EPRI Smart Grid Demonstration Update

An EPRI Progress Report **May 2012**

ABOUT THE NEWSLETTER

The EPRI Smart Grid Demonstration Initiative is a seven-year collaborative research effort focused on design, implementation, and assessment of field demonstrations to address prevalent challenges with **integrating distributed energy resources** in grid and market operations to create a "Virtual Power Plant." This newsletter provides periodic updates on projects, relevant industry news, and events.

PROJECT UPDATE

Smart Grid Demonstration Host-Site Updates

This issue features news from host utilities Duke Energy, Electricité de France, Hydro-Québec, Sacramento Municipal Utility District, Southern California Edison, and Southern Company.

Duke Energy Smart Grid Demonstration Update

Duke Energy has some tips for utilities that are planning to install batteries, now that the utility has experience deploying their third battery system as part of the smart grid demonstration.

Duke Energy is currently commissioning a battery system (the Marshall battery) that will perform diurnal peak shaving for a 12.47 kV distribution circuit that includes over 1 MW of solar generation, shown in the picture to the right. The battery is a 750 kWh, 250 kW Kokam Superior Lithium Polymer battery with a 1MW/1.25 MVA S&C Storage Management System. Control algorithms will be developed during the demonstration project to optimize the dispatch of the battery and Duke Energy intends to quantify the system benefits, such as reduced generation costs and asset deferral, for this peak shaving energy storage system.

The Marshall battery system is the third energy storage system commissioned by Duke Energy in 2012. The utility has installed two other storage systems: a power swing mitigation energy storage system at their Rankin substation and two community energy storage (CES) systems. The Rankin unit is a 402 kW, 282 kWh FIAMM sodium nickel battery using the same type of S&C Storage Management System as Marshall. The CES units were made by S&C Electric Company and include a 25 kW, 25 kWh Kokam battery.

After installing these three different types of battery systems and evaluating their initial performance, Duke Energy has the following recommendations for utilities planning to deploy their own battery units:

System design:

- Storage management systems need a method to isolate the battery from the inverter and the inverter from the grid.
- Connect to any utility's standard transformer.
- Isolate as many energized components as possible in areas where personnel operate.

System operation/dispatch:

- Display operational limits clearly on the system operator's control screen.
- "Fly by wire" provides simple control interface but detailed remote monitoring of all components.
- Provide the ability for operators to optimize and prioritize different battery functions such as peak shaving, islanding, etc.

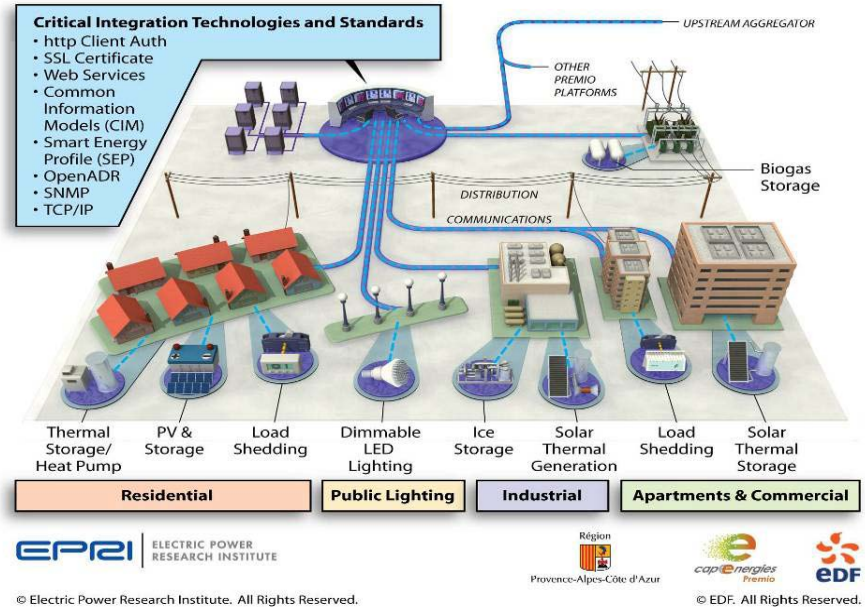
Automation and control:

- A high degree of autonomous decision making coupled with the ability to remotely adjust setpoints.
- Industry standards are needed for these areas.

