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HIP-PV: PV VISUALIZATION & INTEGRATION UPDATE

Discussion Topics

- Project & Motivation
- Impact of PV on our Utilities today
- What Have We Been Doing?
- Has It Been Productive?
  - > Project results
  - > Examples of Spinoff projects using results from projects
- Q&A

Motivation - Timeliness of Partnership

- Exponential growth in levels of distributed generation "behind-the-meter" generation (variable & DG)
- Levels of penetration exceeding "rules-of-thumb" and standards used in traditional utility practices for planning & operations
- Industry lacks capability (tools/data) to effectively plan and account for PV impacts on the grid (especially at the distribution and DG level)
- Limited commercial solar forecasting capabilities, experience and integration at utilities
- Lack industry guidance (standards/best practices) for monitoring equipment, measurement parameters, modeling and data resolutions for planning & operational timelines

This was….

Our Operational View of Wind & Solar….

SMUD/HECO High Penetration PV Initiative (HiP-PV)

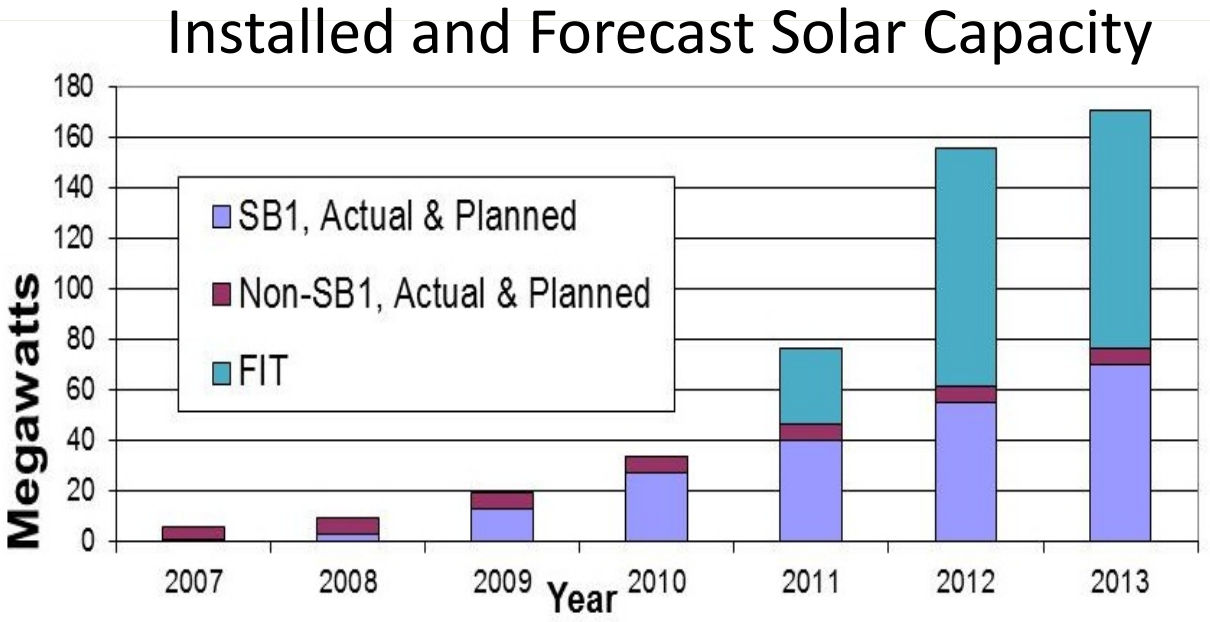
Goal:

Enable appropriate capability to reliably plan and operate with high penetration of variable renewable resources on the grid especially during high impact conditions (e.g. variable weather, peak loads, minimum loads, contingencies)

Objectives:

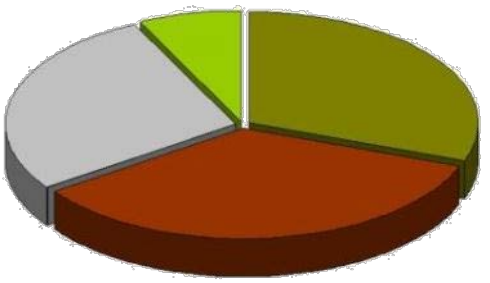
- Inform and pilot the development of visual tracking, field measurement and validated analytical (modeling) capability including hardware and software integration needs to evaluate the impact of high penetrations of PV systems on our grids
- Collaborate with other utilities, validate and transfer lessons learned

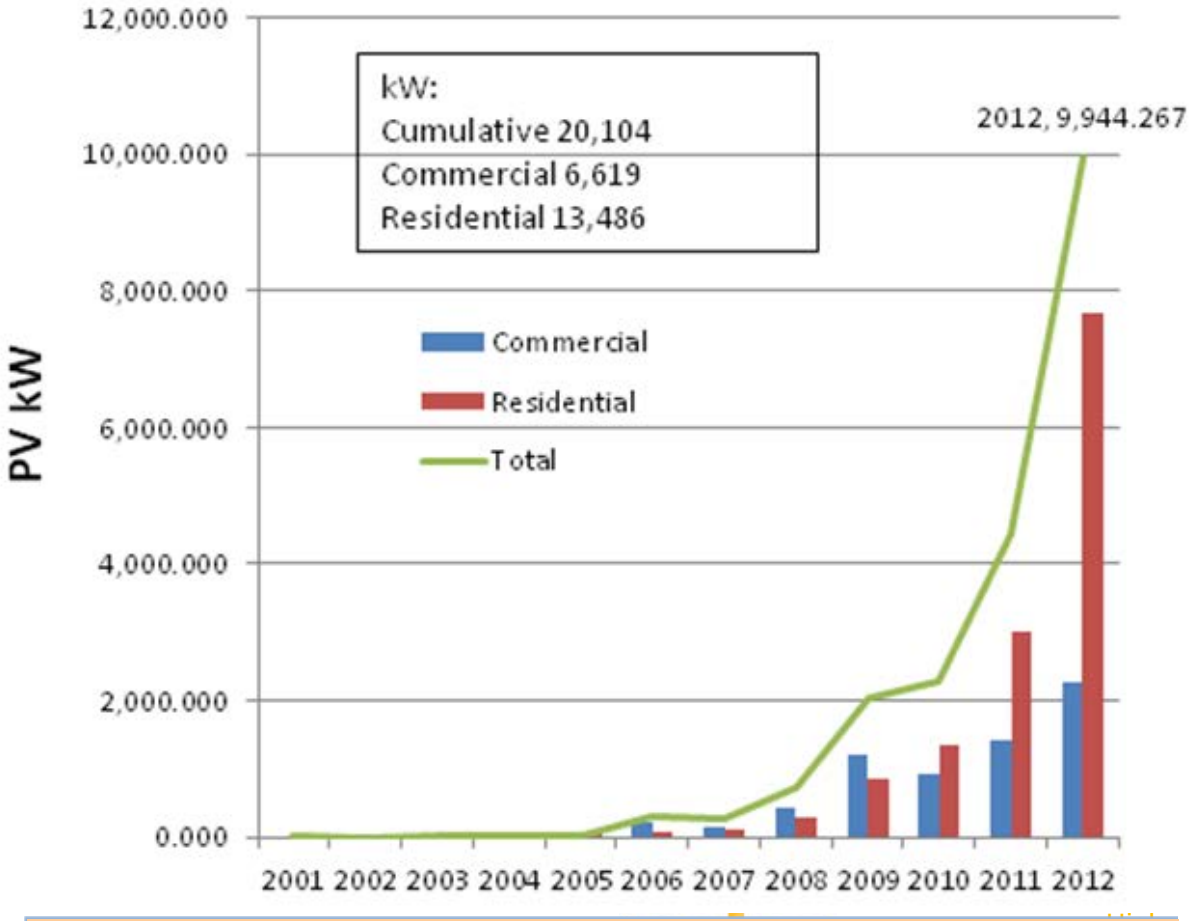
Solar Energy Growth at SMUD



- Community solar projects
- FIT projects
- Aggressive CA RPS – 33% Renewables by 2020

DG Growth in Hawaii





Growth of distributed PV at HELCO, 2001-2012.

