“Enhanced Modeling and Monitoring Tools for Distributed PV Interconnection”

Mark Rawson, Sacramento Municipal Utility District and David Pinney, National Rural Electric Cooperative Association with introductory remarks by Rick Thompson, Greentech Media

May 28, 2014
Purpose of Today’s Meeting

• Foster stakeholder collaboration and awareness
  o Learn about Green Tech Media’s (GTM) new Grid Edge Initiative, Rick Thompson, GTM

• Hear an example of how a municipal utility is planning for solar interconnection and roadmapping the future of PV integration
  o Mark Rawson, Sacramento Municipal Utilities District (SMUD)

• Learn how the National Rural Electric Cooperative Association’s (NRECA) software development effort is making power systems models usable in the electric cooperative community
  o David Pinney, NRECA
Speakers

Rick Thompson
President and Co-Founder
Greentech Media

David Pinney
Lead Software Engineer
National Rural Electric Cooperative Assoc.

Mark Rawson
Energy Research Technology Officer of
Energy Research and Development
Sacramento Municipal Utility District

Kristen Ardani
Solar Analyst
National Renewable Energy Laboratory
(DGIC moderator)
Market Forces Behind the Grid Edge

Grid Modernization
- Reliability/Resiliency
  - Grid Control and Modeling (DMS/OMS/SCADA)
  - Distribution Automation
  - Asset Health and Management
- Intelligence
  - Workforce Optimization
  - Physical Security
  - Data Management Systems (e.g. MDM)
  - Network Management
  - Grid Analytics
  - Grid Networking (AMI/FAN, WAN)
  - Sensors and Monitors
  - Cybersecurity

Customer Evolution
- Concoration
  - Distributed PV
  - Combined Heat and Power
  - Fuel Cells
  - Other DG Technologies
- Storage
  - Battery Storage
  - Flywheel Storage
  - Thermal Storage
  - EV Storage
- Optimization
  - Energy Management Systems
  - Demand Response
  - Intelligent Efficiency

Next-Gen Energy System
- Market Evolution
  - Utility Business Model Adaptation
  - Transactive Energy Services
  - Intelligent Rate Design
  - Third-Party Energy Service Providers
  - Regulatory Advancement
- Technology Evolution
  - Volt/VAR Optimization
  - Demand Response Management Systems (DRMS)
  - Distributed Energy Resource Management Systems (DERMS)
  - Distributed Storage Management
  - Smart PV Inverters

GTMR RESEARCH | www.gtmresearch.com
PV Growth is the Ultimate Grid Edge Driver

“Every four minutes, another American home or business goes solar.”
- President Obama’s State of the Union address, citing GTM Research findings

GTM Research is forecasting the U.S. to install nearly 6 gigawatts of solar in 2014.
This will bring the cumulative total to 18GW.

The U.S. will rank third in solar installations worldwide.
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New and Upcoming Market Research

- Distributed Energy Storage 2014: Applications and Opportunities for Commercial Energy
- Advances in Grid Power Electronics for High Penetration PV Integration
- DER Management Systems 2014: Market Definitions, Deployments and Value
- The Future of Demand Response 2014: Technologies, Architectures and Market Forecast
- Volt/VAR Control and CVR: Strategies, Deployment, and Case Studies
- Grid Edge Data Analytics 2014: Technologies, Applications and Market Forecast
Current Members

[Logos of various companies]
Join GTM at Grid Edge Live Next Month!

- June 24-25, 2014
- San Diego, CA
- Hyatt Regency Mission Bay Spa and Marina
- 19 Sessions
- 63 Speakers
- ~350 attendees
Questions?

