Hawaiian Experience with the Integration of Uncertainty Forecasts into the EMS

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UVIG

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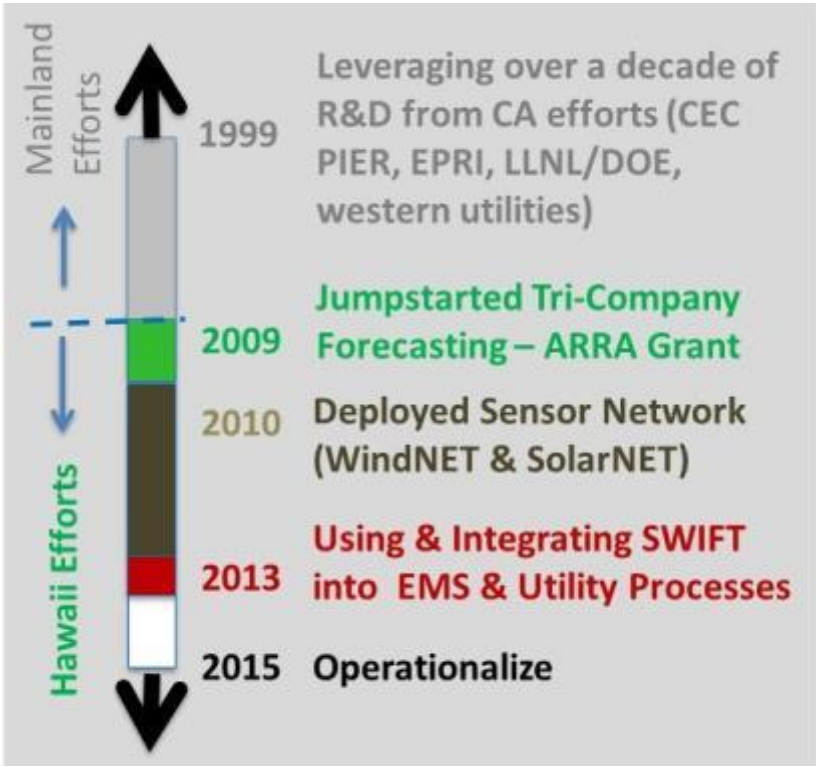
Overview

- The operational challenge in Hawaii: recent events
- Maximizing value from the SWIFT forecast system
- SEAMS for SHINES: new tools and approaches to manage variability
- EMS integration activities



SWIFT: Solar and Wind Integrated Forecast Tool

Phase 1:
Improve Forecast Models
= Address Operational Need

Phase 2:
Monitoring & Field Validation
= Building Confidence

Phase 3:
Integrate & Operationalize
= Retool & Train Workforce

Some Perspective

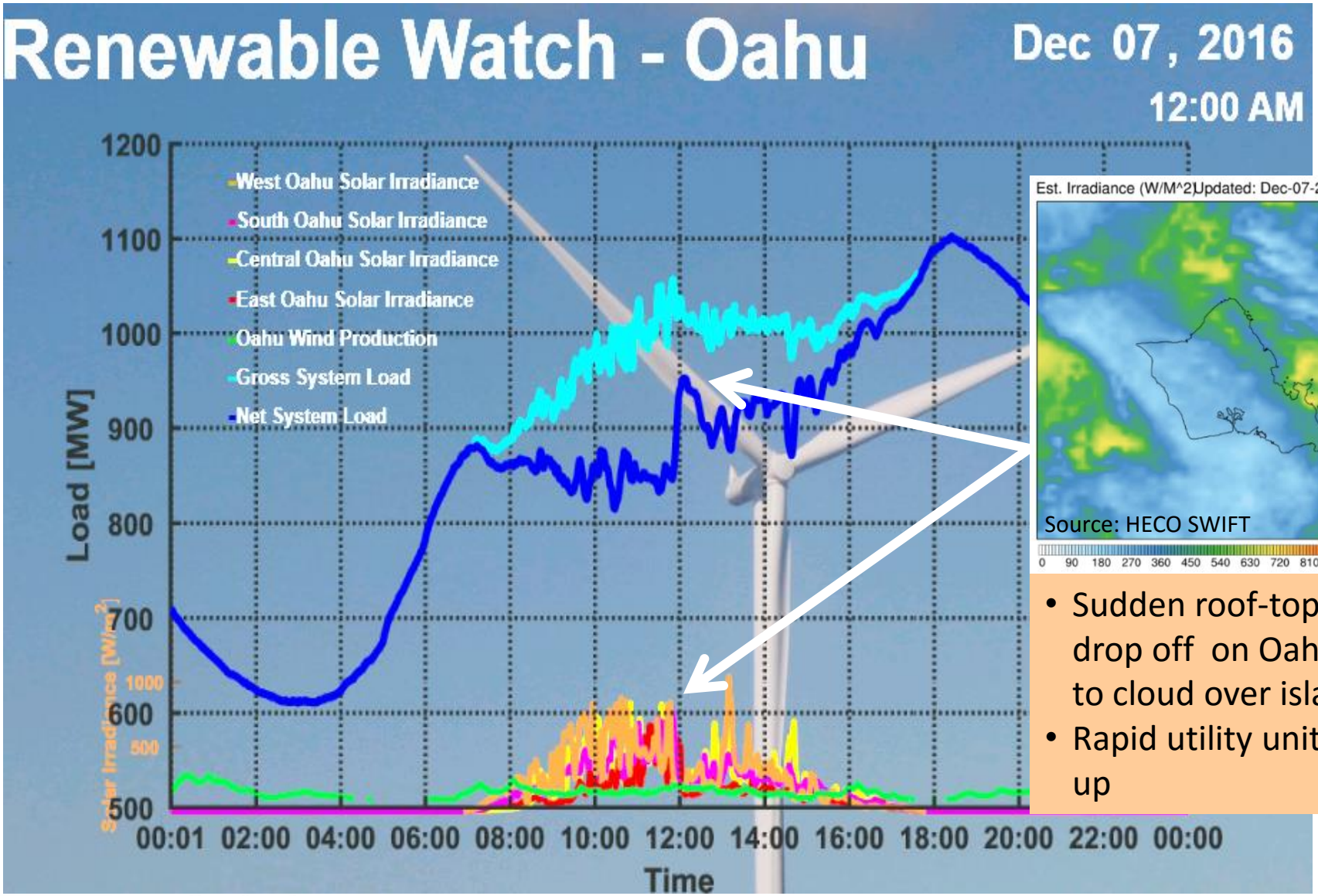
Forecasts will NOT…

- Be a “silver bullet”
- Be perfect
- Tell operators what to do
- Be useful without practice
- Solve everything