- RPS – 40% renewables from electricity, 70% total (includes transportation) by 2030
- Energy efficiency standard of 30% by 2030 (3,400 GWh)
- HECO – 17%, HELCO – 42%, MECO – 26%

Project Team & Approach

Task 1: Project Management

Task 2: Baseline DG Modeling of SMUD and HECO Systems

Task 3: Field Monitoring and Analysis

Task 4: Visualization Effort

Task 5: Solar Resource Forecasting

Emphasis of Today's Presentation

SMUD™

Hawaiian Electric Company
Maui Electric Company
Hawaii Electric Light Company

KEMA
DNV

NEO
Virtus
Engineering, Inc

Itron CSI RD&D Program Manager

SunShot U.S. Department of Energy

GO solar CALIFORNIA

Key Areas of Impact & Deliverables

- Enhance T&D Modeling Tools & Inform PV Data Needs
  - > Developed and validated method for accounting for impact of aggregated DG as generating on distribution feeders
  - > Completed upgrades on utility modeling tools for T&D infrastructure
- Expedite Interconnection Process
  - > Developed and applying cluster evaluation method for proactively assessing T&D impacts to expedite interconnections
  - > Proactive Process and Interconnection recommendations introduced in regulatory proceedings in Hawaii
    - Interstate Renewable Energy Council (IREC) January 29, 2013 Press Release (www.irecusa.org/2013/01/breakthrough-for-hawaiian-solar-power-announced-by-clean-energy-groups/)

Key Areas of Impact & Deliverables (Con't)

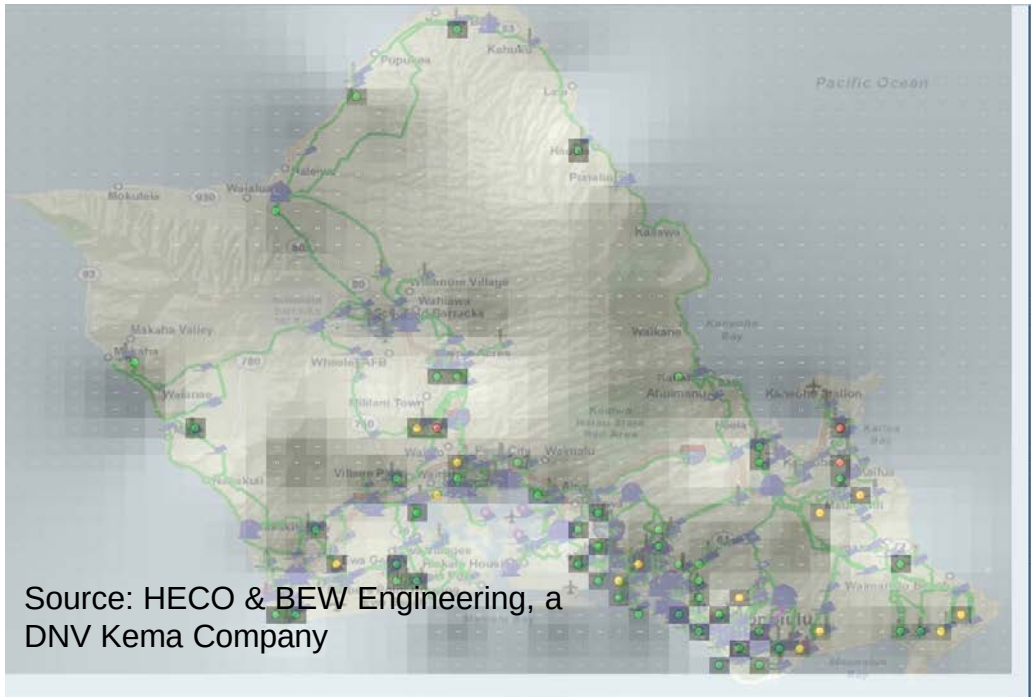
- Jump start development of Real-time Solar Forecasting Tool
  - > Functional utility network of solar irradiance and distribution circuit monitoring devices in the field and integrated into SCADA
  - > Completed solar database representative of local conditions and resolutions (1sec to 15 min) for utility integration and R&D needs
  - > Working with industry EMS vendors and forecasters to integrate real-time solar forecasting data into operating tools/environment
- Building Knowledgeable Energy Workforce through Outreach
  - > Completed in-house utility training on data, tools and lessons learned
  - > Continuing workforce development/training efforts
  - > Presented on project and results at university and PV industry meetings
  - > Accepted/Invited to Industry presentations (i.e. AMS, SEPA, DistribuTECH, UWIG, AWEA, IEEE) & published peer reviewed industry journal articles (IEEE/PES, IJCNN)

Modeling & Sensor Deployments

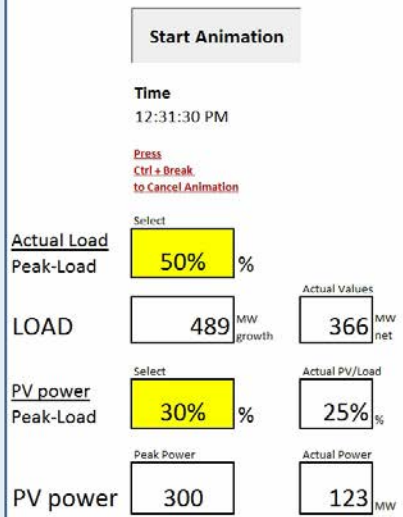
Source: HECO & SMUD

RESULTS

- Installed and integrated solar monitoring units
- Increased visibility to DG in the field (i.e. PV generation)
- Applying validated models for planning & operations
- "Heads up" on impacts through modeling



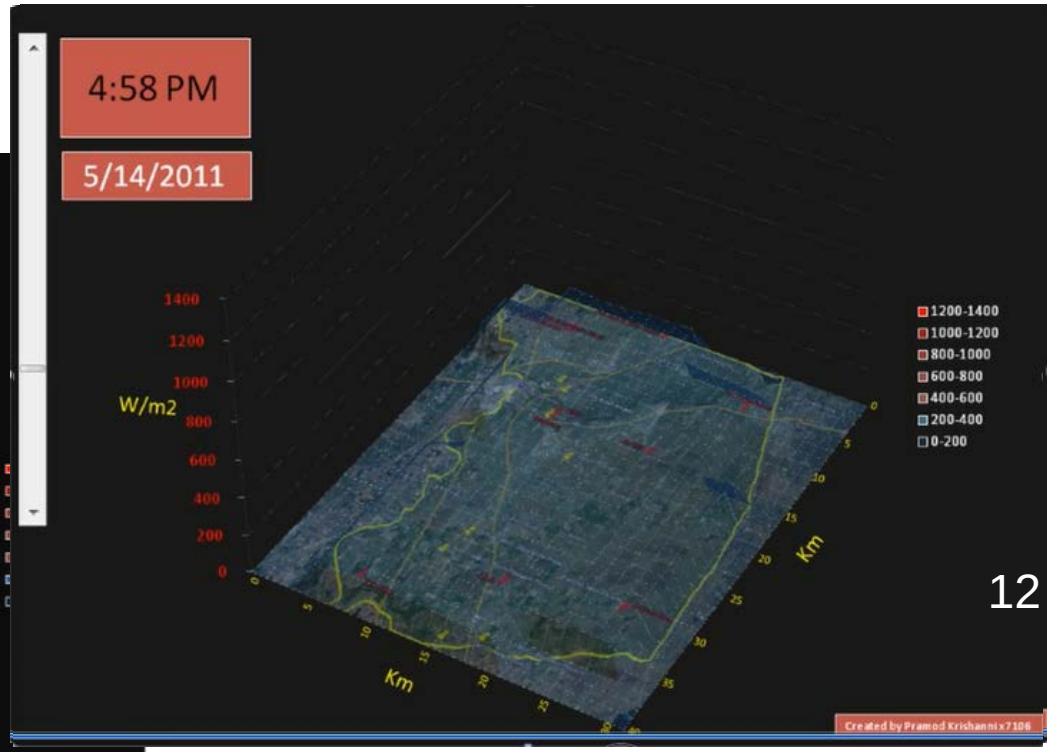
Source: HECO & BEW Engineering, a DNV Kema Company