Installation and field operations:

- Reduce footprint size of battery system.
- Develop field operations manual for battery system.
- Build battery systems so that individual components can be easily removed and replaced.
- Design system for easy integration into typical utility field work practices.

Electricité de France Smart Grid Demonstration Update



EDF's PREMIO project has been extended for an additional year through 2012. PREMIO (Production Répartie, Enr et MDE, Intégrées et Optimisées) is designed to demonstrate an innovative, open, and repeatable architecture to optimize the integration of distributed energy resources. These resources are put in place to provide load relief, local network support and help reduce CO_2 emissions in the South East of France.

The PREMIO extension has provided the opportunity to optimize operating conditions and get more measurements throughout. This enables better operation and finer analysis of the results.

Host-customers were asked whether they wanted to participate or not during the extension period. The large majority of participants (87%) decided to stay a part of the project, mostly because they are not especially inconvenienced by the direct load control or because they want to foster innovation. The rest of participants left the project because of technical or use incompatibilities. For instance, PLC (power line communication) in the home area is used by one of the load shedding technologies tested in PREMIO. This PLC was not compatible with new Internet boxes provided to some customers who needed an alternative to a wireless Ethernet cable connection. In this case, PREMIO technology had to be removed.

Additional partners are participating in PREMIO. RTE, the French transmission system operator, tests human/machine interfaces directly from a regional control center to evaluate and improve ergonomics and human factors of these interfaces. ERDF, the French distribution system operator, wants to make their maintenance engineers and technicians aware of the new grid operation conditions in the context of different smart grid solutions such as the ones tested in PREMIO.

As the equipment for PREMIO was chosen for an experimental application of three years, the extension of one year led to the replacement of some devices. Electrical batteries for decentralized storage that were reaching the end of their life cycle, as well as some measurement devices, were replaced. For example, heating circuit pipes of heat pumps (coupled to thermal storage) were equipped with more precise flow meters.

A second round of tests over the winter 2011-2012 is being analyzed, and will provide the remaining lessons expected from the platform.

Hydro-Québec Smart Grid Demonstration Update

Anti-islanding remains a contentious issue when it comes to the integration of distributed generation. At the heart of the debate is the choice between passive anti-islanding protection, based on local measurements, and transfer-trip schemes that rely on onerous communication channels that relay the position of the substation breaker to the distributed generation site. Hydro-Québec is testing an alternate approach, referred to as an autoground, which was proposed in the context of the IEEE 1547.8 recommended practices working group. The premise of the approach is to allow the distributed generation system the time to detect the islanding situation. This is done using a passive approach up until just prior to reclosing of the substation breaker, at which point the autoground momentarily short circuits the feeder, forcing any remaining distributed generation to disconnect based on line protection.

Hydro-Québec constructed an autoground system and has been operating it on the utility's distribution test line. Results show that the system can be built using off-the-shelf distribution equipment and can be effectively used to avoid any problems with out-of-phase reclosing, at a cost that is an order of magnitude lower than a transfer trip.

