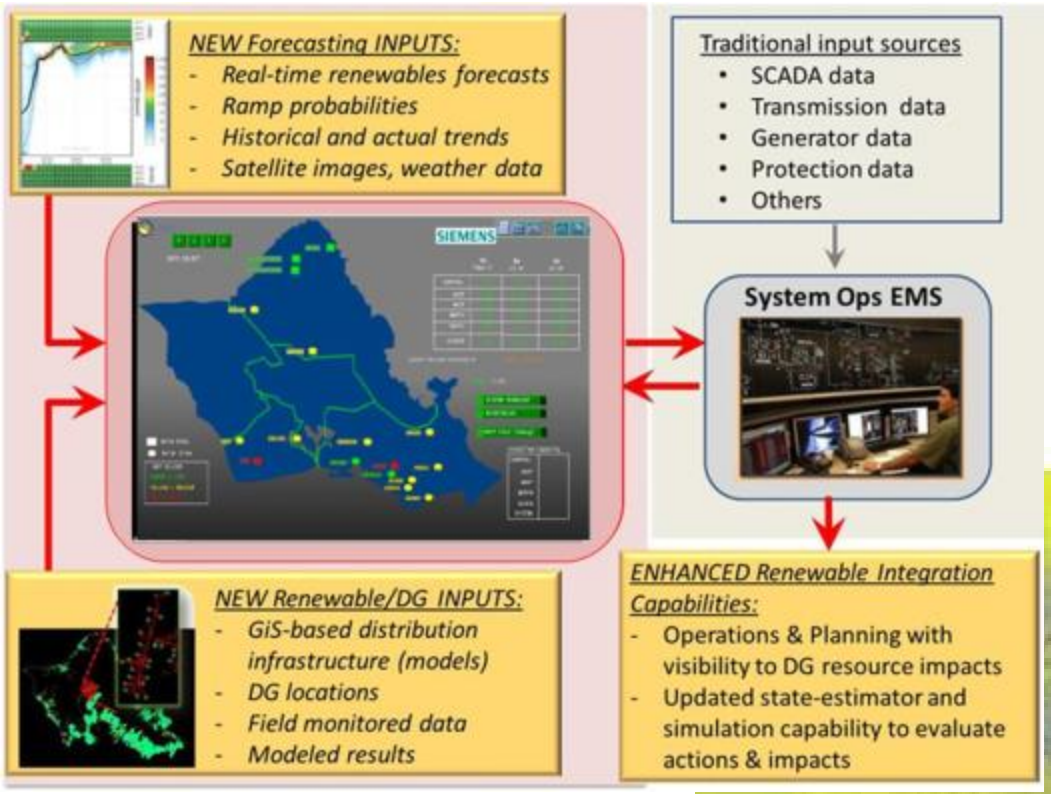
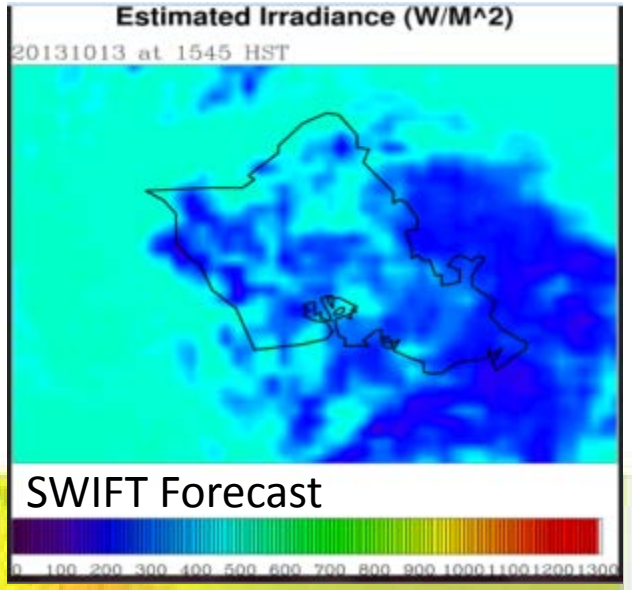