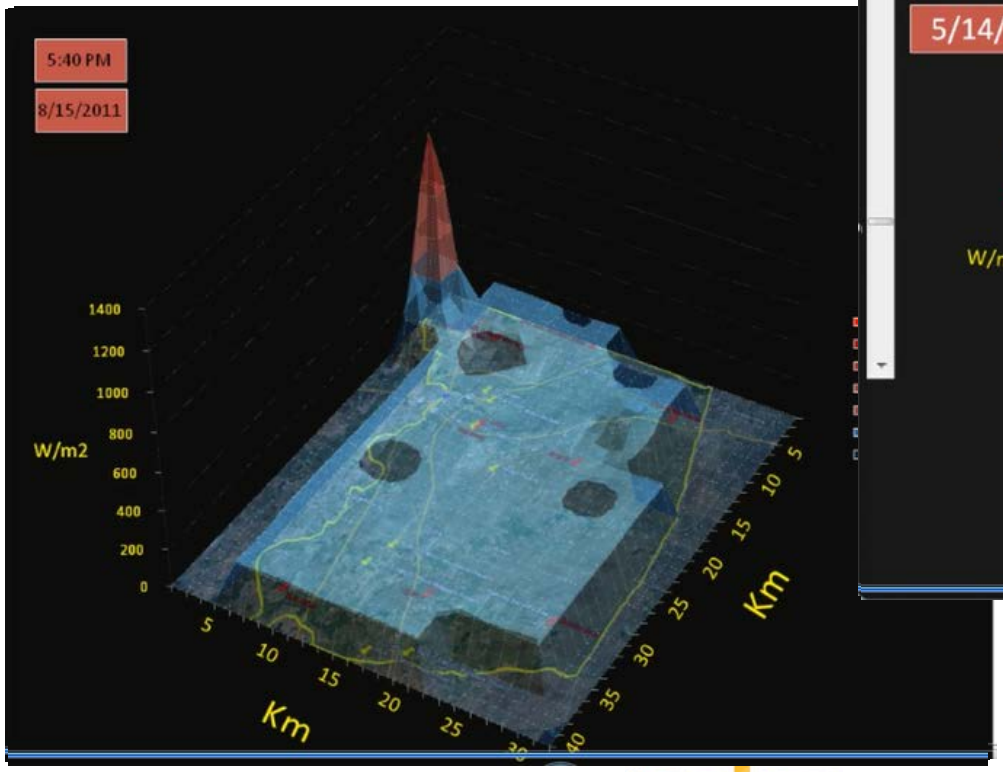
Results: Solar Field Data Visualization Highlights the Magnitude of Resource Variability

NEO Virtus Engineering, Inc

Cloudy Day Data



Clear Day Data



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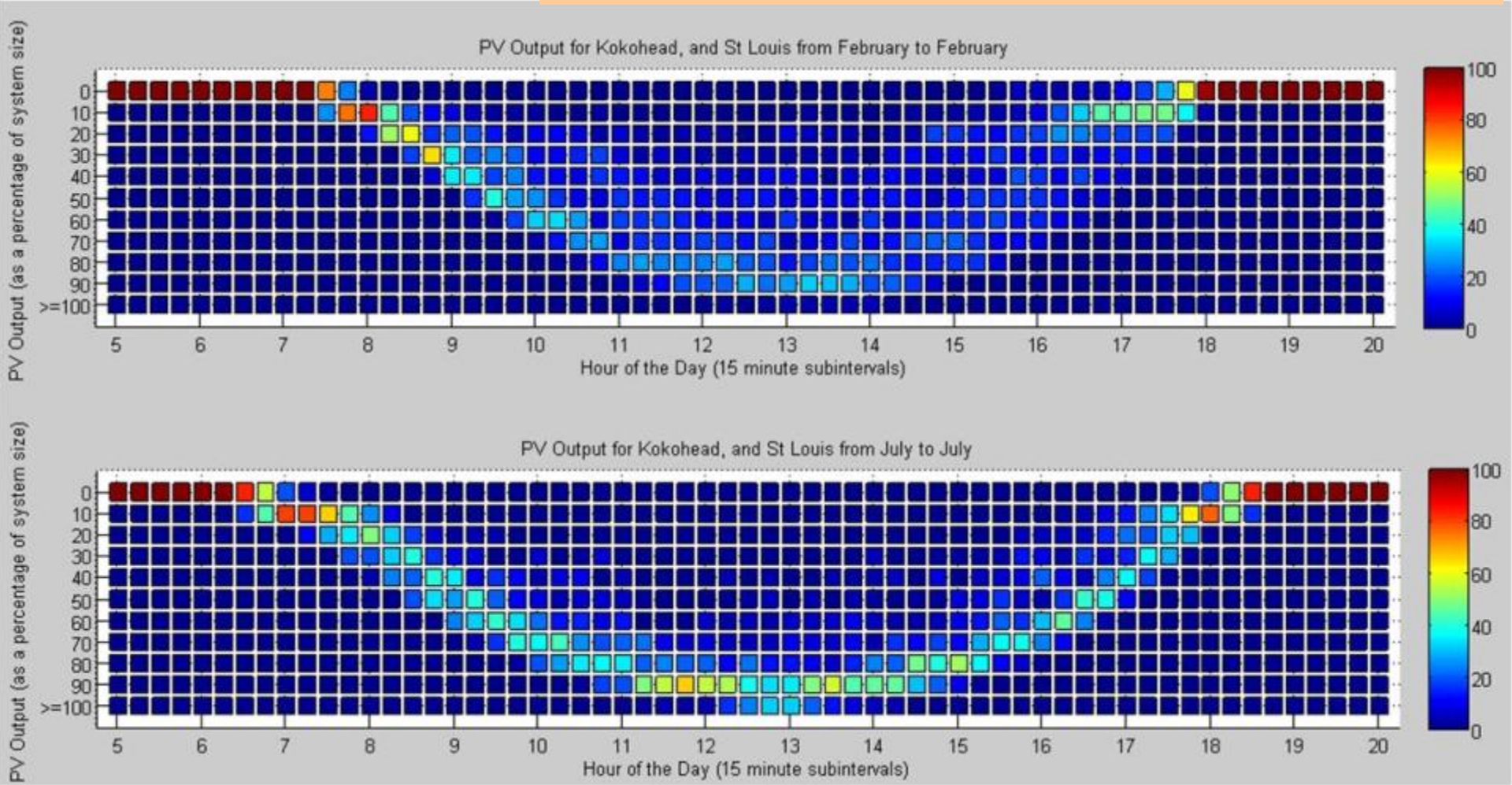
Ex: Probabilistic Metrics by Time & Location

Capturing statistical variation of PV with respect to time and by geographic location.