Forecasts Are…

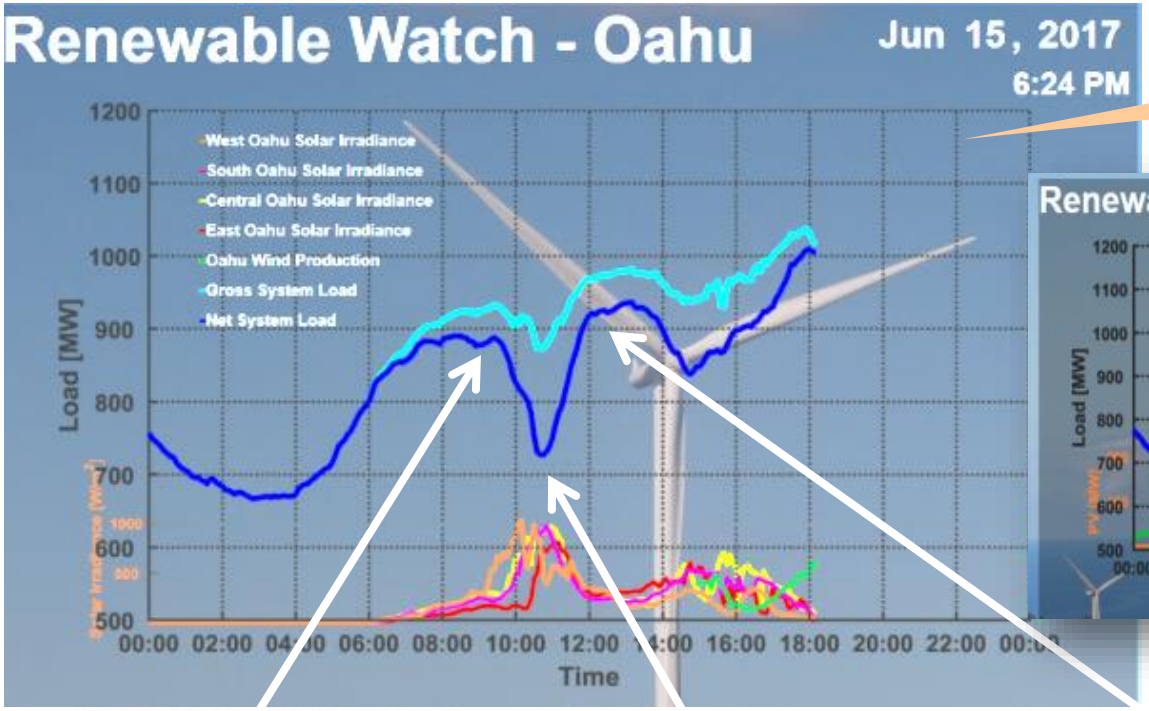
- Improving situational awareness
- Being used to inform decision-making especially during sensitive times or conditions
- Being Improved
- Being Integrated (process + tools + knowledge base)
- Helping reduce risks & uncertainties

Extreme Net Load Variability: 100 MW/15 Min UP

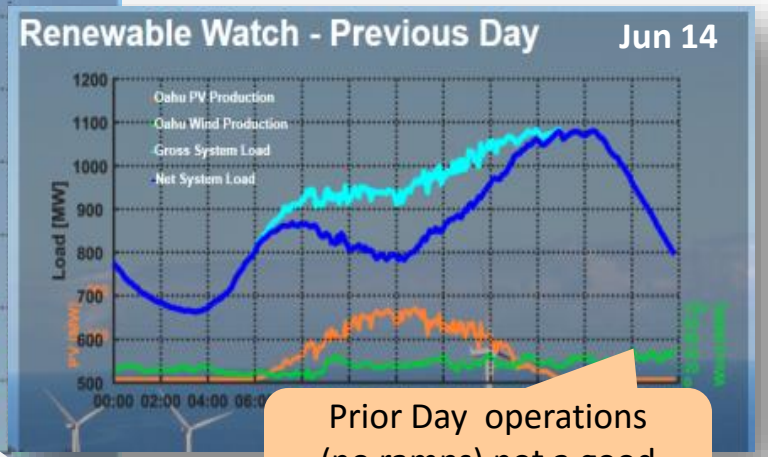


- Sudden roof-top PV drop off on Oahu due to cloud over island.
- Rapid utility unit ramp up

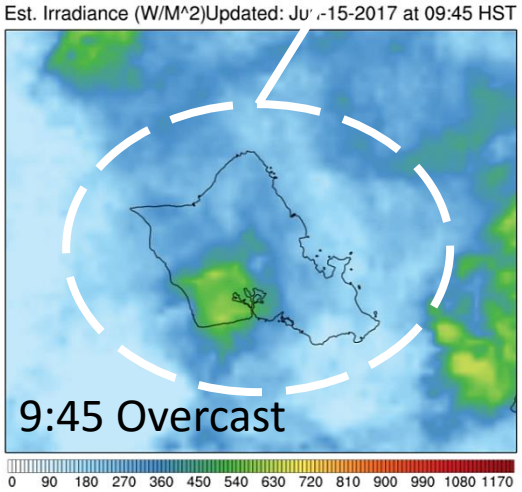
Extreme Net Load Variability: 200 MW UP/DOWN in 1 HR