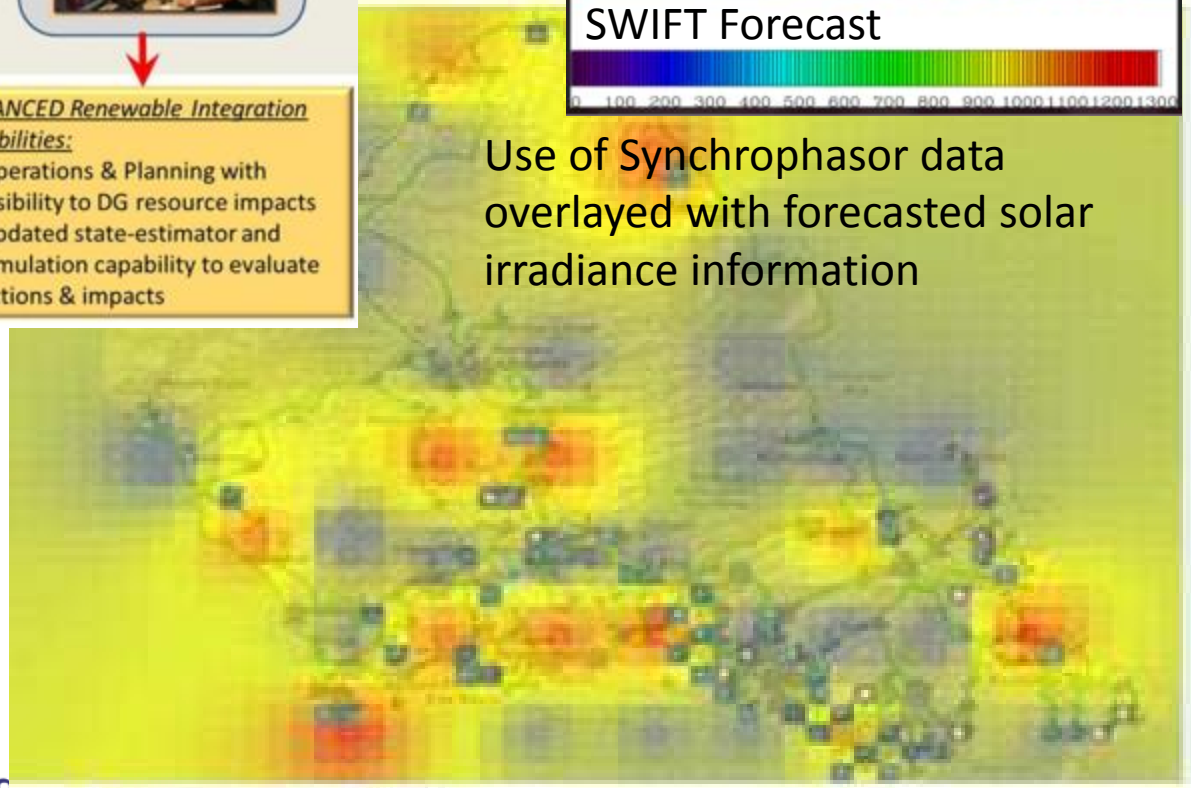
Potential Integration Views into EMS