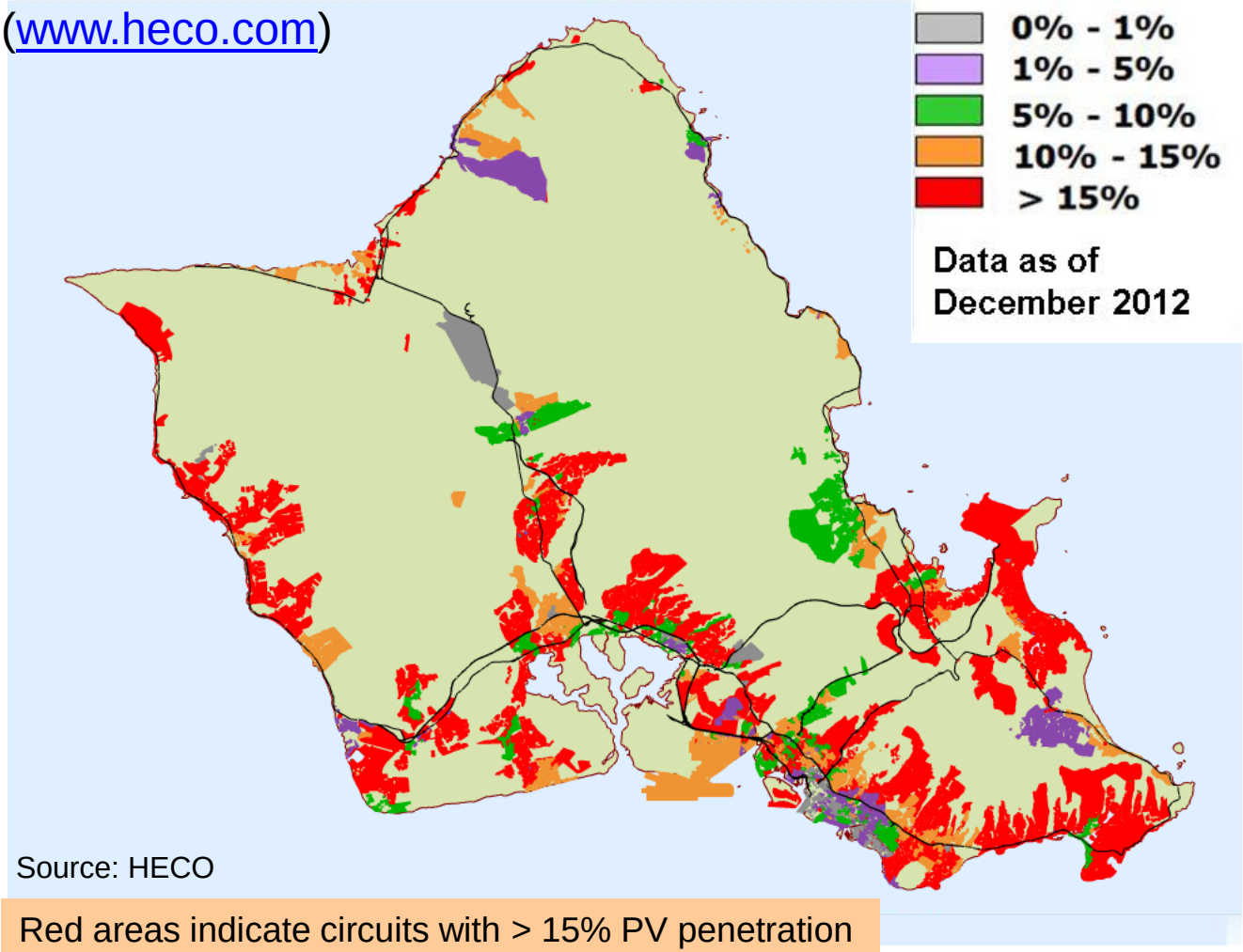
Visualization – A Picture is Worth 1000 Words

RESULTS

- Graphically view PV data to develop local measures and perf. metrics
- More effective data handling, mining and analysis medium
- Effective and transparent tool to communicate and track change

HECO Locational Value Maps Trending Penetration Levels

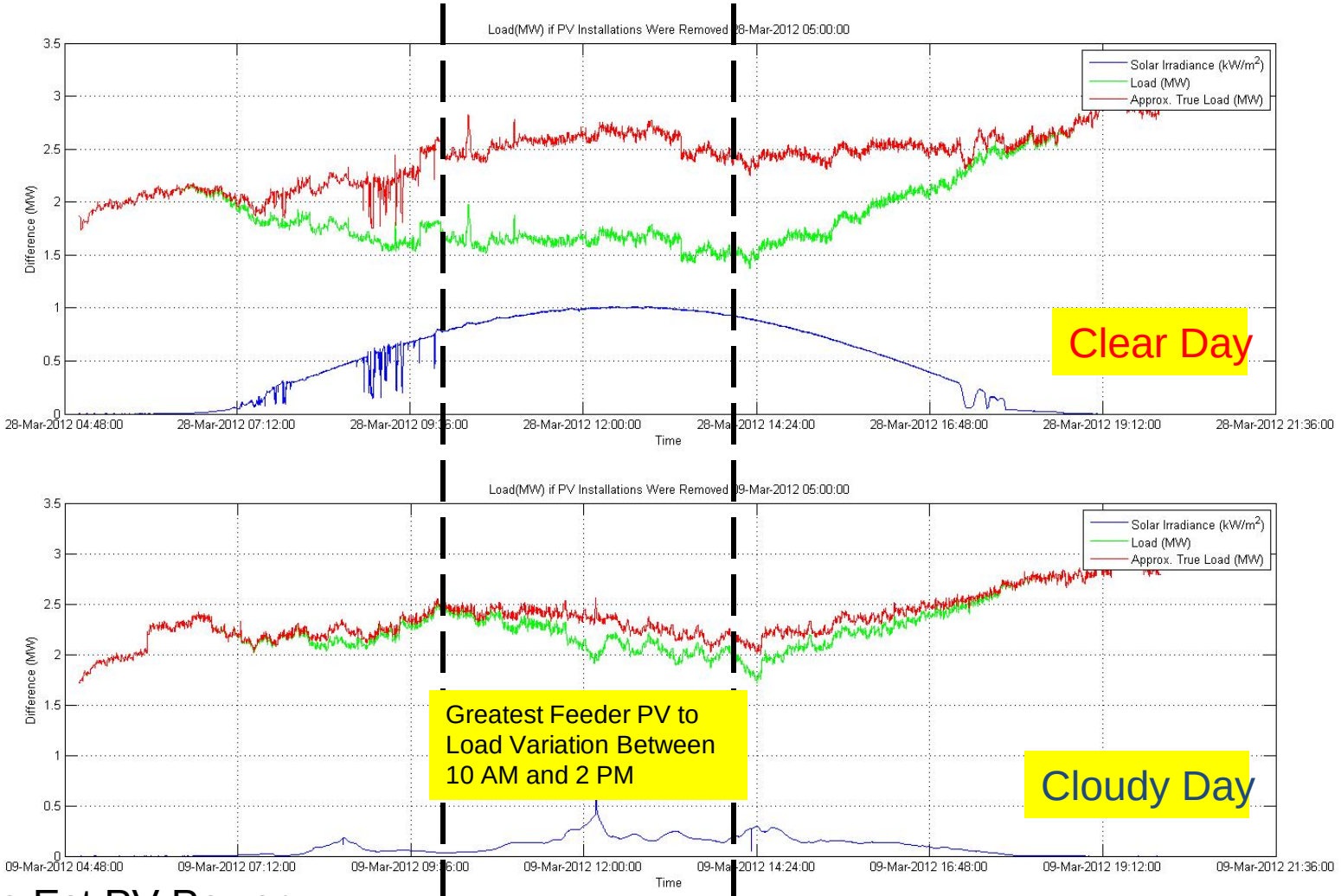
(www.heco.com)