Sacramento Municipal Utility District (SMUD) Smart Grid Demonstration

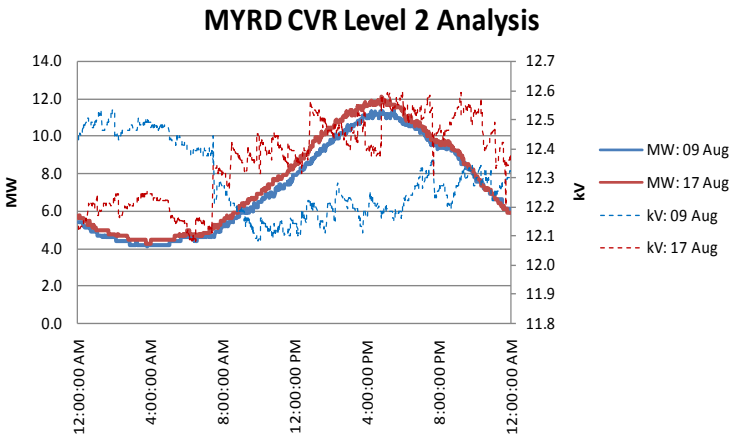
Like several other utilities in the Demonstration, SMUD is conducting a volt/VAR optimization (VVO) and a conservation voltage reduction (CVR) project. It is among the first of several SMUD projects to be considered as a case study for publication by EPRI.

The goal of this pilot project is to determine the loss reduction, energy savings and peak demand reduction on six distribution feeders served from two 69/12 kV substations. SMUD is installing switched capacitor banks, capacitor bank controllers with two-way communications, new VVO software, local control override for voltage regulation controller, and new CVR control in the Siemens SCADA system.

Field tests on the six feeders will use different CVR voltage levels. Voltage settings changes will range from slightly lower settings in the load tap changing (LTC) power transformer controller to significant changes that would decrease voltage to near the lowest allowable level. Field tests are planned for the summer months.

The graph to the right shows one of SMUD's CVR tests conducted in 2011 (MYRD or Myrtle-Date example). This shows the implementation of the CVR at a voltage setting reduction of 2% at approximately 7:30 am. The bus voltages of the test day (09 August) change to a lower level almost immediately. Similarly the voltage for the reference day (17 August) makes an upward change at the same time due to CVR being turned "off" for Myrtle- Date at the conclusion of the 16 August testing. Also, the MW demand is affected throughout the day as load increases.

The analytical testing portion of the project will establish a range of annual impacts for the pilot feeders if CVR were to be implemented year around.



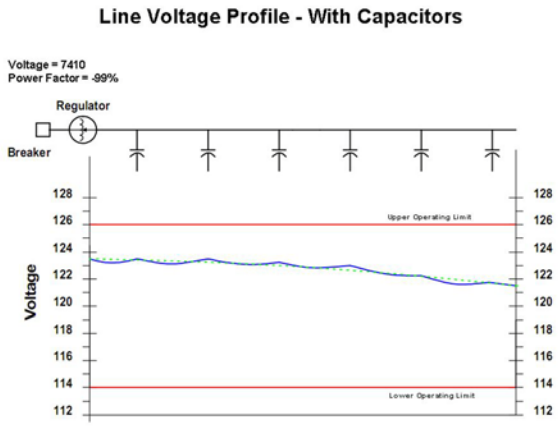
Southern Company Smart Grid Demonstration Update

Georgia Power, a Southern Company, is implementing a unique integrated volt/VAR control (IVVC) scheme on approximately 560 of their distribution circuits. The goal is to maintain the power factor between 97% lagging and 99% leading for all hours of the year.

The scheme is unique in that it only requires communications to the voltage regulators and load tap changer (LTC) power transformers to lower the voltage in order to lower the demand on the circuits. This decentralized IVVC relies on the feeder voltage level as the control feedback information for both capacitor banks and regulators to maintain the desired circuit voltage profile.

With careful planning, the switched capacitor banks are being installed along circuits in combination with fixed capacitor banks to meet the VAR demand at valley and at peak conditions. The IVVC project is a second generation approach to Volt/VAR control.

