ELECTRIC POWER RESEARCH INSTITUTE

EPRI Smart Grid Demonstration Initiative

THREE YEAR UPDATE

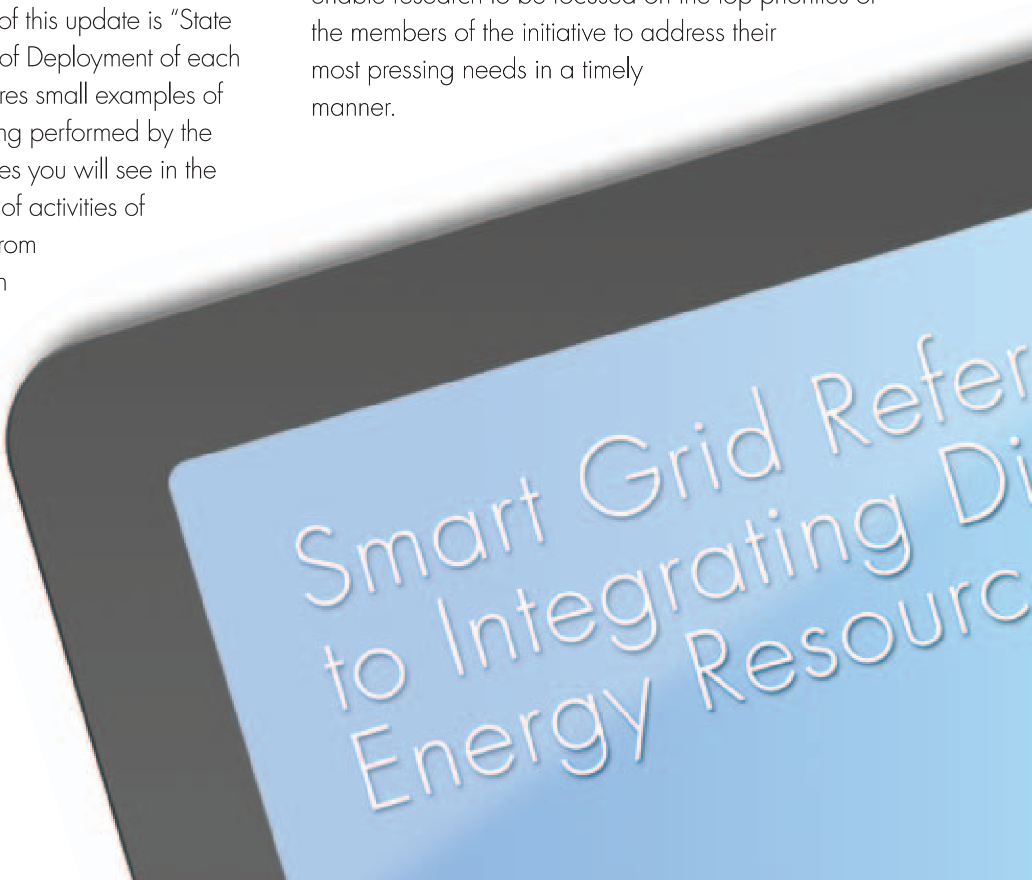
EPRI Smart Grid Demonstration Initi

The EPRI Smart Grid Demonstration Initiative is a seven-year international collaborative research initiative demonstrating the integration of Distributed Energy Resources (DER) in large scale demonstration projects. The initiative began in 2008 with a goal of leveraging the multi-million dollar Smart Grid investments being made by the electric utility industry. This collaborative demonstration initiative is a good example of the well-known adage, "the whole is greater than the sum of its parts." By uniting electric utilities with common goals in a collaborative environment combined with a solid scientific research foundation, shared lessons and gap identification, the initiative is minimizing repetitive research more effectively than if done individually. We are also excited to add three new members to the initiative in the past year. With the addition of CenterPoint Energy, Hydro-Québec, and Sacramento Municipal Utility District, we now have twenty-one electric utilities in the initiative.

This three-year update picks up where the two-year update (EPRI Report 1021497) left off. Last year, we primarily reported on methodologies and tools that were used in developing the foundational research plans for each project. Most of the projects are transitioning from planning phases into deployment phases. Thus, the theme of this update is "State of Deployment." To capture the State of Deployment of each project, this year's annual update shares small examples of the people, equipment and work being performed by the members of this initiative. The examples you will see in the following pages depict the full range of activities of a 3 to 5 year demonstration project from planning, deployment, data collection and analysis.

Smart Grid Strategic Topics:

The breadth of research being performed in this initiative provides an excellent resource to perform targeted research on strategic topics in a collaborative manner. At the October 2010 Smart Grid Demonstration Advisory Meeting Hosted by Consolidated Edison in New York, the collaborators selected the highest priority research topics to collaborate on within this initiative in 2011. Our goal was to select the top three strategic topics. Due to a tie, we ended up with four strategic topics as well as some secondary topics to consider. The strategic topics for 2011 are Conservation Voltage Reduction (CVR) and Volt/VAR Optimization, DMS Integration and Visualization, Energy Storage Monetization, and Consumer Behavior and Engagement. The secondary topics included Cyber Security, Electric Vehicle Charging, Modeling and Simulation Tools. The research goals and deliverables for each topic were set by the team and are being reported on at the three face-to-face advisory meetings hosted at a different utility throughout 2011. The selection of strategic topics and deliverables is being conducted in the fall of 2011, 2012 and 2013 to enable research to be focused on the top priorities of the members of the initiative to address their most pressing needs in a timely manner.



ative Three Year Update

The Final Deliverable – A Smart Grid Reference Guide to Integrating Distributed Energy Resources

The research and lessons learned from this initiative are creating a wealth of information. Is it possible to have too much information? One of the challenges we are facing is that because we have so many individual reports and results (over 70), it is difficult to know where to look to find answers to questions. To address this problem, we have developed our First Edition of a *"Smart Grid Reference Guide to Integrating Distributed Energy Resources"* EPRI Report 1023412, to be published in September 2011. The first edition is a compilation of existing deliverables and commonly known smart grid information organized as an easy to use reference guide with the following sections: Smart Grid Technologies, Applications, Case Studies, and Planning Resources. We will continue to add content to this reference guide with updates in 2012, 2013 & 2014. Next year, updates will focus on the edition of case studies as the projects transition from planning and implementation into data collection and analysis. The first set of case studies will be the focus of the public Smart Grid Demonstration Four Year Update in 2012.

On behalf of the Electric Utility members of this initiative and the EPRI Technical staff, I hope you find this update valuable.

Matt Wakefield,

Sr. Program Manager, Smart Grid, EPRI

Issue Base Research – Extending Collaboration

All utilities in the Smart Grid Demonstration initiative are Collaborators and fund the research performed across the Host Site demonstration projects. All utility Collaborators have the opportunity to propose a Host Site project with research objectives that are aligned with the overall goals of EPRI's initiative. Research performed by EPRI is primarily conducted for Host Site projects; Non-Host Sites also have the opportunity to have targeted research performed that meets at least one of the research goals in the form of "mini-demos." Research results are shared with all the Collaborators. Non-Host-Site members'