Source: HECO

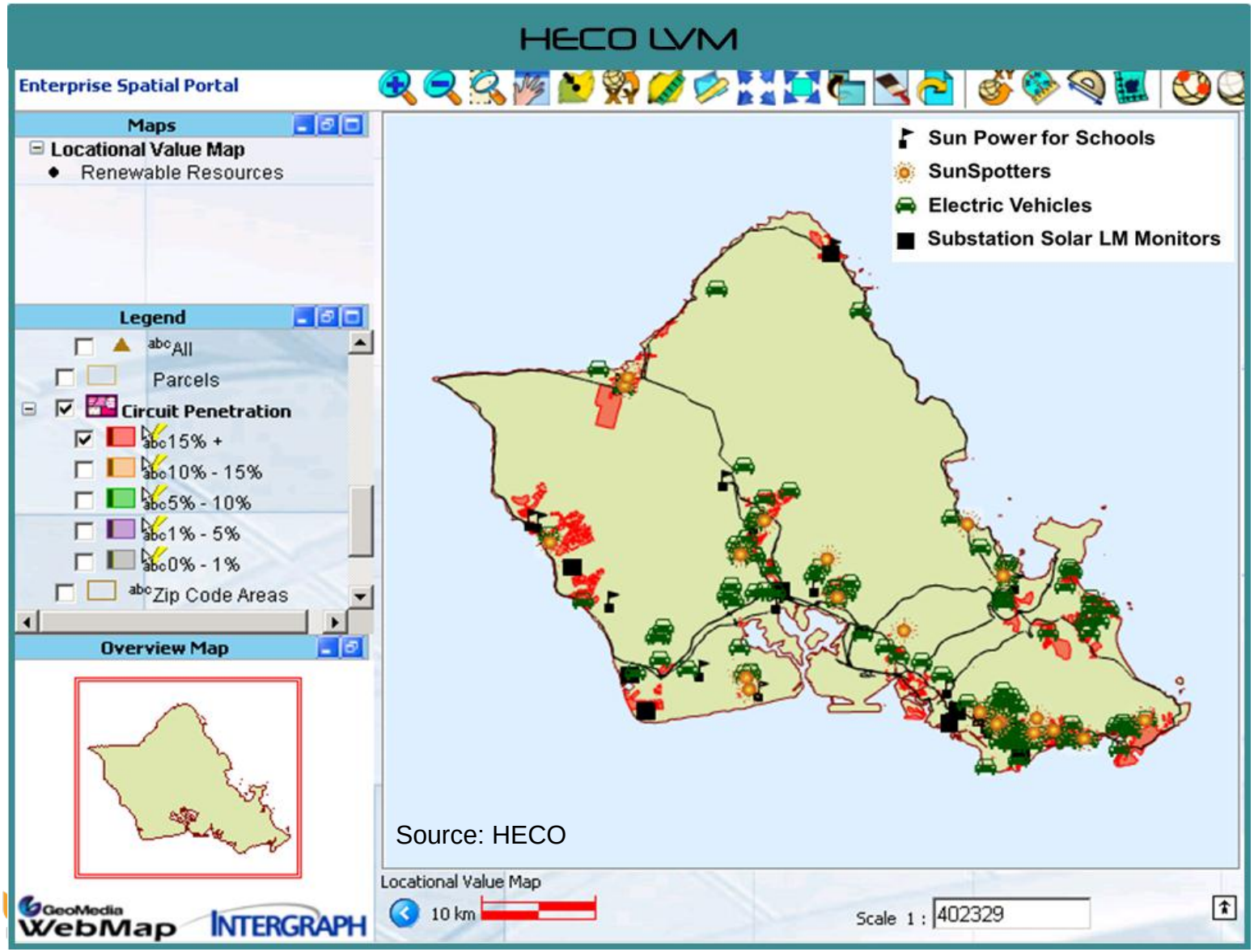
Red areas indicate circuits with > 15% PV penetration

Solar Impact on Feeder Load : March 2012 Weekday

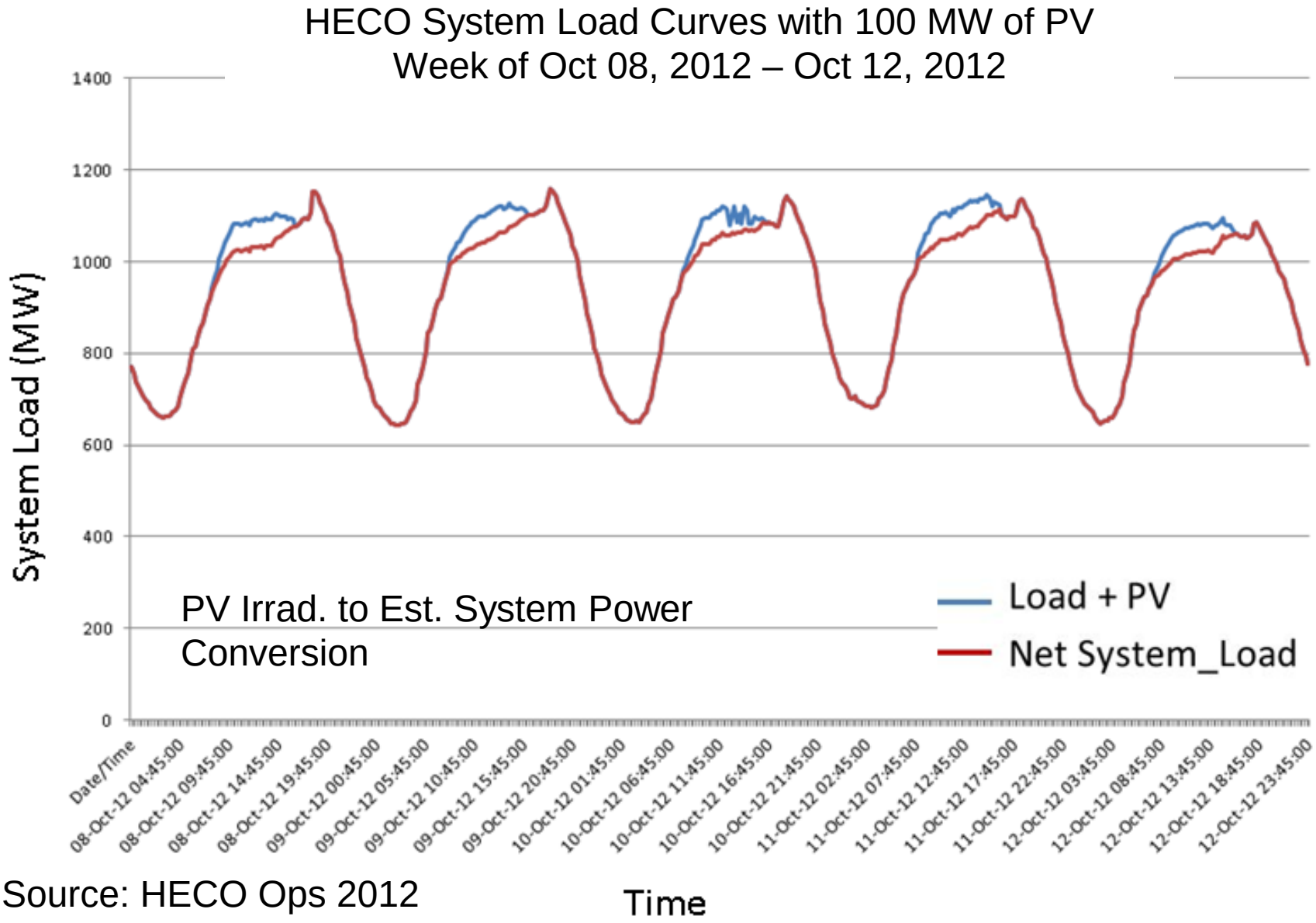


Irrad. to Est PV Power

Ex: Inspired Development of GIS-based Common Platform for Monitoring and Assessing PV, DG/DR, EV