The first generation control method, originally deployed in 1998, relies on a fixed voltage bandcenter, upper and lower voltage limits and control timers in the capacitor bank controllers to maintain the desired power factor. In addition, the voltage at the substation is regulated based on a VAR-biased line drop compensation (LDC) setting. This first generation regulation scheme accomplished the goal of maintaining a relatively flat voltage profile as shown by the center blue line in chart at right. Although this control strategy is capable of supplying 180 MW of load reduction at peak, the system requires more planning and coordination analyses to maintain the proper control settings,

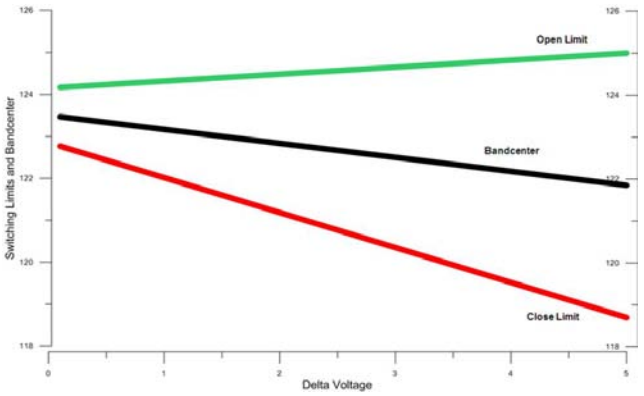


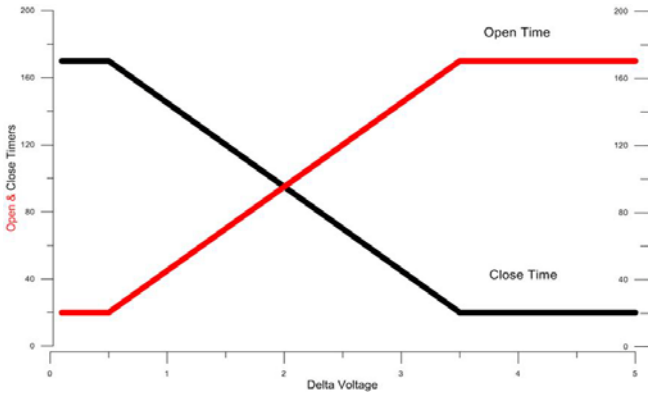
along with the right mix and sizes of fixed and switched capacitor banks. In addition, the system is not optimally designed for circuit reconfiguration.

The second generation IVVC strategy uses adaptive settings in the controls to adjust when the capacitor bank is switched ON or OFF based on system conditions. The bottom two graphs illustrate how the adaptive settings change based on the difference in voltage (delta voltage), which is a function of the line impedance.

The new IVVC control system is meeting expectations. For example, if too few capacitor banks are installed on a circuit, resulting in system voltage being at an undesirable level, Georgia Power is able to address the issue by utilizing the advanced features of the modern voltage controls. By either using the VAR Bias Method, a feature of the Beckwith controller, or the LDC Limit Method, the controller is able to adjust the voltage levels on the circuits based on system conditions even when circuits are abnormally switched.

The Integrated Volt/VAR Control system will include 1400 new capacitor bank controls and 2700 new regulator controls, and will provide Georgia Power with an additional 200 MW of demand response capability at peak from voltage reduction and VAR optimization.





Southern California Edison Smart Grid Demonstration Update

To ensure the proper operation and integration of smart grid technologies on Southern California Edison's (SCE) Irvine Smart Grid Demonstration Project, SCE is conducting rigorous evaluation of products and systems in a controlled environment before doing field deployments. This environment is comprised of a number of laboratories, including SCE's Advanced Technology Labs in Westminster, California, which provide an integrated platform for testing safety and operability.

Tours of several of the Advanced Technology Labs will be available for EPRI advisors during the June 2012 Smart Grid Demonstration Advisory Meeting (see pages 5 & 6):