	Primary Integrated Technologies & Applications	Host Site Collab						
		American Electric Power	Con Edison	Duke Energy	Electricité de France	ESB Networks	Exelon (ComEd/PECO)	FirstEnergy
Distributed Energy Resources	**Demand Response Technologies**	■	■	■	■	■	■	■
	Electric Vehicles	■		■		■		
	Thermal Energy Storage	■			■	■	■	■
	Electric Storage: <= 100 kWh (Utility Local Storage, Customer Storage,...)	■	■	■	■		■	■
	Electric Storage: > 100 kWh (Typically at substations or near renewables)	■						■
	Solar Photovoltaic	■		■	■		■	
	Wind Generation	■				■	■	
	Conservation Voltage Reduction (volt/var management and related)	■		■		■		
	Distributed Generation (Microturbin, Fuel Cell, Diesel Generator, Biogas,...)	■	■		■		■	
Communications and Standards	**Customer Domain** (SEP, BACnet, HomePlug, WiFi, etc.)	■	■	■		■	■	
	Transmission & Distribution (IEC 61850, 60870, DNP3, IEEE 1547)	■	■	■		■	■	■
	Operations Domain (IEC 61968/61970, MultiSpeak, OpenADR,...)	■			■	■	■	
	Cyber Security (Authentication, Certificates, Encryption, Intrusion Detection,...)		■	■	■	■	■	
	AMI or AMR	■		■		■	■	
	RF Mesh or Tower	■				■	■	■
	Public or Private Internet		■	■	■	■	■	
	Cellular Based (3G): (1xRTT, GPRS, EVDO, CDMA,...)	■		■		■		
	WiMAX (4G): (WiMAX (IEEE 802.16), LTE,...)			■				
Programs	**Price Based** (RTP, DA, CPP, PTR, TOU, Block,...)	■		■		■	■	■
	Incentive Based (DR, DLC, Ancillary Services, Interruptible, Bidding,..)	■	■		■	■	■	■
Ops & Planning	**Integration with System Operations** (RT Visibility of DER, DMS Integration)	■	■	■		■	■	■
	Integration with System Planning (Visibility of DER in planning,..)	■	■	■	■	■		■
	Modeling and/or Simulation Tools	■	■	■	■	■		■
State of Deployment	**Planning**							
	Deploying	●	●	●				
	Data Collection				●	●	●	●
	Analysis							

■ Technologies and Applications Integrated in the Demonstration

■ Cross-collaborative teams share early technology transfer in targeted topics across member projects. Results and lessons support existing and

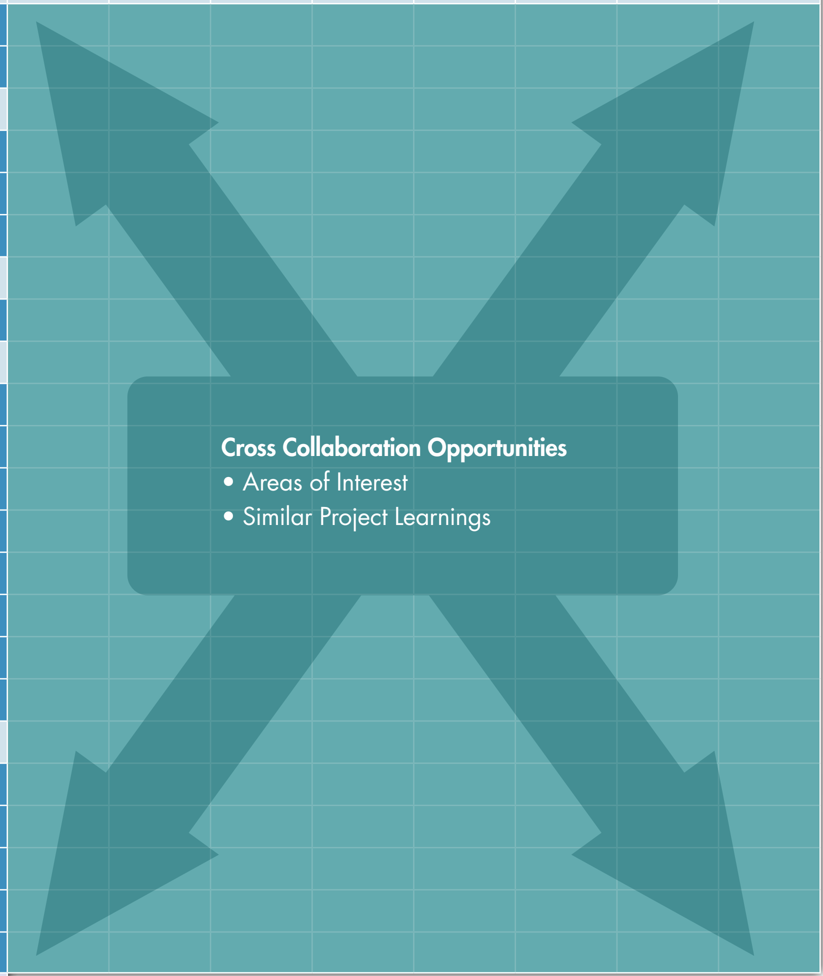
● Demonstration "State of Deployment" in mid-2011

across the Demonstrations

benefit from the knowledge gained without the cost of deploying capital intensive projects, while Host-Sites benefit from research performed specifically on their projects. All of the collaborators have committed to sharing high-level results with the public to help advance Smart Grid efforts in the industry. The below matrix identifies high-level technologies and applications of each project that are aligned with the initiative's goals. No single project can evaluate every research scenario, but by collaborating across multiple projects, the research lessons can be greatly enhanced beyond what the projects could do individually.

Smart Grid Demonstration Members

orators						Collaborators							
Hydro Québec	KCP&L	PNM Resources	Sacramento Municipal Utility District	Southern California Edison	Southern Company	Ameren	CenterPoint Energy	Central Hudson Gas and Electric	Entergy	Southwest Power Pool	Salt River Project	Tennessee Valley Authority	Wisconsin Public Service
●	●	●	●	●	●								



emerging projects to advance integration of Distributed Energy Resources.

Host Site Collaborators

American Electric Power

Anthony Chiles (left), Dale Thompson (right)

American Electric Power Community Energy Storage.

The AEP project includes a variety of resources such as demand response, storage, and distributed and renewable generation. These resources, if equipped with sensing, controls, and communication, could be aggregated into a "virtual power plant" by using the technologies in the distribution and overall power system operations, including end-use technologies and systems.

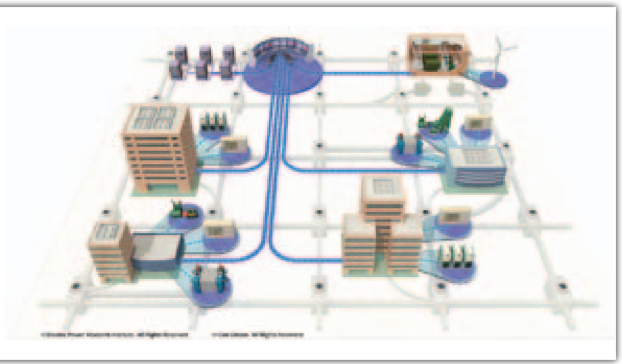
The modeling and simulation work in the AEP project allows a look into both the benefits and system conditions surrounding the addition of smart grid technology. The overall project will benefit from simulation of both individual technology and multiple concurrent technologies. This enables evaluation that would otherwise be costly and difficult to manage.

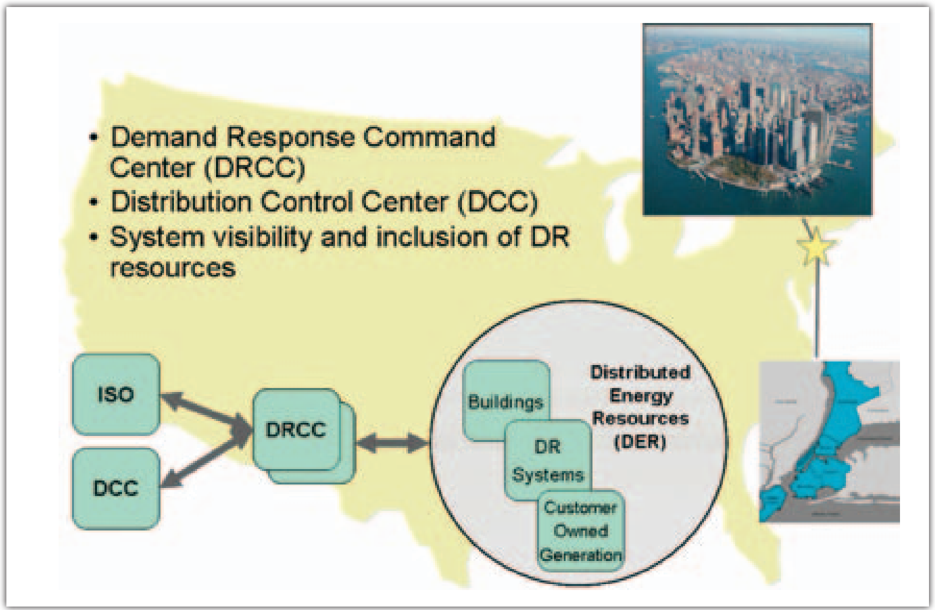
Community Energy Storage (CES) is one part of the focus for the AEP smart grid demonstration. A single CES unit is a small distributed energy storage unit (25 kVA, 25 kWh) connected to the secondary of a transformer serving approximately 2-5 houses. AEP plans to install a total of 80 CES units on a distribution circuit in 2011. These 80 units will be controlled as an aggregated fleet for up to 2 MVA of total storage. The CES fleet will be used to demonstrate peak shaving and var support for the circuit. The individual CES units will be used for backup power for CES connected customers during a utility outage to demonstrate reliability benefits.