EMS Integration



Use of Synchrophasor data overlayed with forecasted solar irradiance information



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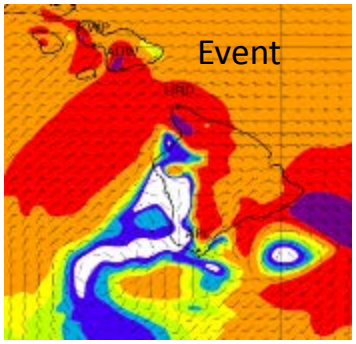
SynchroVIEEU Desired Benefits

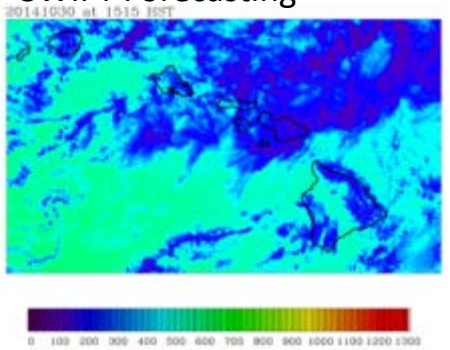
- Demonstrated integration of synchrophasor data within production ready platforms (i.e. TREX, LVM, REDatabase, EMS)
- Establish procedures and data handling protocol compatible with industry (i.e. IEEE) standards
- Utilize new visualization techniques that incorporate synchrophasors to inform modernization needs
- Demonstrated and replicable capabilities using synchrophasors to enhance operational awareness focused on grids contending with high penetrations of renewables (recommend ties to EMS displays)
- Collaboration across a broad base of industries, utilities and software technology providers
- Direct access to industry technology providers and commercializ pathways

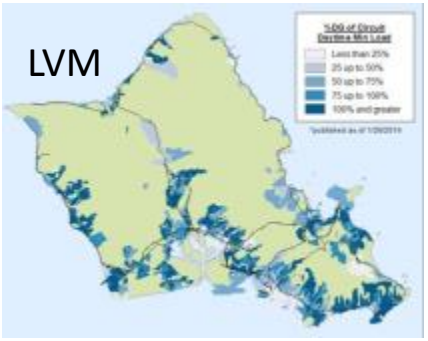
Portfolio of Resources for Integration

- Renewable Resource Monitoring & Forecasting (SWIFT)
- RE & DG Infrastructure Modeling
- REData Analytics & Visualization
- Ops Integration & Transformational Technologies
- Technical Outreach Collaborations & Workforce Development

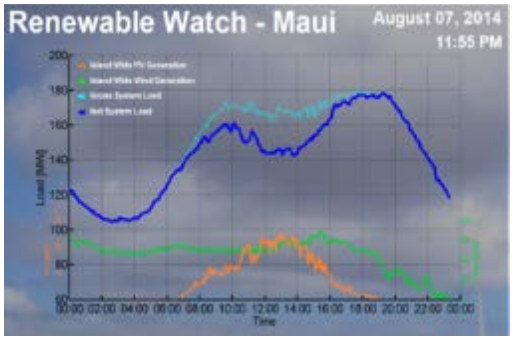


SWIFT Forecasting

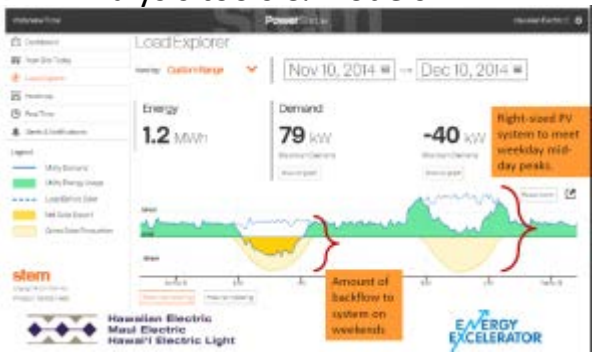


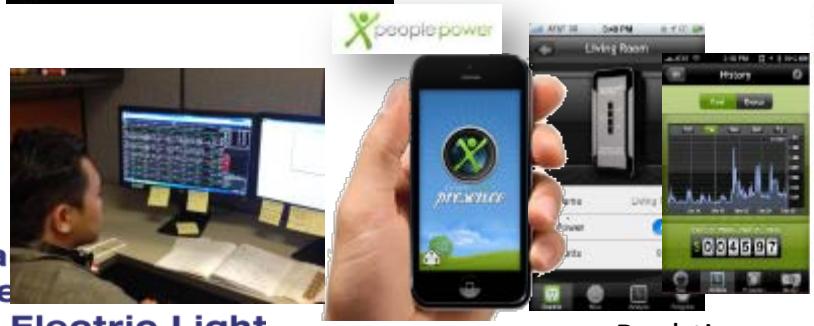


STEM Distributed Storage



Analysis tools & models





i Electric Light

Real-time customer data & devices

Questions/Comments??

Mahalo

For more information please contact:

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