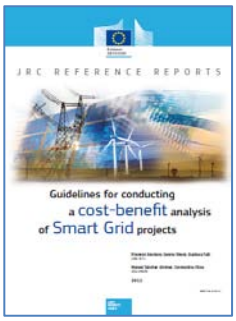
- *Situational Awareness Lab* – SCE can monitor the status of the electric grid and display test data from adjacent labs, using Hiper-Wall technology (a scalable video display wall). The facility also has a proprietary modeling system for analyzing historic outage data.
- *Communications and Computing Lab* **–** Researchers can evaluate smart grid communications systems and cyber-security hardware, software, and systems.
- *Power Systems Lab* – Using a real-time power system simulator, closed-loop testing of protection and control equipment are performed.
- *Distributed Energy Resources Lab* – This lab is designed to test devices such as solar panels, batteries, and air conditioners. Understanding the behavior of such inverter-based generators and loads during grid faults and frequency transients is needed to continue to maintain a reliable distribution system.
- *Substation Automation Lab* – Created for interconnecting and testing next generation substation communications, automation, and protection equipment, this lab is focused on incorporation of secure and open standards-based systems.
- *Distribution Automation Lab* – This is where SCE evaluates the performance of advanced field devices for development of an integrated, scalable, and fully automated distribution system.
- *Home Area Network Lab* – SCE can assess third-party smart energy devices to ensure compatibility with Edison SmartConnect™ meters and SCE rate programs and services.

- *Garage of the Future Lab* – This facility is designed to demonstrate and evaluate the synergy of various technologies including distributed energy storage, renewable energy resources, plug-in electric vehicle charging infrastructure and Edison SmartConnect meter communication.

SCE also has a *Large Energy Storage Test Apparatus* facility, which will be featured during the June 2012 Advisory Meeting tour. The facility provides a platform to evaluate and demonstrate emergent, large energy storage systems, such as a lithium-ion battery system currently being tested.

The picture to the right shows SCE's Ed Kamiab (right), Project Manager for the Irvine Smart Grid Demonstration and EPRI Project Manager Dennis Symanski (left) at the SCE storage test installation.

Smart Grid Cost-Benefit Analysis Guidelines for Europe Released



A framework for conducting a cost-benefit analysis of European smart grid projects has been published by the European Commission's Joint Research Centre Institute for Energy and Transport. The approach is based on EPRI methodology (see EPRI's 2010 *Methodological Approach for Estimating the Benefits and Costs of Smart Grid Demonstration Projects*, Product # 1020342), with some modifications to fit the European context.

The cost-benefit guidelines were tested and are illustrated in the report using an existing smart grid project, InovGrid, which is led by the Portuguese distribution operator EDP Distribuição.

The guidelines include how to tailor assumptions to local conditions, identify and monetize benefits and costs, and to perform a sensitivity analysis of the most crucial variables. Identification of externalities and social impacts that are not easily monetized is also addressed.

The report aims to provide insights on choosing parameters, a systematic approach to link deployed assets with benefits, formulae to monetize benefits, and an indication of most relevant cost categories.

KEY EPRI SMART GRID DATES

Smart Grid Demonstration Advisory Meeting – June 12-14, 2012

Where: The meeting will be hosted by Southern California Edison (SCE) in Westminster, California. Lodging will be at the Hyatt Regency in Newport Beach, California.

To Register: Advisors can register and obtain information on accommodations at http://smartgrid.epri.com under Upcoming Events. You can also contact meeting planner Robin Pitts at rpitts@epri.com.

Agenda: The June meeting will feature presentations on case studies, updates on strategic topics, a panel on conservation voltage reduction, highlights of SCE's cyber security work as well as a tour of the SCE laboratory and a battery storage installation.

An optional training session on IEC 61850, the standard for communication networks and systems in substations, is planned for the morning of June 12. See preliminary agenda on following page.

Photo of Newport Beach, California courtesy of TripAdvisor

Preliminary Agenda for the June 2012 Smart Grid Demonstration Advisory Meeting:

	Tuesday, June 12	Wednesday, June 13	Thursday, June 14
Morning	Optional Training Session on IEC 61850 by Yuchen Lu, EPRI	Case Study Presentations Inverter Software Demonstration	Southern California Edison Presentation Advanced Technology Labs and Battery Installation Tours
Afternoon	Demonstration Updates Strategic Topics Updates: • Distribution Management System (DMS) Applications and Integration • Cyber Security for Field Equipment Roundtable Discussion	Panel Discussion on Conservation Voltage Reduction (CVR) Aggregation of Distributed Energy Resources into a Virtual Top Mode Roundtable Discussion	ADJOURN
Evening	EPRI-Sponsored Dinner	Free Evening	