EPRI added a storage element model to the OpenDSS (Open Distribution System Simulation) tool to accommodate simulation of the CES technology parameters such as properties, states, losses etc. for use in the simulation exercises. AEP developed several dispatch control models for the CES fleet to be simulated. These included basic and advanced models such as a follow mode to test a predefined dispatch curve. An additional element represented the storage controller and corresponding dispatch modes based on time, peak shaving, following, loadshapes and schedules. Once the impact of CES on the target circuit was understood, simulations were performed to examine the circuit response to volt/var and conservation voltage reduction methods and plug-in electric vehicle charging.

The next area of focus is on simulations examining the concurrent operation of several technologies. Simulations of the cross-technology scenarios should provide insights into how smart-grid technologies might interact and influence each other's as well as the circuits operation. This multi-technology barrier effort will help identify and understand potential impacts and necessary mitigations required to balance a modernized grid infrastructure and maximize benefits given a diverse technology portfolio.

Con Edison





High Level DER System View

Con Edison delivers electricity to more than 3 million customers in much of New York City and Westchester County through a complex transmission and distribution network. The company has installed a large system of underground electric cables to accommodate the congested and densely populated urban area it serves, resulting in a distribution network that is one of the largest, most complex, and most reliable in the world. Con Edison's high load density makes it a complex and diverse test bed for urban Smart Grid challenges.

The Consolidated Edison project is focused on developing the technology necessary to realize a Demand Response Command Center (DRCC). The DRCC will link the utility's Distribution Control Center (DCC) to the customer's distributed resources. This system will provide the utility with visibility and control to treat distributed resources as a virtual generation source and will allow utilities to move closer to the concept of a virtual power plant. A distribution operator will have increased visibility into the customer domain and enhanced system situational awareness. This information will enhance planning and early response to real and potential problems on the distribution system. The tools and system under development will help alleviate system reliability issues and extend the life of assets by reducing overload conditions.

Consolidated Edison is partnering with Verizon and Innoventive Power to develop and demonstrate methods to view, dispatch, and utilize customer owned demand response (DR) resources. Increasing demand response resources will give Con Edison a cost effective alternative to meet peak demand while maintaining a high level of system reliability.

The GridAgents platform enables a manageable level of local and remote distributed intelligence to provide grid visibility, automation, and control for distribution operations. The project will include the dispatch of customer resources for compact network load alleviation and on-going testing and validation of additional system functions. The Demand Response Control Center (DRCC) utilizes these resources and serves as the backbone for the automated deployment of aggregated DR resources.

Duke Energy

Steve Hinkel (Duke) and Jared Green (EPRI) discuss communication infrastructure at Duke's Envision Center


Duke communication node

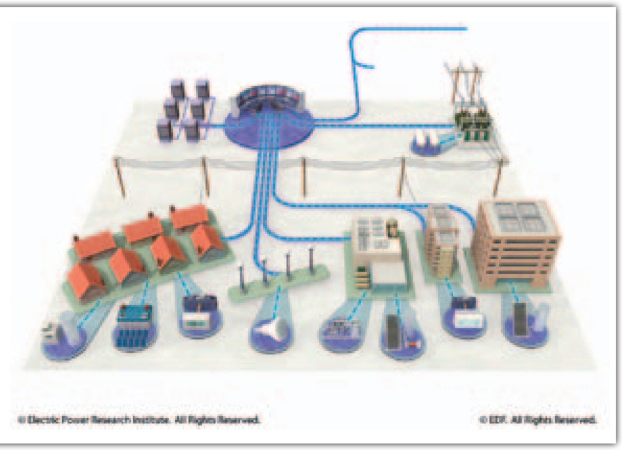

Solar ground mount at substation

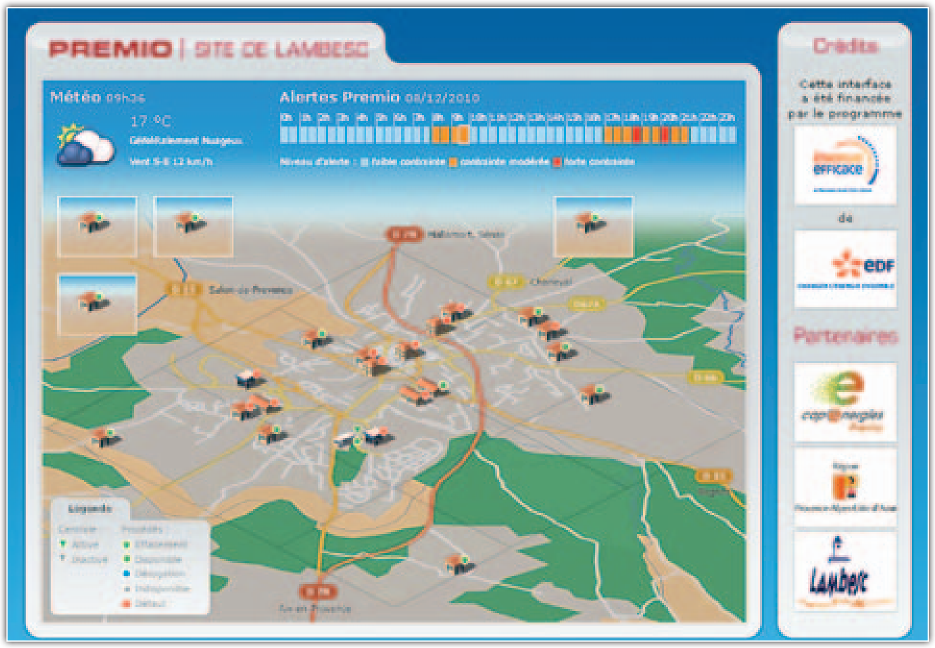
The Duke Energy Smart Grid Demonstration activities include work in the Envision Energy pilot in Charlotte, North Carolina. The Envision Energy project consists of two substation scale energy storage installations, a one MW solar installation, two community energy storage locations, communication nodes, distribution devices, metering, home energy management systems, residential PV, intelligent EVSE and plug-in vehicles. The residential systems (PV, PEV, EVSE, CES, HEM, and smart appliances) will be installed at five employee homes.

Equipment for Envision Energy is in various stages of deployment. The communication nodes, smart metering and distribution devices have all been installed. The energy storage installations will occur during the second half of 2011, as will the HEM systems, smart appliances, and residential PV. Five Chevy Volts for the employees in this program arrived in May and the intelligent EVSE were installed in advance of arrival of the Volts. Communication and data systems for collecting vehicle information are being tested at this time.

The larger component of PEV testing related to Duke's SG host site program is located in Central Indiana. Approximately 80 THINK electric vehicles are now operating in the Indianapolis area with intelligent home, workplace, and public level two charging stations installed. Ten of these vehicles are being driven by Duke employees that were selected based on commuting patterns, home electrical loads, and the location on the distribution system. Data gathering is underway for consumer behavior and distribution impact analysis. In addition, planning continues for 2nd life battery testing as part of the Indiana test bed. A community energy storage system is scheduled for installation in the 3rd quarter of 2011 which will become the first test location for use of a 2nd life battery from one of the THINK vehicles.