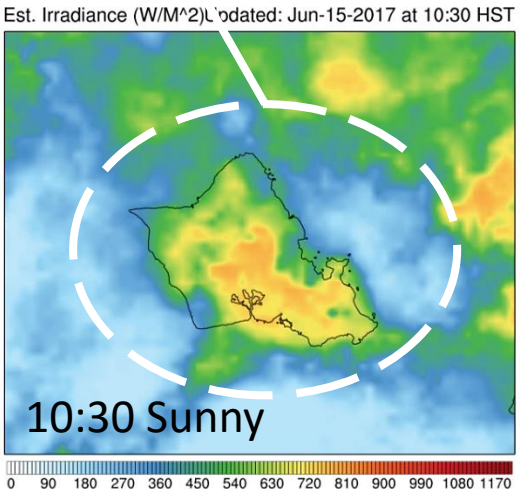


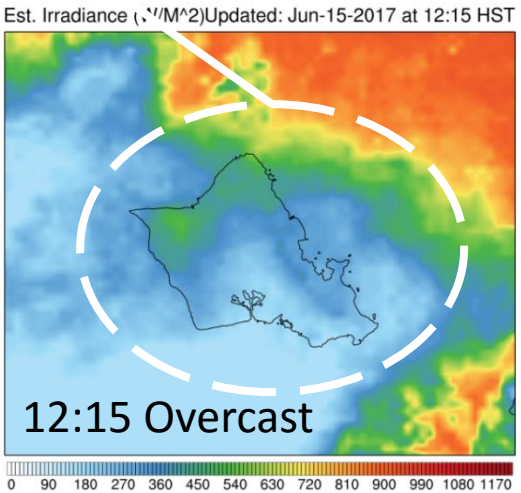
Approx 200 MW Down and Up Ramp



Prior Day operations (no ramps) not a good indicator of current day



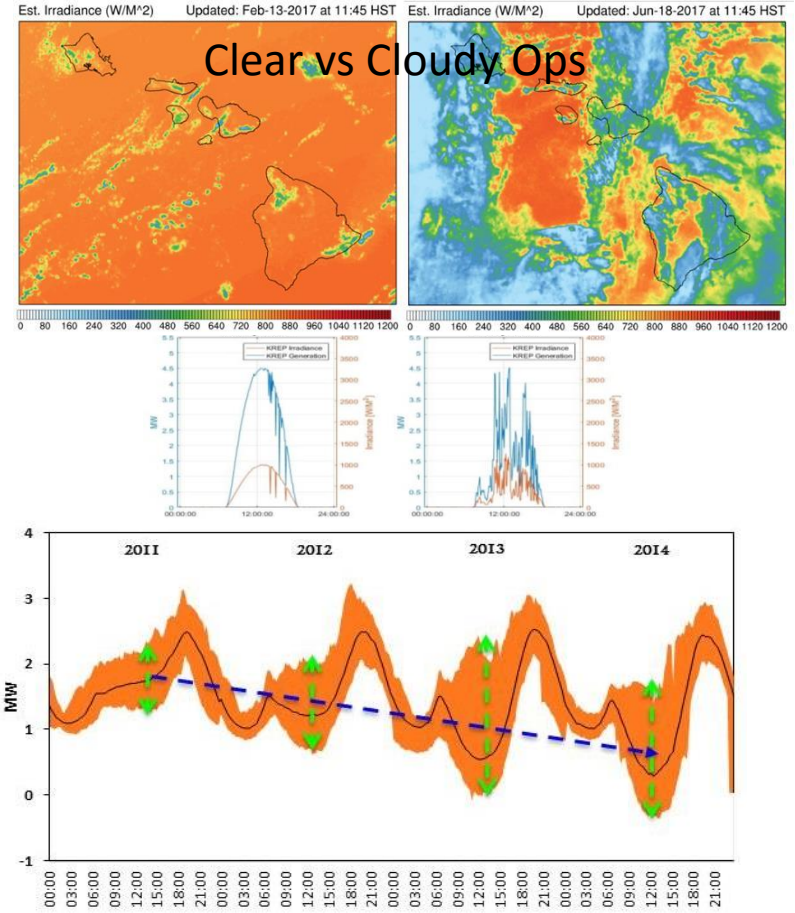




Maui Electric
Hawai'i Electric Light

Grid Changes Increase Uncertainty

- Variable & uncertainty in weather
- Uncertainty and change with customer resources (PV, storage, EV & Load) impacting traditional Supply = Demand
- Change in dispatch procedure & reserve planning (more dynamic vs traditional economic dispatch)
- Deployment of smart devices
- New operator tools & integration procedures