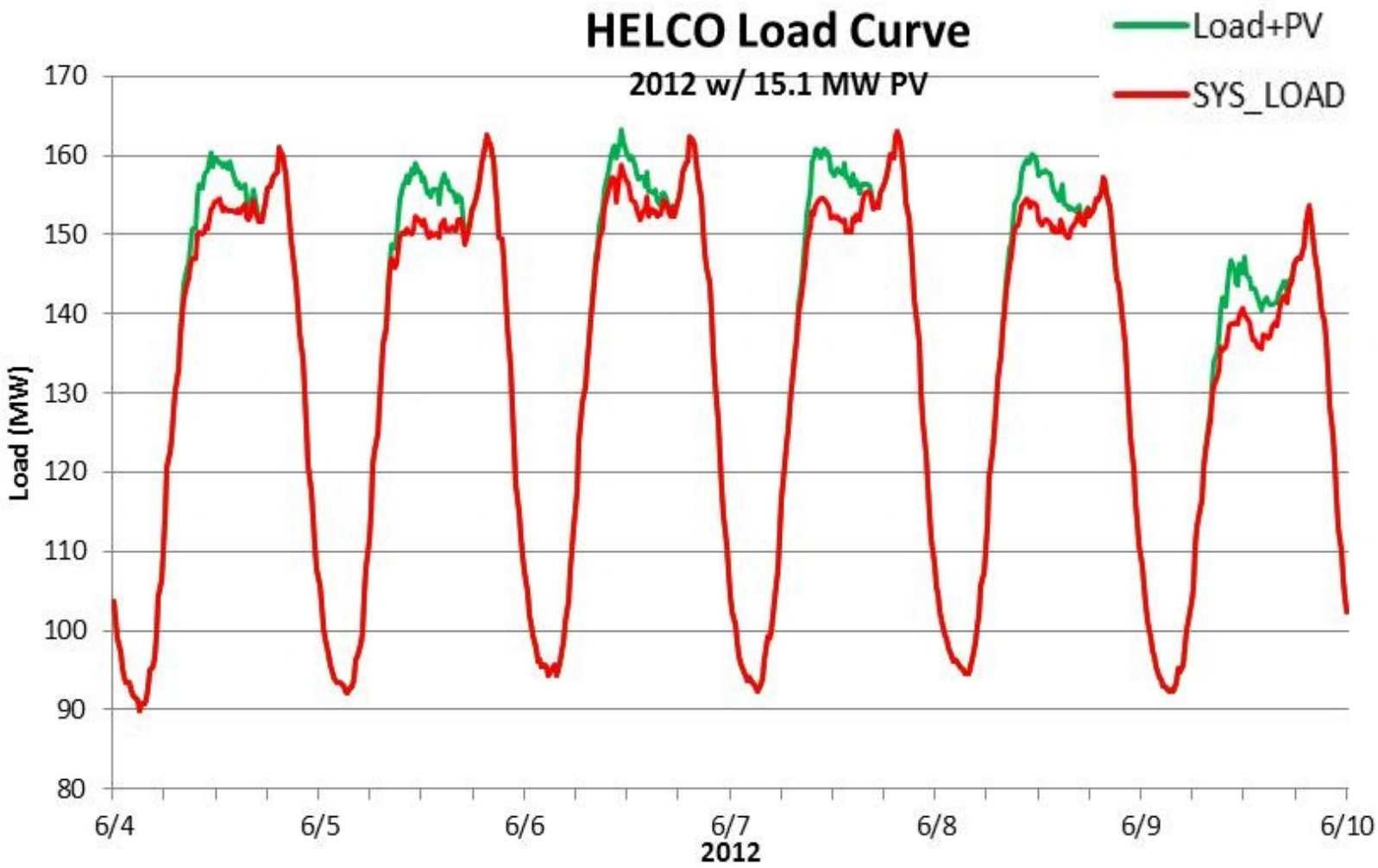


“Seeing” DG PV Contributions onto the System



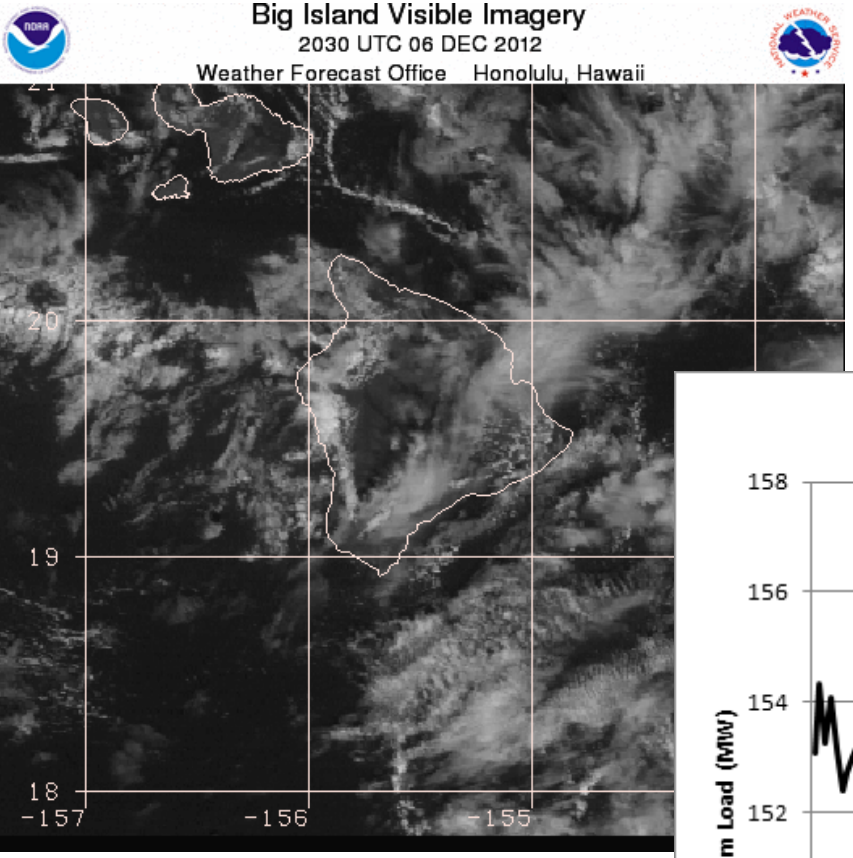
Source: HECO Ops 2012

“Seeing” DG PV Contributions onto the System

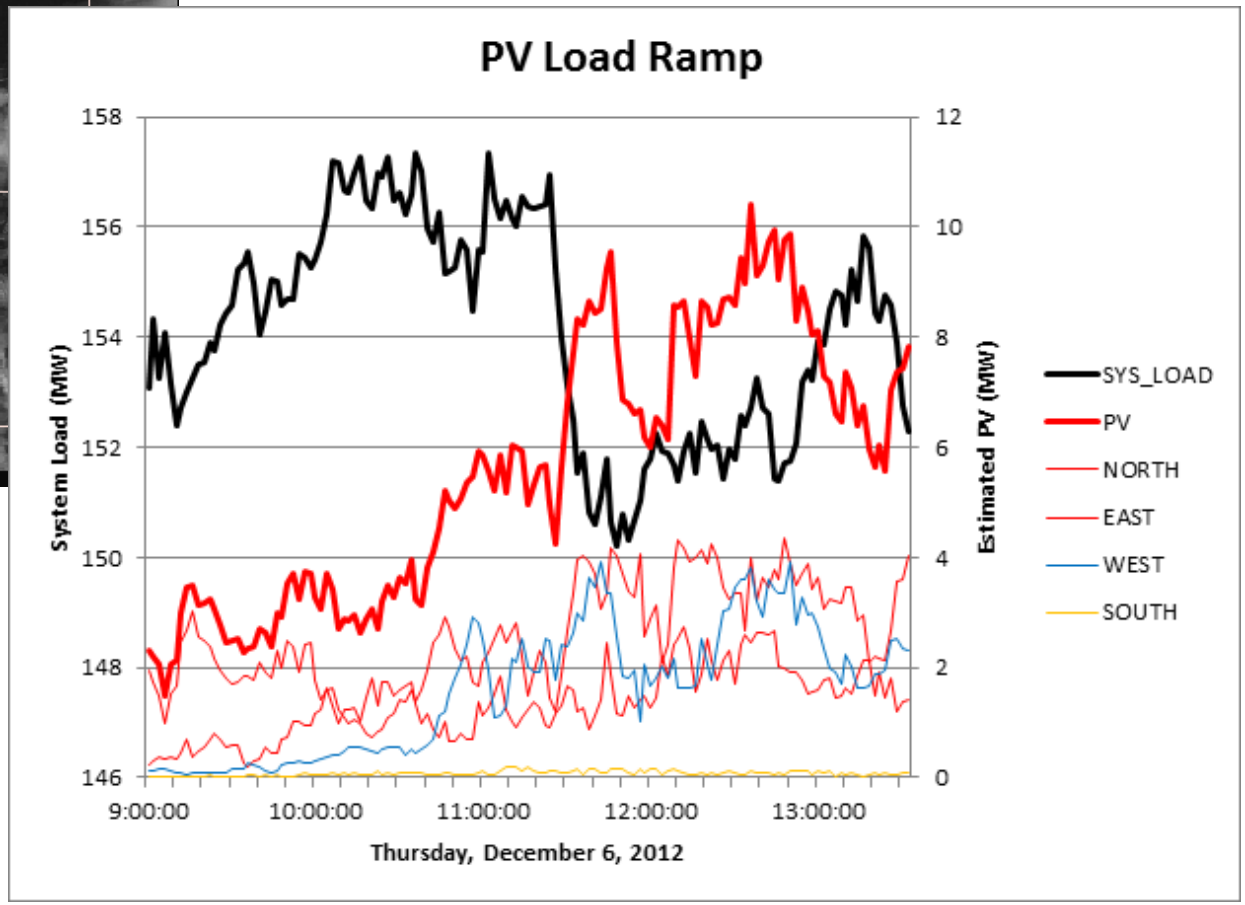