Rick Thompson
President & Co-Founder
Greentech Media & GTM Research
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Additional Information:
http://www.greentechmedia.com/gridedge
Planning for Solar at SMUD – Beyond Interconnection

Mark Rawson
May 28, 2014

NREL - Distributed Generation Interconnection Collaborative

Powering forward. Together.
SMUD – Owned By Customers

• Not for Profit, Publicly Owned Utility
• Began (1946)
• Sacramento County (small part of Placer & Yolo Counties)
• Almost 600,000 Customers; 1.4 Million Population
• Peak Load: 3,299 MW (July 2006)
• 6th Largest POU in U.S.
• 7 Member Board of Directors
• Elected by Customer Owners
• Not a Part of City or County
• Manage Balancing Authority of Northern California (BANC)
• Low Rates, Reliable, Innovative & Green!
Outline

• Context for Solar R&D – growth in solar at SMUD
• PV Integration Roadmap
• Solar Resource Characterization
• Grid Impacts Mitigation
• Resource Planning Studies
Solar History and Range of Potential 2020 Capacity at SMUD

- SMUD share of Governor’s DG Targets + Potential Utility Scale Arrays
  - SMUD 130 MW Rooftop Goal + 125 MW Utility
  - 100 MW SMUD FiT 2011, 2012

1st 1 MW PV Array Constructed at Rancho Seco
SMUD PV Pioneer Rooftop Program for Residential and Commercial Customers Launched
Contractor Driven Retrofit Programs, SolarSmart Communities, SolarShares,
SMUD's smart T&D system will be capable of integrating growing penetration of PV while maintaining high system reliability and operational flexibility, with minimal grid integration costs.
Can storage technically mitigate voltage variability due to PV? At what cost? What additional benefits can storage mutually provide?

Can DR, EVs or TES be effectively controlled to address PV variability impacts on voltage? If so, where should it be sited? How does this use case for DR enable more cost effective customer DR programs?

Where is it optimal to site storage to best mitigate PV variability effects (e.g., on DC bus or AC bus at PV project, at the edge of the grid, mid-feeder, substation)?

What impact does variable PV generation have on implementation of CVR/VVO?

How effectively can localized PV forecasting coupled with storage or DR mitigate negative impacts on voltage variability, reverse power flow, minimum load and others?

Can SMUD’s AMI or DA networks effectively monitor and control PV and storage inverters to address PV variability impacts to the grid?

What types of advanced feeder/substations approaches can effectively mitigate high penetration PV and its associated variability on distribution circuits (e.g., dynamic load transfer, line voltage regulation)?

How effective are curtailable and dynamic VAR capable advanced inverters at mitigating PV variability effects?

What storage to PV ratio is required to effectively reduce PV ramp rates?

Where is it optimal to site PV systems to mitigate negative impacts to distribution and the bulk system? What are the optimal PV sizes by location?
How will PV system reliability impact resource planning and grid operations?

Where we are approaching PV integration limits, how do we prioritize and assess grid upgrade costs? How do we prioritize siting of PV to minimize grid upgrade costs?

What value does PV, DR and storage provide to the utility and customer? How can those values be captured for the utility or the customer; for example, tariffs, incentives, rebates, procurements, etc.?

How will net-zero energy policy impact grid and resource planning?

How will PV costs reaching grid parity impact SMUD strategy; for example, customer programs, interconnection costs, grid planning, rate recovery, customer relationship and satisfaction, resource planning, etc.?
Solar Resource Assessment

• Deployed distributed sensor network in 2011 with grant funding from CPUC
• 71 sensors deployed to complement 3 already installed
• 5 km grid spacing to match NDFD forecast granularity
• Multiple Solar Forecasters contracted for solar forecast evaluation
Distributed Solar Sensor Variability and Aggregate Ramp, with Hour-Ahead Forecasts November 8, 2012

Solar resources over 2,200 square km service territory, 25km² resolution

http://www.youtube.com/watch?v=ZE5KL2UyRyg&feature=youtu.be

Irradiance Sensor Network and large PV site Locations

Global Horizontal Irradiance (GHI) - W/m²

- Distributed Solar Sensors (74)
- Average of Sensor Network
- Hour-Ahead Solar Forecasts
Grid Impacts Characterization Studies

High Penetration PV Initiative

Objective: Development and testing of hardware and software to evaluate the impact of high penetrations of PV systems on our grid.