Electricité de France





Graphic interface of the platform

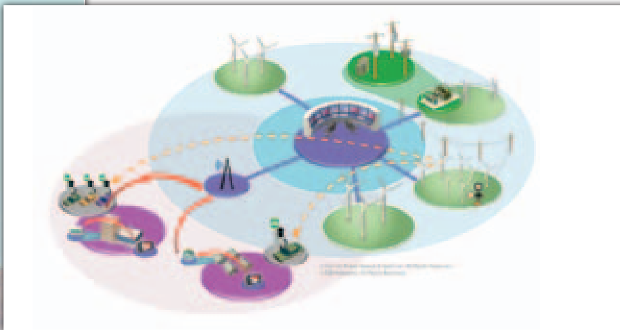
The project planning phase ended in 2009. The installation phase followed with the first Distributed Energy Resources (DER) connected to the control unit in June 2010. The installation phase continues with the last few DER being connected. Now, almost all the DER are connected and are responding to requests sent by the Control Unit. The experimental protocol was established to allow a comparative analysis of the days with and without Direct Load Control (DLC). Analyzed results of the first three months of 2011 revealed that for all connected Distributed Energy Resources, load reductions issued from DLC were effective. No difference has been noticed between the application of day-ahead requests and day-of requests. It appears that reactivity of some DER is compatible with energy markets' services. The estimation's precision of the capacity for load reduction varies depending on the DER considered but can be improved on with a longer analysis period. Depending on the technology, residential or tertiary sectors can be more appropriate. This experimental protocol is progressively adapted according to the first feedback received from the field. Initial results indicate that no excessive drops in inside temperatures occurred. Another important aspect concerns communication means which are the nervous system of the PREMIO platform and must therefore be highly secured and tested.

Some lessons were learned about host-customers and how to deal with a multi-partner and multi-discipline project. The first feedback related to the host-customers showed that they must be informed as much as possible during the installation process and through the operation phase. As they are the closest people to the technology, they are demanding information about the different phases of the project and about the operation of the DER that they are hosting. Because they are chosen on a volunteer basis, many of them are engaged by the concept of Smart Grid. Partners in this type of project are diverse, from institutions to small entrepreneurs. Feedback showed that attention must be paid to the fact that each of them has different objectives by taking part in the project. Thus, specifications must be clearly stated at the beginning of the project and the role of each partner should be precisely described and understood by all parties. Use Cases can help in this process and become a very useful tool.

Installation of technologies relies on the work of sub-contractors for whom host-customers are mostly unfamiliar. This could bring misunderstandings and delays. Therefore, sub-contractors are a critical point and must be considered to be a key element of the project. From the perspective of a Smart Grid technologies' spread out, trainings of the sub-contractors should be a priority.

Eventually, simulations will be run to give an idea of what the impact of the PREMIO platform would be at a larger scale (several districts). A few DR are still to be connected and while some of them will be operating during the summer of 2011, all of them will run for the next winter and thus allow a deeper analysis of the platform.

ESB Networks



ESB In Home Display

Smart meter

ESB Network's Teresa Fallon, manager, smart networks, accepts Renewables/Grid Integration Project of the Year from Teresa Hansen at DistribuTECH 2011

ESB conducted a behaviour and smart metering trial on 6,000+ customers in 2009-2010 and the trials have concluded with significant results. The trials have been designed to ensure that statistically robust results are produced that give an accurate indication of what would be expected in a national smart metering roll-out scenario and the results will thus inform the smart metering cost benefit analysis and potential national rollout as required by the EU.

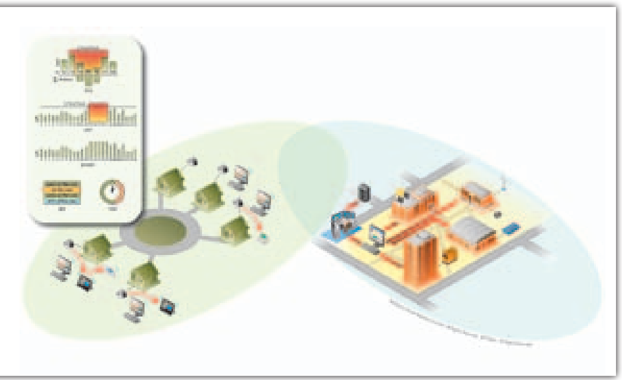
After 18 months of measurements and trials incorporating time-of-use tariffs and a range of stimuli, key findings include:

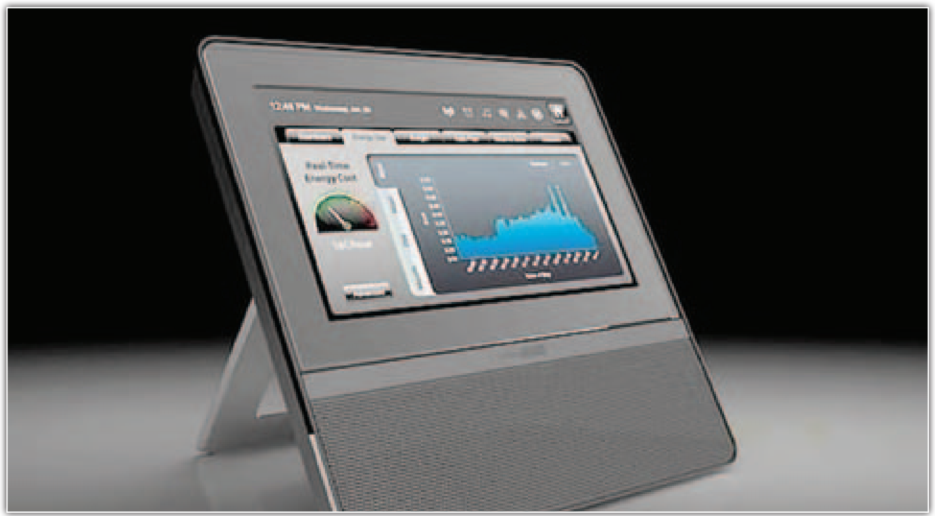
- reduced overall average energy consumption by 2.5% and 8.8% peak power reduction
- in-home display customers showed 11.3% peak reduction
- households with higher consumption tended to deliver greater reductions
- shifting of load was mainly from peak to post-peak period, in general to night usage from peak
- no single tariff stands out as being more effective than the others
- of the four DSM stimuli none is statistically better than any of the others in reducing overall electricity usage
- demand for peak usage estimated is highly inelastic relative to the level of the peak price incentive

The technology element of the trials revealed that none of the communications technologies – DLC, RF mesh or GPRS – fully meet demands of reliability, security and cost efficiency, however, the trials have developed ESBN's expertise ensuring a solution combining elements of these systems can be tailored for Irish deployment.

In high-penetration wind projects, one network has been configured with wind generation providing back feed and voltage regulator mitigating voltage rise – network voltage standards have been met in tests to date. A new SCADA control design has been completed and is being implemented for remote control of this novel voltage regulator configuration. The Volt/VAr project is near the end of the entire first round of control / measurement phases with both wind farms now in voltage control mode, coordinating reactive requirements accordingly to keep the network within standard. For Smart Green networks trials, full protection, remote control and monitoring designs have been completed and are near full implementation on networks, allowing trials of CVR, optimal sectionalization and other efficiency and security solutions later in 2011. Finally, there is ongoing deployment, monitoring and analysis of electric vehicles (EV) on urban Low Voltage (LV) test networks, revealing the potential and limitations of ESB's networks for high EV penetrations in the future.

Exelon (ComEd and PECO)





Advanced In-Home Display (AIHD) utilized by a group of customers in the ComEd demonstration

Commonwealth Edison's (ComEd) Customer Applications Program (CAP) was deployed to approximately eight thousand residential customers for the twelve months beginning June 2010 and ending May 2011. The Electric Power Research Institute (EPRI) is providing an independent and comprehensive assessment of the customer's behavioral impacts and implications of the CAP pilot as part of the Smart Grid Demonstration project.

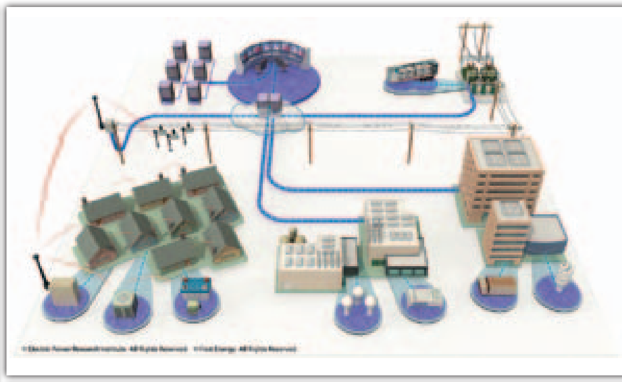
Phase 1 of the program involved a detailed analysis of the first three months, June 2010 through August 2010, of the program and provided preliminary results of consumer responsiveness during the summer season. Note that some customer impacts may require more time to have an effect on consumer behavior as they learn and understand new rate structures and enabling technologies. In addition, evaluation of some of the effects requires consumer survey data that is being collected at the end of the pilot and will be included in the final analysis report.