Source: HELCO Ops 2012

Significance of System Impacts due to Solar Ramp Event

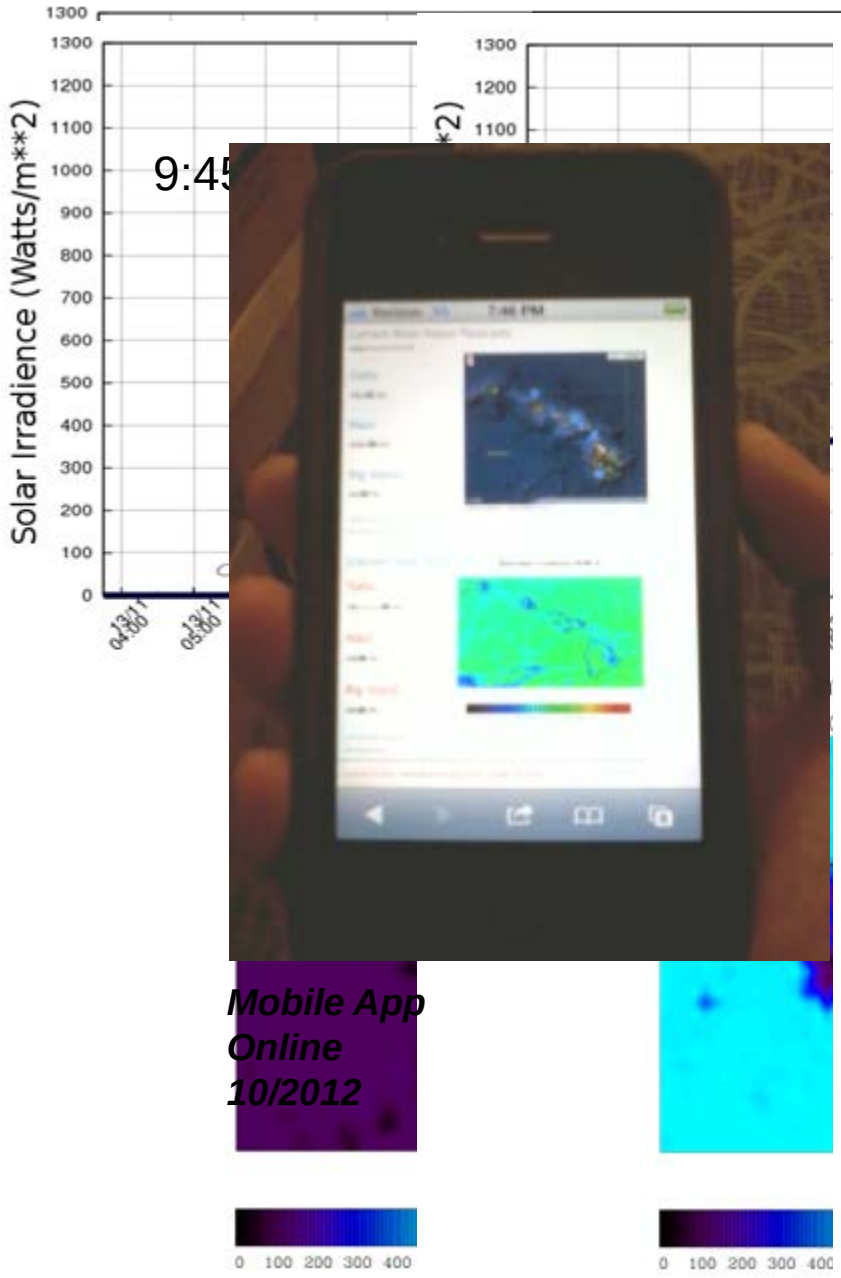


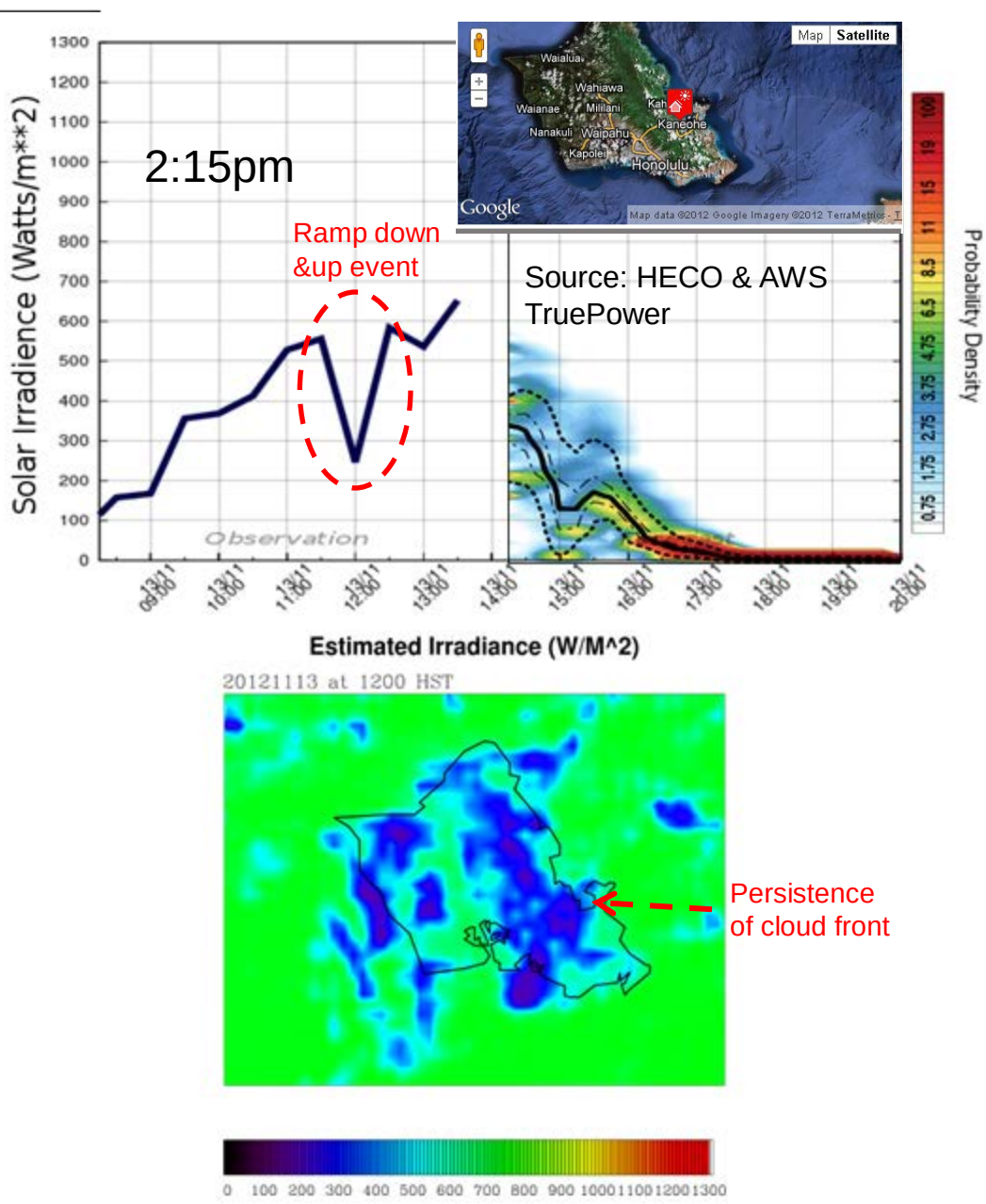
NOAA cloud layer satellite imagery 10:30am – 12:30pm