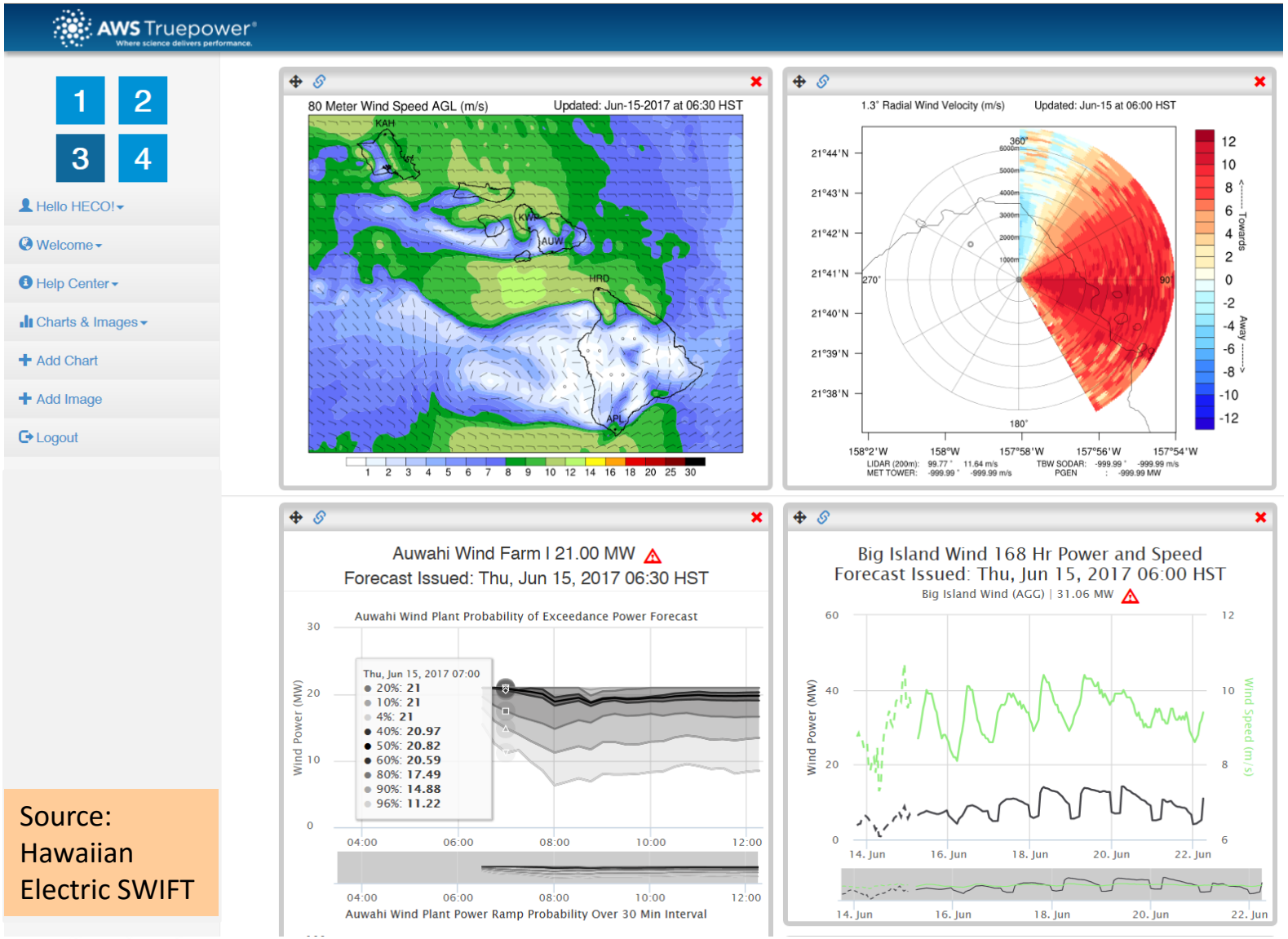


$$\text{Generation} \pm \Delta \text{ Reserves} = Customer\ Demand \; ? \; \sum Customer\ Distr.Gen \pm f(Weather, time)$$

Maximizing Value from SWIFT

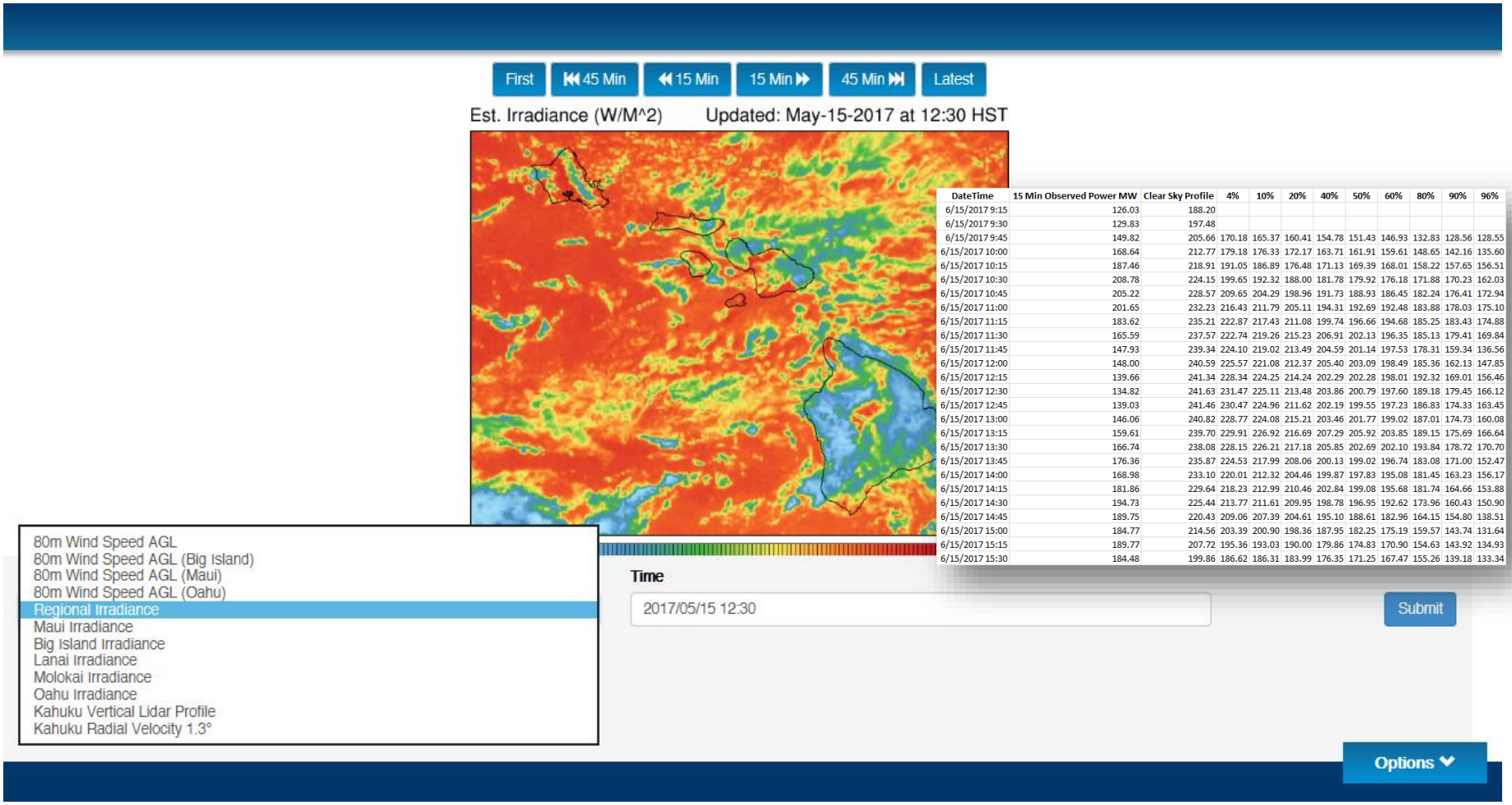
- User Engagement User Training & Feedback
  - User + Forecaster training & feedback on tools/screens
  - Post-event analysis & reviews. Which forecasts were good and what to improve on
- Forecast Enhancements & Research
  - Grid impact driven event analysis: rate of change triggers for ramps, variability during transitions, enhancing satellite imagery for early mornings
  - Review of sensitivities/correlations, new metrics based on “tails”
- Incorporate into Decision-Making & Risk Management
  - Review past events and forecasts for 5-10-15min operating decisions
  - Assess operational contingencies and how to use smart technologies for responding to these short duration events.
- Integration & Automation
  - Integrate and demo controls for edge-of-grid devices under SEAMS for SHINES