ComEd's CAP required an ambitious undertaking to implement and support the complex design that involved twenty seven different applications. The requisite analysis to isolate and quantify the impacts of those applications is commensurately detailed and complex. Unlike pilot programs where an opt-in form of program enrollment was used, the customers in the CAP were randomly selected and assigned to one of the twenty seven treatment groups (applications) in a opt-out method of enrollment. Data was gathered for all the program participants for analysis of each treatment group in addition to individual responses enabled by the AMI interval measurements. The preliminary data indicates that a small percentage of customers responded while a significant number of customers exhibited a minimal response.

The most important Phase 1 finding is that statistically significant responses were exhibited by some of the customers served under the dynamic pricing applications, those that involved day-ahead real-time pricing (DA-RTP) alone and in combination with Peak Time Rebate (PTR) or Critical Peak Pricing (CPP). EPRI's preliminary analysis of individual customer effects found that 5% to 7% of CPP and PTR customers reduced event-period load by 32% to 37%. The analysis included six of the seven price change events (those in June through August) implemented during the summer of 2010.

The CAP effects are addressed in a series of hypotheses, derived from the CAP design, regarding the effects of the various rates, technologies, and education treatments featured in the pilot. The findings support some of the hypotheses and do not support other hypotheses. The final analysis, Phase 2, will detail participants' electricity consumption and price data for the entire year of the CAP pilot, as well as the final consumer survey data. The final findings will contribute to understanding how AMI-enabled price structures and technology alter consumer electricity consumption.

FirstEnergy



FirstEnergy Technicians Installing Distribution Line Sensors.

The FirstEnergy Smart Grid Demonstration is deploying smart grid technologies in its Jersey Central Power & Light operating company distribution grid. The Integrated Distributed Energy Resource (IDER) project technologies are controlled with data warehousing through an Integrated Control Platform (ICP) that is operated from the regional distribution system control center. The first technology integrated into the ICP was direct load control equipment and has now been expanded to include distribution line sensors and ice energy storage units. The IDER system is designed and has been tested to support both operational and RTO/ISO (PJM) market programs, including emergency, economic, and ancillary services.

Over 25MW of direct load control via two-way wireless mesh communications are installed and will be operated during the 2011 peak season. The IDER system is used to support distribution operations as an emergency resource. In one event the system was utilized during a non-planned substation transformer replacement. The system was enabled to relieve stress on certain circuits as the IDER system is designed to target a specific, localized group of resources. Testing with PJM verified the IDER system functionality enabling registration of these resources in the ISO meter grade reliability programs. The system operator initiates load reduction events as required by participation in the RTO/ISO market programs.

Additional project technologies include distribution line sensors, ice storage, and substation monitoring. Distribution line sensors have been installed for evaluation from two vendors. Ice storage is used to shift air conditioning load to off-peak periods, which in this case are Ice Energy ice storage units. Substation monitoring equipment includes a three-phase power meter, power quality monitoring, data logging, and enabled control and alarm functions.

Hydro-Québec

Representation of the Hydro-Québec Smart Grid demonstration

H.-Q. EV with onboard data acquisition system

The Distribution test line at IREQ

The state of progress of Hydro-Québec's Smart Grid demonstration varies among the key projects. The conceptual drawing above depicts the Smart Grid Zone with 13,500 clients with a mix of residential, commercial and industrial loads. It includes: 1 substation, 12 feeders, and an AMI deployment and testing of 5,800 meters. Deployment and testing of Wimax technology will start in the Fall of 2011.

The Distribution Test Line at the Hydro-Québec research facility (photographed above) is an integral tool in the validation of technologies prior to their deployment in the Distribution Smart Grid Zone. This 25 kV system, which consists of three overhead lines and multiple conventional and new distribution equipment, permits the testing of either individual equipment or the integration of technologies for smart grid applications.

The volt/var optimization (CATVAR) project has been under development since 2006 in the Smart Grid zone. The objectives of the CATVAR project are to increase the amount of energy reduced through advanced volt/var optimization. Energy savings have been confirmed at a CVR ratio of 0.4. By 2015, Hydro Québec anticipates 11 TWh of annual energy efficiency savings through this project and others.

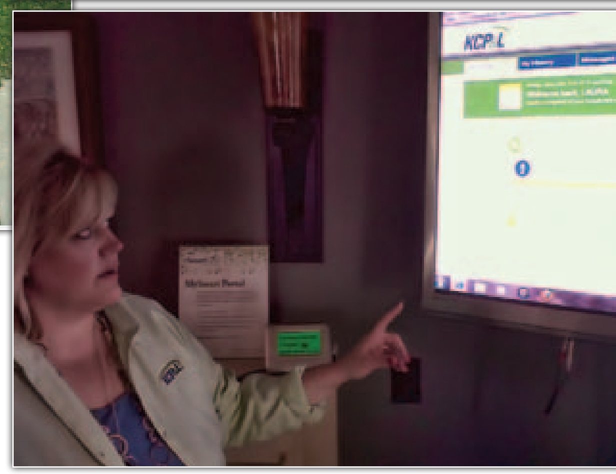
Hydro-Québec's goal for the electric vehicle charging stations in the Smart Grid Zone is to master charging station technology and agree on how such stations are to be integrated into the power system. There are 35 charging stations operational now with an additional 15 stations to be installed by Fall 2011. Twenty five EV's with onboard data acquisition systems (see photo) are on the road.

The Hydro-Québec team expects various benefits from the Smart Grid Zone, but key benefits can be listed within 3 categories including expertise, risk management and greenhouse gas reduction. The deployment and testing of technologies within the project area will allow Hydro-Québec to gain expertise in regards to the Smart Grid technologies themselves, monitoring, information and control with telecom and centralized control, the integration with existing systems, and gain an understanding of how multiple Smart Grid applications operate in parallel. The lessons learned resulting from testing of new applications, identification of potential problems before large scale deployment, energy conservation, and quantification of the reduction in energy consumption due to smart grid technologies will aid Hydro-Québec in risk management efforts. Finally, a detailed GHG reduction analysis for the Clean Energy Fund component will be performed.

KCP&L

KCP&L's partner, Metropolitan Energy Center, demonstrates weatherization and home upgrades that took place to make the smart grid demonstration home a "Project Living Proof" for all that tour the home.

Outside the home Scott Grafelman, Mgr Asset Mgmt & Planning and Project Manager for Smart Grid T&D, is addressing a group of engineers about the benefits of the smart grid network.



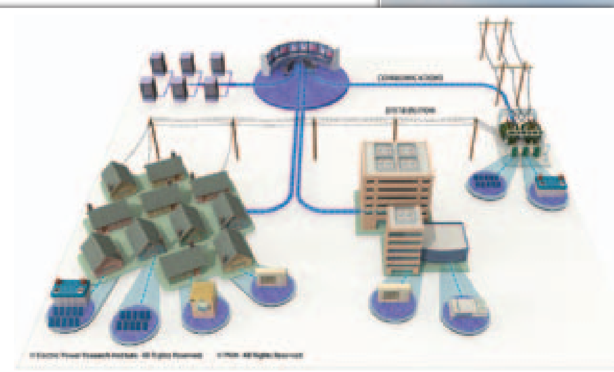
Gail Allen, Customer Education and End Use Project Manager, is demonstrating the portal during a recent tour

The Smart End-use sub-project of the KCP&L Green Impact Zone smart grid demonstration is nearing the end of the experimental design phase. The official launch of the home area network and the programmable communicating thermostats will begin in Q3 2011. The in home displays and smart portal were made available to customers the day of the meter launch on October 18, 2010. The smart meter roll out was completed in Q1 2011 with approximately 14,000 smart meters installed in the demonstration area.

The KCP&L smart grid demonstration is a unique initiative among smart grid deployments due to its concentration in the urban core of Kansas City, Missouri, including low income areas. Several important lessons learned regarding consumer engagement have emerged thus far in the project. Utilizing grassroots efforts and talking to the customer early and often has been a key to gaining consumer interest in smart grid technology. Engaging community stakeholders upfront, looking for opportunities to engage the consumer face-to-face, and managing a technology-focused project from a customer-focused viewpoint are also key to a successful pilot.