Source: HELCO

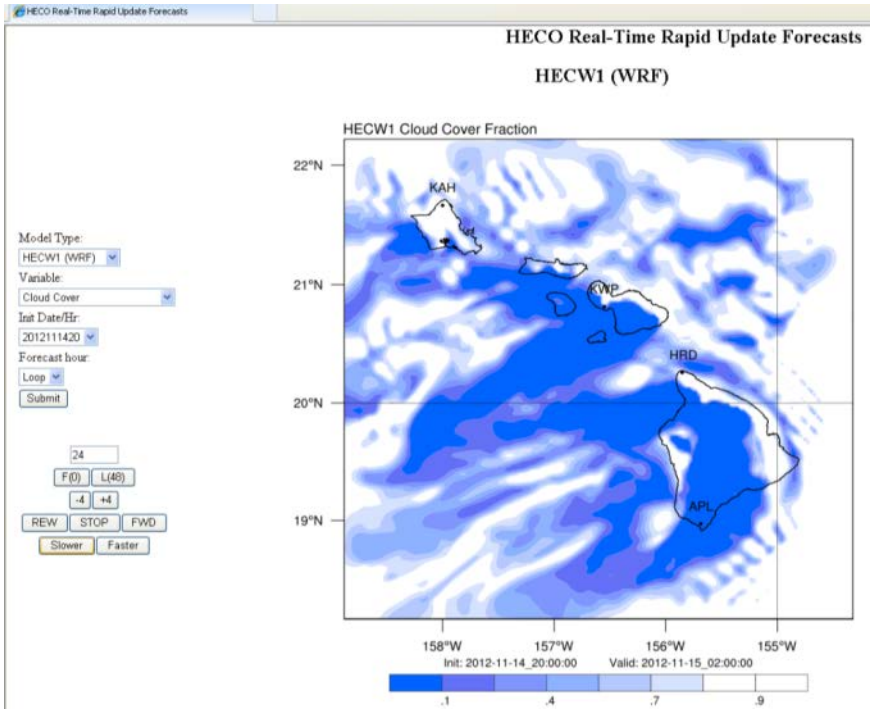
Ex. Jumpstart Real-time Regional Solar Forecasting (Supporting for Planning, Procurement & Customer Acct Mgrs)



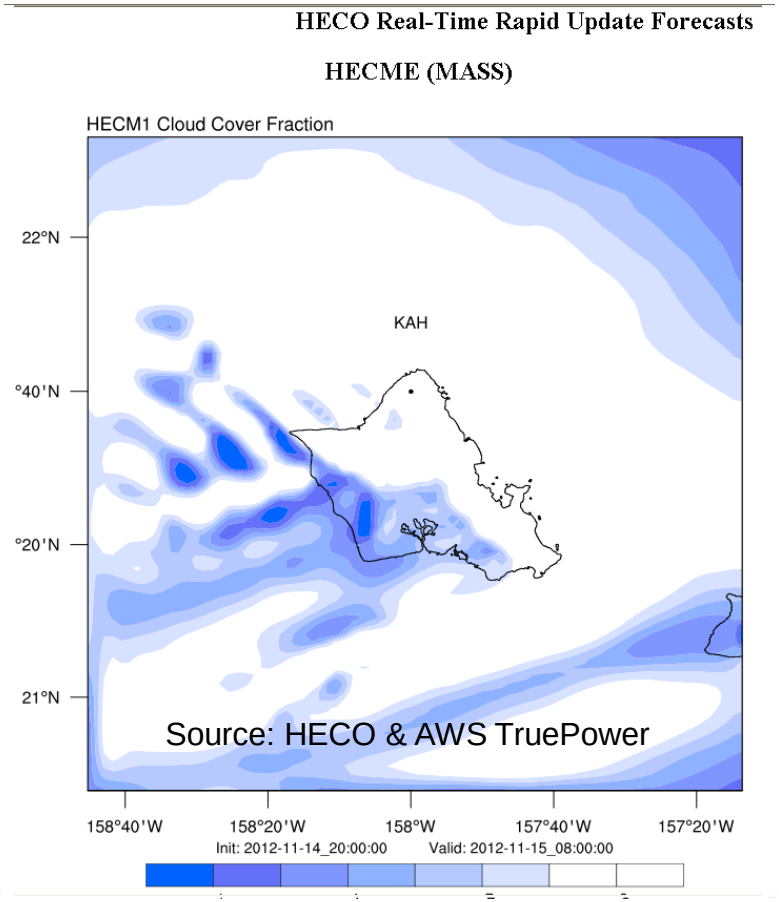


Ex. Field Data Supporting Industry Solar Forecasting & National R&D on Modeling Needs (US DOE SunShots Grant UCAR/NCAR Team)

All Islands



Source: HECO & AWS TruePower

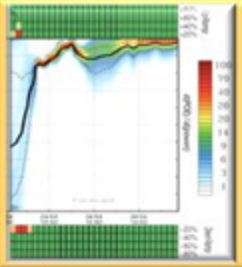


Source: HECO & AWS TruePower

Island Specifics

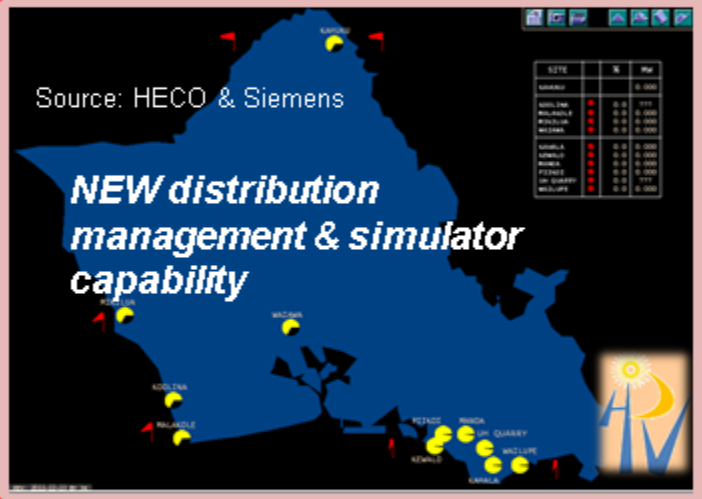
Pulling it all Together – Visual Ops Tool

DMAS Development Project with DNV/AWS/Siemens on EMS Integration



NEW Forecasting INPUTS:
- *Real-time renewables forecasts*
- *Ramp probabilities*
- *Historical and actual trends*
- *Satellite images, weather data*

Traditional input sources
- SCADA data
- Transmission data
- Generator data
- Protection data
- Others

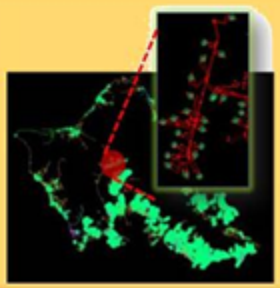


System Ops EMS

WindSENSE Utilities Industry DOE

SolarSENSE Utilities Industry DOE

EPRI ELECTRIC POWER RESEARCH INSTITUTE



NEW Renewable/DG INPUTS:
- *GiS-based distribution infrastructure (models)*
- *DG locations*
- *Field monitored data*
- *Modeled results*

ENHANCED Renewable Integration Capabilities:
- Operations & Planning with visibility to DG resource impacts
- Updated state-estimator and simulation capability to evaluate actions & impacts

Other Key Benefits

Efforts are helping to informing change (time and cost benefits):

- Validation of T&D models and new data (solar, circuit) needs
  - > BENEFIT: Informing where and what data needs to be collected
  - > BENEFIT: Enabling utilities to "see" and be proactive in planning
- Instilling sense of confidence to change at high penetrations
  - > BENEFIT: Field validated examples, experience/lessons learned
  - > BENEFIT: Engaging utility users to design, develop and understand "probabilistic heads-up" tools to manage future grid
- Ensuring knowledgeable energy workforce
  - > BENEFIT: Inform new standards and vendor product requirements
  - > BENEFIT: Maintaining interoperability & reliability functions and supporting sustainable change practices/procedures

Q&A & Discussions

Some Related References and Recently Accepted Presentation Venues

Date/Venue	
2013 DistribuTECH	Presentation – Cluster Evaluation Methodology Presentation – High Penetration PV and evaluation of impact on LTC
2013 UWIG	Presentation – Solar and Wind Integrated Forecasting Technology (SWIFT)
2013 PUC	Filing provided by the RSWG PV Subgroup on Proactive Approach: DG and PV modeling & Hawaii Rule 14H interconnection recommendations
2012 IEEE PES	Paper/presentation – Flicker Evaluation for PV Paper/presentation – Managing High Penetration of Variable Renewables including wind and solar
2012 UWIG	Presentation – WindNET and SolarNET deployment lessons learned
2012 SEPA USC	Presentation/Poster – HiP-PV Project

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