Information Flow: Customizable SWIFT Dashboard



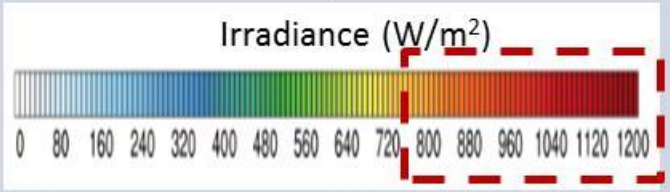
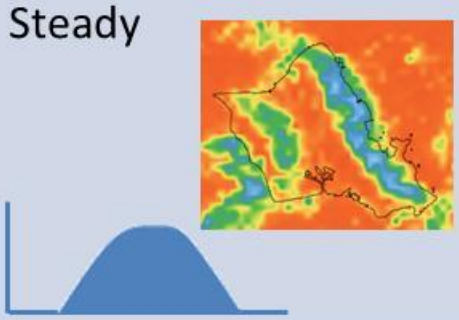
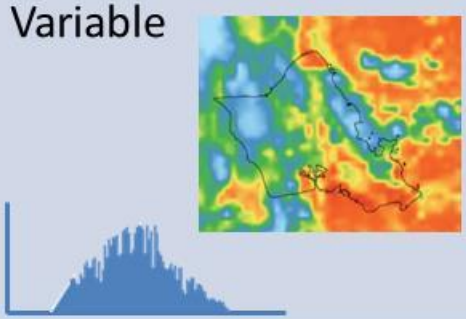
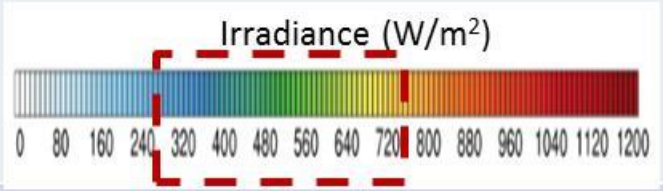
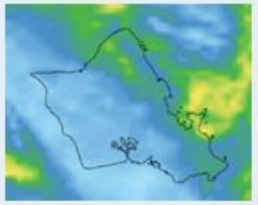
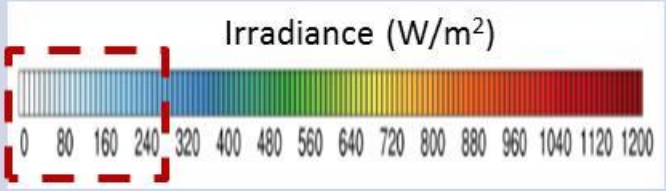
Source: Hawaiian Electric SWIFT

