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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

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%

Growth of distributed PV at HELCO, 2001-2012.
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
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
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)
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 & SMUD

Source: HECO & BEW Engineering, a DNV Kema Company
Results: Solar Field Data Visualization Highlights the Magnitude of Resource Variability

Cloudy Day Data

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

Ex: Probabilistic Metrics by Time & Location
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)

Data as of December 2012

Red areas indicate circuits with > 15% PV penetration

Source: HECO
Solar Impact on Feeder Load: March 2012 Weekday

Greatest Feeder PV to Load Variation Between 10 AM and 2 PM

Clear Day

Cloudy Day

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

HECO System Load Curves with 100 MW of PV

PV Irrad. to Est. System Power Conversion

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)

Mobile App
Online
10/2012

Source: HECO & AWS TruePower
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

HECO Real-Time Rapid Update Forecasts

HECM1 Cloud Cover Fraction

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

NEW distribution management & simulator capability

Source: HECO & Siemens

System Ops EMS

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

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<tr>
<th>Date/Venue</th>
<th>Presentation/Poster – Cluster Evaluation Methodology</th>
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<td>2013 DistribuTECH</td>
<td>Presentation – High Penetration PV and evaluation of impact on LTC</td>
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<th>Filing provided by the RSWG PV Subgroup on Proactive Approach: DG and PV modeling &amp; Hawaii Rule 14H interconnection recommendations</th>
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<th>Paper/presentation – Flicker Evaluation for PV Paper/presentation – Managing High Penetration of Variable Renewables including wind and solar</th>
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