Schedule of Upcoming EPRI Smart Grid Demonstration Advisory Meetings

2012	March 6-8	Meeting hosted by CenterPoint Energy in Houston, Texas
	June 12–14	Meeting hosted by **Southern California Edison** in Westminster and Newport Beach, California
	October 16-18	Meeting hosted by **Sacramento Municipal Utility District** in Sacramento, California
2013	March	Meeting host TBD
	June/July	Meeting hosted by **ComEd** in Chicago (Tentative)
	October	Meeting hosted by **Hydro-Québec** in Montreal, Canada
2014	3 Meetings	Meeting hosts TBD

All Smart Grid Demonstration Members (not just host sites) are invited to host future meetings. Interested members should contact Matt Wakefield (mwakefield@epri.com) or Gale Horst (ghorst@epri.com).

RESOURCES

Deliverables Published Since Last Newsletter

Product ID	Name	Published
1025000	Field Data Integration for Asset Management and Grid Operations: A Paper on EPRI's Coordinated Research	08-May-12

Webcasts

Smart Grid Demonstration Strategic Topic Webcasts

Recordings and copies of presentations of strategic topic webcasts are available to members at the Smart Grid Demonstration Program Cockpit (log on to www.epri.com and select Program Cockpits).

May 8, 2012 - The agenda of this strategic topic review included:

- **Common Information Model (CIM) for Distributed Energy Resources (DER)**
  A brief update by Gerald Gray, Sr. Project Manager, Enterprise Architecture/Utility Enterprise Integration, EPRI
- **Security for Field Equipment**
  A brief update by Glen Chason, EPRI Project Manager, Cyber Security, EPRI
- **Cost/Benefit Analysis for Advanced Distribution Management System (DMS) Applications**
  Jeff Roark, Sr. Project Manager, Smart Grid Economics, EPRI

April 3, 2012 - The agenda of this strategic topic webcast included:

- **Volt/VAR Control at HQD for Energy Efficiency**
  A presentation featuring implementation, activities and lessons learned at Hydro-Québec by Adile Ajaja, PE, Hydro-Québec
- **Distributed Energy Resource Management System (DERMS) Integration**
  A project recap and presentation of the DER architecture survey results and DERMS use case results by John Simmins, Sr. Project Manager, Smart Grid, EPRI

2012 Smart Grid Demonstration Host-Site "Deep Dive" Webcasts

Deep Dive Schedule

Throughout 2012, host-site utilities will provide an update on their projects.

With the exception of the AEP webcast, all Deep Dive meetings are held on the 3rd Thursday of the month at 11am (Eastern) for 1 ½ to 3 hours. AEP's will occur on a Wednesday at 11am Eastern.

- February 2, Hydro-Québec **(COMPLETE)**
- February 23, ESB Networks **(COMPLETE)**
- March 15, Exelon **(COMPLETE)**
- May 24, Electricité de France **(COMPLETE)**
- **June 20, American Electric Power**
- **July 19, PNM Resources**
- **August 16, Southern California Edison**
- **September 27, Southern Company**
- **October 25, Duke Energy**
- **November 15, Consolidated Edison**
- **December 20, Kansas City Power & Light**

A continuous thank you to the 23 member utilities of EPRI's Smart Grid Demonstration Initiative

American Electric Power | Ameren | Central Hudson Gas & Electric | CenterPoint Energy | Consolidated Edison | Duke Energy Electricité de France | Entergy | Ergon | ESB Networks | Exelon (ComEd & PECO) | HECO | Hydro-Québec | FirstEnergy | KCP&L | PNM Resources | Sacramento Municipal Utility District | Southern California Edison | Southern Company | Southwest Power Pool | Salt River Project| Tennessee Valley Authority | Wisconsin Public Service Corporation

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