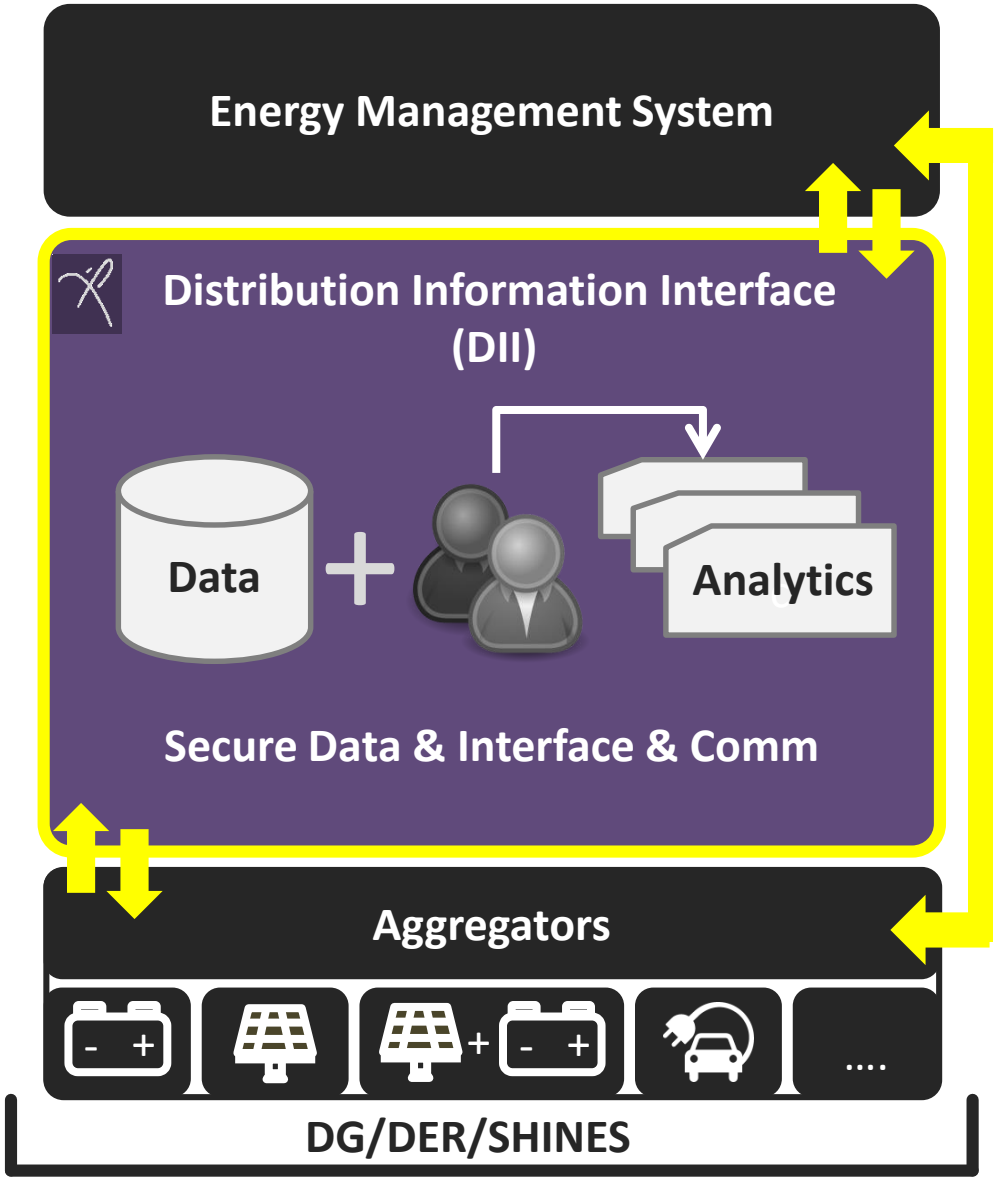
Event Analysis: Geospatial Graphics and Data Downloads



DateTime	15 Min Observed Power MW	Clear Sky Profile	4%	10%	20%	40%	50%	60%	80%	90%	96%
6/15/2017 9:15	126.03	188.20									
6/15/2017 9:30	129.83	197.48									
6/15/2017 9:45	149.82	205.66	170.18	165.37	160.41	154.78	151.43	146.93	132.83	128.56	128.55
6/15/2017 10:00	168.64	212.77	179.18	176.33	172.17	163.71	161.91	159.61	148.65	142.16	135.60
6/15/2017 10:15	187.46	218.91	191.05	186.89	176.48	171.13	169.39	168.01	158.22	157.65	156.51
6/15/2017 10:30	208.78	224.15	199.65	192.32	188.00	181.78	179.92	176.18	171.88	170.23	162.03
6/15/2017 10:45	205.22	228.57	209.65	204.29	198.96	191.73	188.93	186.45	182.24	176.41	172.94
6/15/2017 11:00	201.65	232.23	216.43	211.79	205.11	194.31	192.69	192.48	183.88	178.03	175.10
6/15/2017 11:15	183.62	235.21	222.87	217.43	211.08	199.74	196.66	194.68	185.25	183.43	174.88
6/15/2017 11:30	165.59	237.57	222.74	219.26	215.23	206.91	202.13	196.35	185.13	179.41	169.84
6/15/2017 11:45	147.93	239.34	224.10	219.02	213.49	204.59	201.14	197.53	178.31	159.34	136.56
6/15/2017 12:00	148.00	240.59	225.57	221.08	212.37	205.40	203.09	198.49	185.36	162.13	147.85
6/15/2017 12:15	139.66	241.34	228.34	224.25	214.24	202.29	202.28	198.01	192.32	169.01	156.46
6/15/2017 12:30	134.82	241.63	231.47	225.11	213.48	203.86	200.79	197.60	189.18	179.45	166.12
6/15/2017 12:45	139.03	241.46	230.47	224.96	211.62	202.19	199.55	197.23	186.83	174.33	163.45
6/15/2017 13:00	146.06	240.82	228.77	224.08	215.21	203.46	201.77	199.02	187.01	174.73	160.08
6/15/2017 13:15	159.61	239.70	229.91	226.92	216.69	207.29	205.92	203.85	189.15	175.69	166.64
6/15/2017 13:30	166.74	238.08	228.15	226.21	217.18	205.85	202.69	202.10	193.84	178.72	170.70
6/15/2017 13:45	176.36	235.87	224.53	217.99	208.06	200.13	199.02	196.74	183.08	171.00	152.47
6/15/2017 14:00	168.98	233.10	220.01	212.32	204.46	199.87	197.83	195.08	181.45	163.23	156.17
6/15/2017 14:15	181.86	229.64	218.23	212.99	210.46	202.84	199.08	195.68	181.74	164.66	153.88
6/15/2017 14:30	194.73	225.44	213.77	211.61	209.95	198.78	196.95	192.62	173.96	160.43	150.90
6/15/2017 14:45	189.75	220.43	209.06	207.39	204.61	195.10	188.61	182.96	164.15	154.80	138.51
6/15/2017 15:00	184.77	214.56	203.39	200.90	198.36	187.95	182.25	175.19	159.57	143.74	131.64
6/15/2017 15:15	189.77	207.72	195.36	193.03	190.00	179.86	174.83	170.90	154.63	143.92	134.93
6/15/2017 15:30	184.48	199.86	186.62	186.31	183.99	176.35	171.25	167.47	155.26	139.18	133.34

Training: Solar Conditions Reference Sheet

Resource Production by Irradiance Level	Visual Reference	
High Production Greater than 800 W/m^2 	Steady 	Variable 
Moderate Production From 300 to 800 W/m^2 	Steady 	Variable 
Zero to Low Production From 0 to 300 W/m^2 	Steady 	Variable 