As part of KCP&L's Smart Grid demonstration project, KCP&L is the lead sponsor of the Metropolitan Energy Center's Project Living Proof (PLP) initiative. PLP consists of a demonstration house where visitors can see first-hand the new MySmart tools and products available to customers in the project area. There are three levels to the demonstration home. The main level has the "look and feel" of a home and the main parlor showcases the energy management portal and in home display. Various technology components such as solar battery storage and monitoring and advanced water heating are located in the basement of the home along with several heating and cooling technologies.

PNM Resources



Work is underway at the Prosperity site with most of the PV panels installed.

A major component of the PNM EPRI demonstration is the Department of Energy project for utility scale photovoltaic (PV) with simultaneous battery voltage smoothing and peak shifting at PNM's Prosperity, NM site. Because of the unique location of the project site, the project will test the introduction of PV at both the beginning and end of feeder – thereby allowing further understanding of voltage control specific to the location on the feeder of the intermittent distributed resource, and broadening the applicability of the project results. The project will establish a baseline after the introduction of the PV resource and prior to battery operation, acquiring distribution voltage levels associated with high-penetration PV in two configurations: end of feeder and beginning of feeder. Subsequently, with the battery functioning in a smoothing role, the team will record distribution feeder voltages in both configurations and compare those to the baseline utilizing a high volume data acquisition system. These voltages will be studied with regard to ANSI Range A limits to show the battery's ability to keep voltages within tolerance in a variety of configurations when positioned at each end of a feeder.

Construction at the Prosperity site started on May 16th and is well under way. Site development is nearing completion with structural and underground/overhead electric work commencing the week of June 7, 2011. The battery and power conversion systems (PCS) are in final manufacturing and the data acquisition system is being assembled off site. Back office IT efforts are mostly complete with the installation of the project PI database occurring the week of June 13, 2011. The project should enter commissioning phase in early August and will feature 2 – forty foot container smoothing batteries (rated at 500kW) and 6 – forty foot container smoothing batteries (lead-acid batteries rated at 250kW, 1MWH) from East Penn, a PCS from S & C Electrics and a 500kW solar array featuring Schott panels. The solar array is expected to be completed by August 14, 2011 with the batteries completed the following week.

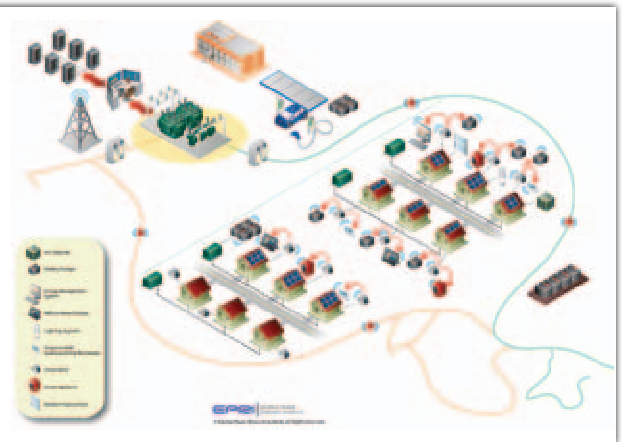
Sacramento Municipal Utility District

Left to right, Mark Rawson, SMUD Microgrid Project Manager; Bob Labbe, SMUD Facilities; Dennis Symanski, EPRI; and Jim Parks, SMUD Smart Grid Program Manager standing in front of a 100kW TecoGen natural gas co-generation unit (one of three to be installed in the microgrid project).

SMUD's SmartSacramento project is a large, long-term effort comprised of over 20 individual projects valued collectively at almost $400 million. The projects are proceeding at different rates ranging from project planning to the installation and operation of new equipment. SMUD has exceeded the 50% mark in smart meter installations with over 300,000 meters installed. The advanced metering infrastructure project is ahead of schedule with completion expected by the end of Q1 2012. SMUD's distribution automation project is also progressing with 8 of the 35 scheduled substations upgraded with SCADA and 90 circuits selected (of which 6 circuits will form the initial pilot) for implementation of conservation voltage reduction and volt/var optimization. The first of three 100 kW TecoGen cogeneration units (see photo) have been delivered for SMUD's microgrid project and installation is scheduled for Q4 2011. The waste heat will be used to provide cooling (absorption chiller) and hot water.

The Electric Vehicle Grid Impact Study is moving forward with the design of experiments, charging simulator system design, identification of infrastructure under "stress" and battery procurement. Delivery of the programmable load bank and assembly of simulator hardware will occur during Q4 2011. Testing is scheduled to begin January 2012. Customer participation agreements are in the process of being signed for the residential energy storage demonstration at the Anatolia Solar Smart community as well. The portfolio of projects comprise the basic building blocks that will help SMUD determine the next steps in moving SmartSacramento to the next level. The individual projects will be evaluated singularly and corporately to determine overall project impacts and the results will form the basis for SMUD's long-range smart grid implementation plan.

Southern California Edison



Standing in front of the 2 MW Lithium-ion containerized battery and support equipment are left to right, Ed Kamiab, SCE ISGD Project Manager, Dennis Symanski, EPRI and Henning Wollnik, SCE ISGD IT Support.

The Southern California Edison (SCE) Irvine Smart Grid Demonstration (ISGD) project is currently in the late planning stage with one of the sub-projects in the early installation stage. SCE is continuing with construction of the testing/lab station at their Westminster location for the distribution grid support sub-project. Preliminary locations and permitting/easements necessary for the installation and operation of the 2 MW energy storage unit have been proposed to the vendor partner. The 2 MW containerized Lithium-ion battery photographed above will be connected to the 12 kV Arnold distribution circuit and will primarily be used to provide power changes in support of deep grid situational awareness. Strategies will be developed for energy storage control and protection. Field testing will determine the peak load shaving capabilities as well as the ability of the PMU hardware and offline signal processing to confirm step load changes (charging and discharging) of various magnitudes at distribution and transmission substations.

A final review of the scope of work (SOW) has been completed and final comments have been provided to the vendor partners for the ZNE homes, solar car shade, advanced volt/var control, and self healing distribution circuit sub-projects. The vendors for major segments of the solar car shade system have been identified and SCE has met with vendor partners on proposed location, permitting & easement requirements. SCE is working with partners on engineering, design and construction of the car shade system including the inverters and batteries.

Various partner SOWs were reviewed and security scopes were added in regards to the Secure Energy Network (SENet) sub-project. SCE began the procurement process for the security aspect of certain sub-projects, and began network design. SCE is also working on various aspects of the workforce of the future sub-project with vendors and educational institutes.

Southern Company

Chad McMicken from Southern Company is monitoring the electrical characteristics of a PHEV. Subcycle data from transient tests will be analyzed for power quality impacts.

Southern Company is in the process of deploying and testing many of the distributed resource technologies related to a Smart Grid. To date, the Smart Grid Demonstration project includes 48kW of field deployed Lithium Ion energy storage capacity with a 500kW Zinc Bromide flow battery installation scheduled for the first quarter of 2012. Also, testing has begun to evaluate the power quality requirements of four different PHEVs according to the proposed SAE J2894 Standard that was developed in April 2011. Southern Company has increased its electric vehicle fleet to over ten and will continue to evaluate new models as they are developed. Two dynamic rate programs have been developed at Georgia Power. The first program is based on a critical peak pricing (CPP) rate. The second program based on real time pricing (RTP) is more popular and has approximately 2,000 participants for approximately 5,000 MWs of total load. As a part of the demonstration, Alabama Power and Georgia Power are continuing to expand their distribution efficiency programs through added capacitor installations, voltage conversions, line reconductoring, and increased CVR capability. After full deployment, these programs are expected to reduce the peak by approximately 425MW. To date, Southern Company is monitoring four solar research projects that total over 54kW and has received regulatory approval to build a 1MW portfolio of medium scale solar installations across the state of Georgia.

The Integrated Distribution Management System for Alabama Power is progressing as planned and it will undergo Factory Acceptance Testing in the near future. The project is on schedule for deployment of the major DMS applications later this year, including many of the integrated advanced applications. This will allow operators to become familiar with the all new interface and operating methodologies and will be followed quickly by the next round of integration in the first part of 2012 that will integrate the Outage Management System and additional advanced applications.