Team: SMUD, HECO, DNV KEMA (BEW Engineering), EPRI and NEO Virtus Engineering

Project activities: Feeder and system modeling, baselining, field monitoring and analysis are conducted on identified case studies that include sites and feeders within SMUD territory and Hawaii. Visualization tools are being developed. Irradiance monitoring sensors are deployed. Solar resource data is being collected and forecasting activities conducted. Demonstrate inverter monitoring via AMI communication from smart meter to inverter.
Grid Impacts Characterization Studies

- Gridiant Integrated T&D Modeling Tool evaluating scenarios for impacts of high penetrations of PV
- Evaluation of up to 200% of daytime minimum load on feeders
  - Voltage deviation
  - Reverse power flow
Grid Impacts Mitigation Demos

- Battery Storage Projects
  - Anatolia storage project – 15 RES and 3 CES Li-Ion batteries deployed and tested in residential and transformer applications, 21 use cases evaluated
  - Mitsubishi storage project – 500kW 125 kWh Li-ion battery connected to 3 MW PV array for firming
  - FIAMM Sodium Nickel Chloride battery storage project – 50kW 130kWh smoothing PV and EV fast charger load
  - 2500 R St. Residential battery storage project – 34 residential Li-Ion storage units coupled with PV
Grid Impacts Mitigation Demos

• Smart Inverter Testing
  – Tests performed under CSI RD&D 1 to demonstrate ability to send signal over AMI network to curtail PV output using SEP 1.1 signal over Zigbee from L&G Smart meter
  – New grant to EPRI under CSI RD&D 4 to demonstrate a standardized communications module under CEA 2045 standard to demonstrate smart inverter functions that are proposed for Rule 21 updates. Will use SEP 2 and Open ADR Standards
Resource Planning Studies

- Working with EPRI, CPR to evaluate economic value to SMUD of our planned 400 MW Pumped Storage project for mitigating intermittent renewable supplies
  - Planning cases around 1,000 MW of variable renewables
- Working with Energy Exemplar, NREL, CPR to evaluate Operations Impacts of >1,500 MW of solar and 600 MW of wind on SMUD’s system
- SUNRISE grant to UCSD, working with CPR, PNNL to evaluate the value of informing AGC and improving generator dispatch with a solar forecast
Summary

• Variable generation requires lots of changes to accommodate:
  – Forecasting
  – Grid modeling, planning and operations
  – Mitigation measures
  – Resource planning
  – Rates?
Thank You!

Mark.Rawson@smud.org
Open Modeling Framework

Background and Applications to Distributed Generation Planning

David Pinney
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Lead Software Engineer
NRECA Cooperative Research Network
The OMF is a software framework for modeling smart grid technologies.

Goal: it enables cost-benefit and engineering analysis of smart grid investments.

Why build this?
- Cost benefit analysis was identified as one of the key barriers to smart grid deployment by NRECA's Smart Grid member advisory group.
- Needed to complete CRN’s Smart Grid Demonstration Project.

What technical problems are we solving?
- The best models took weeks or months to run.
- No one tool had all the modeling features needed for smart grid technology evaluation: behavior over time, weather, customer response, usable interfaces, monetization.
- Many literature results were not reproducible.
- Needed a way for 900 NRECA member utilities to collaborate.
Existing Tools

Power

Usability
Comparison of 3 systems over 4 days.

OMF Output: Solar Simulation

Reports on zSolar Trio

Power Consumption From Transmission System

Reverse powerflow predicted.

Full climate simulation.
OMF Output: Solar Simulation Continued

1: Overvoltage predicted in rooftop solar configuration.
https://www.omf.coop
Register for Next DGIC Webinar: June 12th

Lessons Learned with Early PV Plant Integration

- This webinar will highlight the Arizona Public Service (APS) interconnection process for systems greater than 1MW, feature APS case studies on high penetration, and explain APS’s lessons learned with early PV plant integration. Featured speakers from APS are Frank Greco, Senior Electrical Engineer of Renewable Energy Delivery and David Narang, Engineer of Energy Innovation.

https://www3.gotomeeting.com/register/312708902
Thank you!