EMS PLATFORMS

GE/Alstom

Siemens

SECURE DATA INTERFACE

In2lytics/Referentia

RENEWABLE PRODUCTION FORECAST

AWS Truepower

SHINES TECHNOLOGIES

Stem

Apparent

Gridco

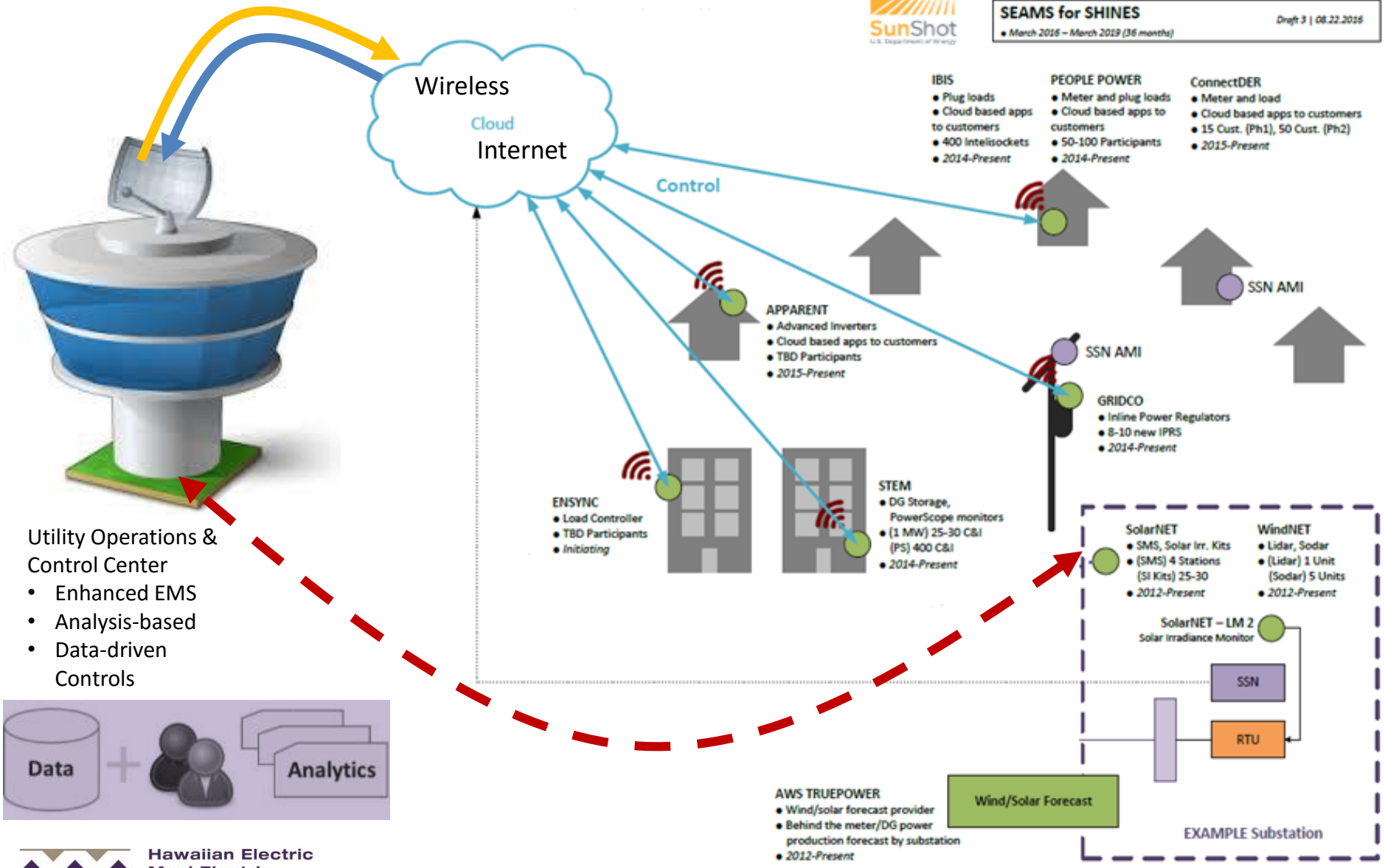
ECONOMIC EVALUATIONS

DNV GL

SEAMS for SHINES Project

Hawaiian Electric
Maui Electric
Hawai'i Electric Light

Physical Architecture - Enhancing Visibility through Customer Sited Devices



Utility Operations & Control Center

- Enhanced EMS
- Analysis-based
- Data-driven Controls

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Hawai'i Electric Light

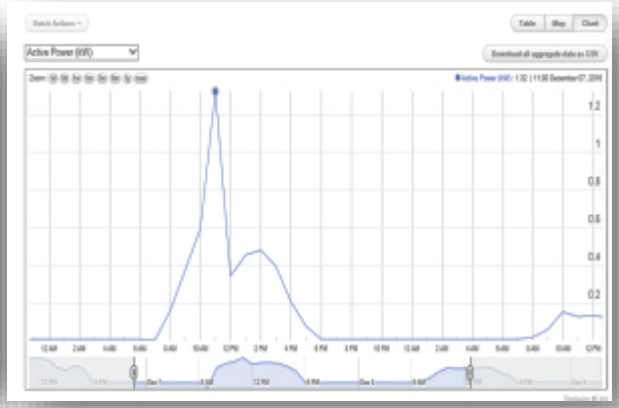
Source: Hawaiian Electric SEAM for SHINES Project