Collaborators

Smart Grid Demonstration Advisory Team

An example of the strength of EPRI's collaboration research model is demonstrated with our three face-to-face advisory meetings per year. By having each meeting hosted by different electric utility members, the team gains first-hand knowledge of the diversity of Smart Grid deployments around the world. It also is an opportunity for EPRI and members to jointly share the most recent detailed research results and provide invaluable interactions among members to discuss lessons learned as well as challenges.

October 2010 Smart Grid Demonstration Advisory Meeting, Hosted by Consolidated Edison, New York NY

March 2011 Smart Grid Demonstration Advisory Meeting, Hosted by Southern Company, Atlanta GA

All members of the Initiative collaborate on research results whether a Host-Site or not and the following pages show a few examples of Smart Grid activities by members of the Initiative that are not Host-Sites, but are benefiting from the results of the initiative as well as directly contributing their own lessons to the initiative.

All of the Collaborators have committed to sharing high-level results with the public to help advance Smart Grid efforts in the industry.

June 2011 Smart Grid Demonstration Advisory Meeting, Hosted by Duke Energy, Cincinnati, OH

CenterPoint Energy


Figure 1


Figure 2

Figure 3


Figure 4

CenterPoint Energy has demonstrated the benefits of smart meter and smart grid technology through nearly 700 tours of the company's Energy InSight℠ Technology Center *(Figure 1)*. In *Figure 2*, Greg Thiergart, Sr. Technical Analyst, installs one of 7,000 cell relays which will collect customer electricity usage data from over 2 million smart meters and a significant milestone was reached in February 2011 when CenterPoint Energy tester and installer Anthony Villarreal installed the company's millionth smart electric meter at the home of customer Craig Funni of Pearland - *Figure 3*.

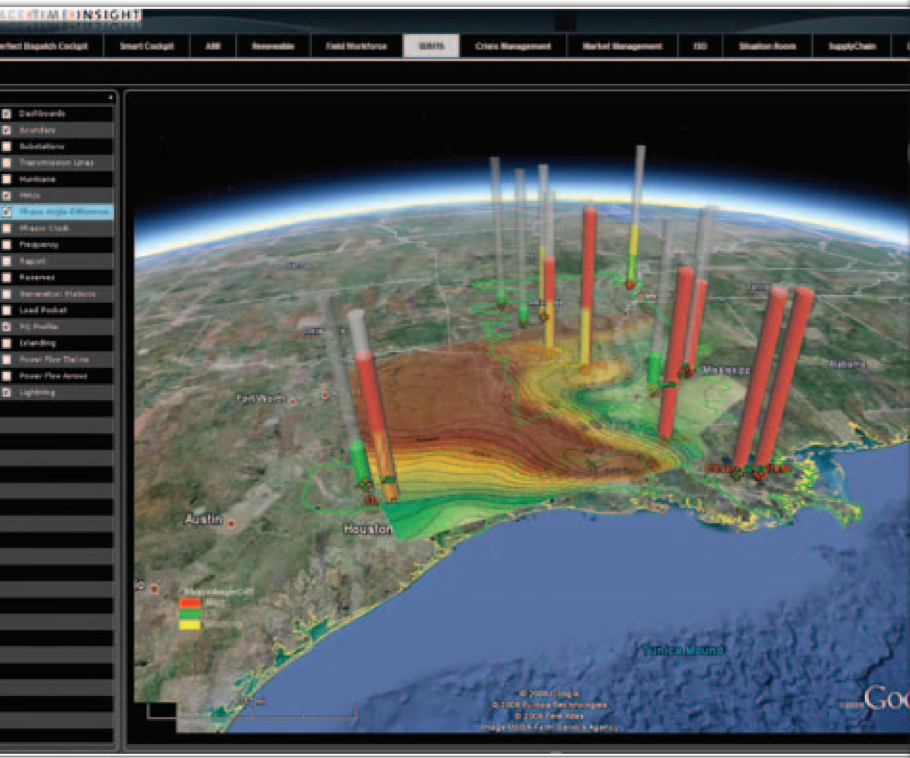
In addition, one of more than 500 Intelligent Grid Switching Devices being installed in *Figure 4* by apprentice lineman Daniel Santemaria will improve power reliability and restoration.

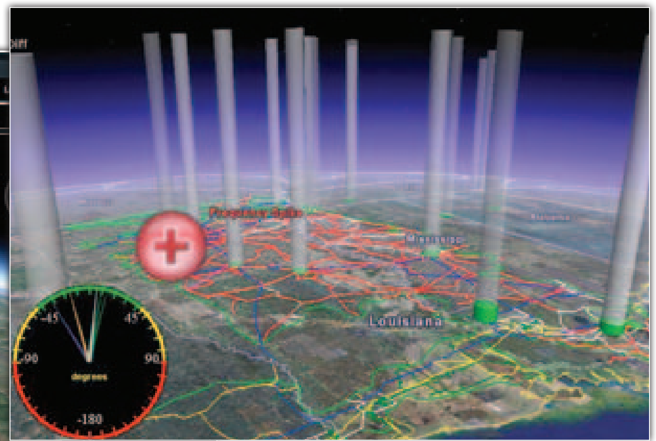
Central Hudson Gas and Electric

Shown here is a photo of one of Central Hudson Gas & Electric's (CHG&E) new VIPER ALT units. This is a good example of applying Smart Grid technology at CHG&E and is part of an intelligent Automatic Load Transfer System comprised of G&W VIPER ST Electronic Reclosers with Schweitzer 651R Recloser Controllers. The units are linked together in teams and communicate their status with each other utilizing the mirrored bits protocol over Schweitzer 3031 Radios.

This was a novel use for the 3031 radios. Schweitzer used CHG&E's idea and created a promo video *(http://www.selinc.com/SEL-3031/)* to feature and advertise CHG&E's use of the system. The VIPER Team provides recloser functionality combined with automatic transfer capability in the event of source side voltage loss. By having communications and status sharing between the team members, we are able to avoid closing in on a fault with the normally open team member.