New Smart Devices with Forecasts & Controls

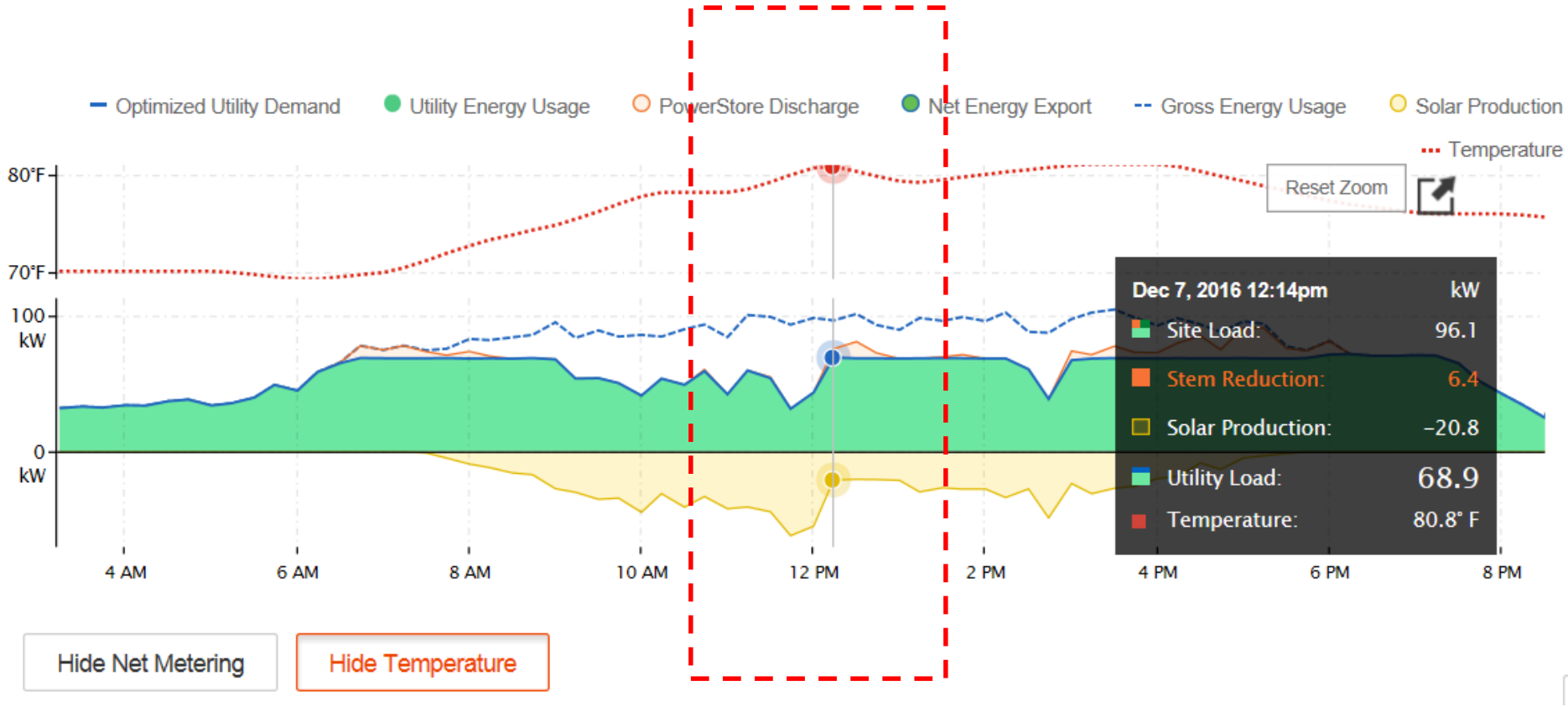
Utility approved Blueline device attached to utility meter.

ConnectDER Meter Interconnect

Stem Powerscope

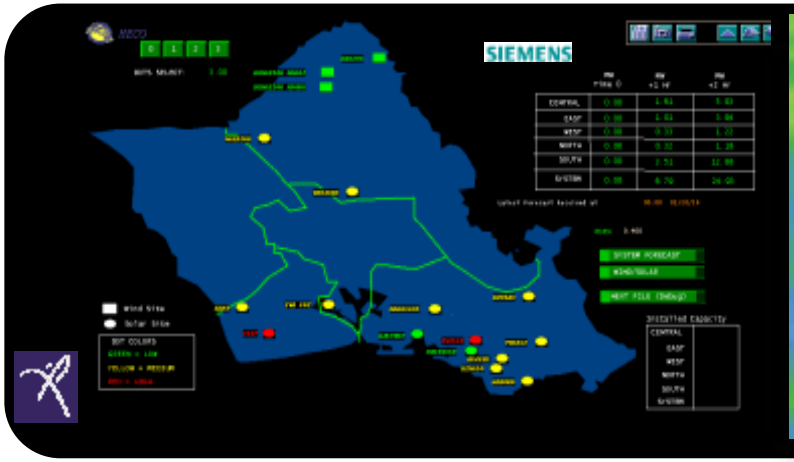


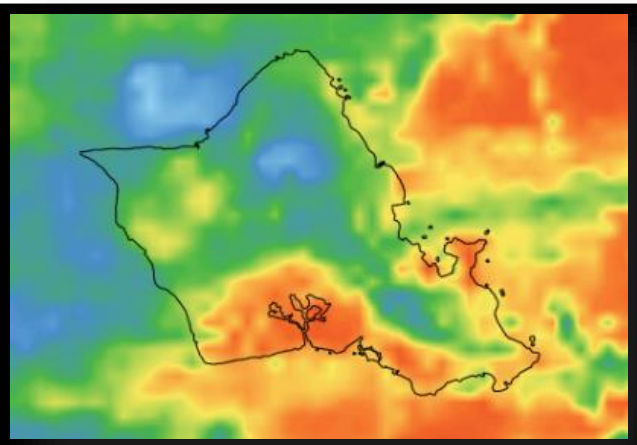
Coupling Forecasts and Smart Devices: Learn How and When to Use New Technologies to Help Support the System



- Intelligent storage demonstrated response to drop in customer PV, maintaining level load at customer site through controlled discharge of PV.
- Provided grid response support during event (6.4kW at 12:14pm)

Integrating VDER into EMS-X Grid Tools to "See & Manage"





- Geographic displays
- Link System Impact with Weather Features
- Post Event analysis & Reviews with Ops increase awareness

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Hawai'i Electric Light

Source: SEAMS for SHINES

Questions/Comments??

Mahalo for the Support

For more information please contact:

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Hawaiian Electric Company