Entergy



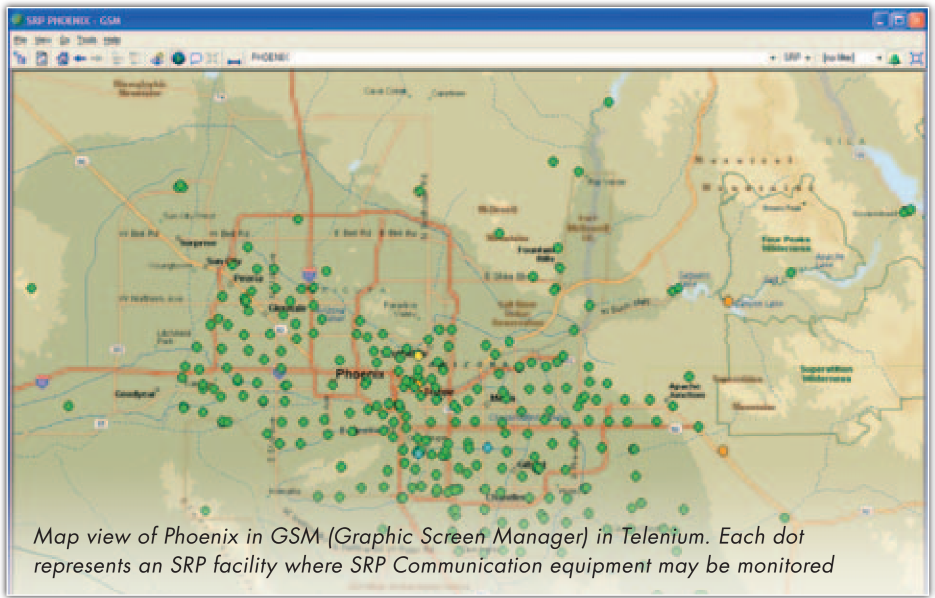


PMU Visualization Tools

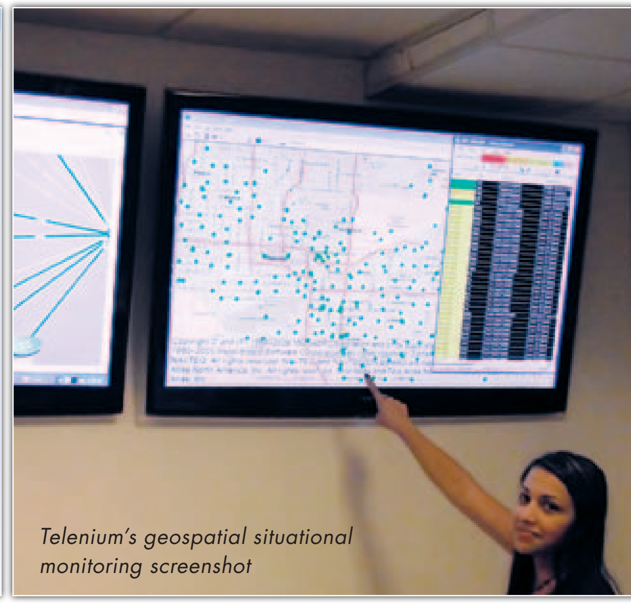
Entergy's Deployment and Integration of Synchro Phasor Technology project is deploying phasor measurement units (PMUs), phasor data concentrators (PDCs), and state of the art decision support tools across Louisiana, Mississippi, Arkansas, and non-ERCOT portions of east Texas. These capabilities shall enhance grid visibility of the bulk power system in near real-time, enable detection of disturbances which may produce instabilities or outages, and facilitate sharing of information with neighboring regional control areas.

Additionally, to provide the foundational learning required to implement these advanced tools, the project will focus on training and education throughout the operations and engineering groups at Entergy.

Salt River Project



Map view of Phoenix in GSM (Graphic Screen Manager) in Telenium. Each dot represents an SRP facility where SRP Communication equipment may be monitored



Telenium's geospatial situational monitoring screenshot

The electric industry is undergoing a significant transformation using modern technology to automate the electric grid. The Salt River Project (SRP) employs intelligent electronic devices (IEDs) deployed in the field that are integrated with a variety of applications to achieve this automation. The result will be improvements gained via increased grid efficiency and resiliency as well as integration of renewable generation resources. A core foundation of this smart grid will be the communications between the IEDs and associated computing that creates this intelligence. This communication infrastructure must be pervasive to cover the electric service territory, robust and reliable to ensure availability and secure.

SRP is in an enviable position of having an extensive fiber optic communications network deployed through its substations running on SRP-owned assets and offering high bandwidth and reliability. Currently, several point solutions have been deployed to support specific requirements for last mile communications. However, the key missing piece is a unified last mile communications infrastructure that will support multiple applications with a desired economy of scale and wide deployment. In order to meet smart grid requirements, this infrastructure must support 2-way secure IP-based communications with sufficient capacity, scalability and security to meet the evolving requirements. Salt River Project's Communication Network Operating Center (CNOC) is a Smart Grid Roadmap initiative currently in deployment. The CNOC orginated from SRP's Smart Grid roadmap strategy number 2, which is "wide area network monitoring". SRP will utilize Telenuim for monitoring of the communication transport network and CA Spectrum for monitoring of the IP network. Installation of Telenuim is a multi-year project. The first phase is expected to be operational in the Fall of 2011, full implementation is expected in Spring of 2015. CA Spectrum went operational in the CNOC in May, 2011.

Another important consideration is SRP's current support of smart grid applications and the associated smart grid strategy. Recent Smart Grid roadmap work includes a pilot project to determine if a business case exists to deploy a private 4G network as well as multiple pilot projects to determine the impact of distributed energy resources on the distribution network. SRP has several ongoing Smart Grid Roadmap initiatives including work on Cyber Security and NERC CIP. SRP is continuing strategic deployment of intelligent devices such as distribution feeder automation, synchrophasors (WECC-WISP DOE grant), AMI (ADAM DOE grant), bushing monitors, transformer monitors, capacitor controllers and microprocessor relays. Continued implementation of a meter data management system (ADAM DOE grant) is also ongoing. Using the foundation of a unified communications infrastructure, the opportunity exists to establish a living laboratory and pilot to advance SRP's orchestration and collaboration towards a truly integrated smart grid strategy and architecture.

Deliverables

2011 Smart Grid Deliverables

Advanced Distribution Management Systems (DMS) Applications Training – Smart Grid Training Session #1
Product ID 1023169

American Electric Power Smart Grid Host Site Progress Report: Period Ending December 2010
Product ID 1021501

Commonwealth Edison Company Customer Applications Program – Objectives, Research Design, and Implementation Details
Product ID 1022266

Commonwealth Edison: The Effect on Electricity Consumption of the Commonwealth Edison Customer Application Program Pilot: Phase 1
Product ID 1022703

Commonwealth Edison: The Effect on Electricity Consumption of the Commonwealth Edison Customer Application Program Pilot: Phase 1, Appendices
Product ID 1022761

Decision Support for Demand Response Triggers: Methodology Development and Proof of Concept Demonstration
Product ID 1022318

Electricity Supply Board Smart Grid Host Site Progress Report for the Period Ending February 2011
Product ID 1023253

Électricité de France Smart Grid Host Site Progress Report For the Period Ending February 2011
Product ID 1022675

EPRI Smart Grid Demonstration Initiative Three Year Update
Product ID 1023411

Estimating the Costs and Benefits of the Smart Grid
Product ID 1022519

Guidebook for Cost/Benefit Analysis of Smart Grid Demonstration Projects
Product ID 1021423

Heart Transverter HT2000: Test and Evaluation
Product ID 1023251

Hydro-Quebec Smart Grid Demonstration Host-Site Overview
Product ID 1023414

Hydro-Quebec Smart Grid Demonstration Host-Site Project Description
Product ID 1023405

A Smart Grid Reference Guide to Integration of Distributed Energy Resources, First Edition
Product ID 1023412

Sacramento Municipal Utility District (SMUD) Smart Grid Demonstration Host-Site Overview
Product ID 1023413

Sacramento Municipal Utility District (SMUD) Smart Grid Demonstration Host-Site Project Description
Product ID 1023406

Smart Grid Communications – Smart Grid Training Session #2 - October 2011
Product ID 1023428

Smart Grid Cyber Security – Smart Grid Training Session #3 - December 2011
Product ID 1023489

Southern California Edison's Smart Grid Demonstration Project: Irvine Smart Grid Demonstration (ISGD)
Product ID 1021420

Strategic Intelligence Update: Smart Grid Conferences and Events June 2011
Product ID 1021472

Strategic Intelligence Update: Smart Grid Conferences and Events September 2011
Product ID 1023427

Description of Building-Scale High-Frequency Photovoltaic Demand Response
Product ID 1022750

2010 Smart Grid Deliverables

American Electric Power (AEP) Smart Grid Host Site Progress Report
Product ID 1020354

Architecture Considerations for Integration of Distributed Energy Resources (DER): EPRI Smart Grid Demonstration Meeting Panel Session Proceedings, March 4th, 2010
Product ID 1021265

Architecture Reference Design for Distributed Energy Resource Integration: Smart Grid Demonstration Task 2.1
Product ID 1020340

Concepts to Enable Advancement of Distributed Energy Resources
Product ID 1020432

Consolidated Edison Smart Grid Host Site Progress Report August 2010
Product ID 1021500

Consolidated Edison Smart Grid Host Site Progress Report February 2010
Product ID 1020355

Distributed Energy Resources and Management of Future Distribution
Product ID 1020832

Duke Energy Smart Grid Demonstration Host-Site Project Description
Product ID 1021399

Duke Energy Smart Grid Demonstration Overview
Product ID 1021421

Electricite de France Smart Grid Host Site Progress Report
Product ID 1021488

ESB Networks Smart Grid Demonstration Host-Site Overview
Product ID 1020598

ESB Networks Smart Grid Demonstration Host-Site Project Description
Product ID 1020597

ESB Networks Smart Grid Host Site Progress Report
Product ID 1021489

Exelon Smart Grid Demonstration Host-Site Project Description
Product ID 1020893

Exelon Smart Grid Demonstration Project
Product ID 1021419

FirstEnergy Smart Grid Host Site Progress Report
Product ID 1020352

International Smart Grid Projects Update
Product ID 1020303

KCP&L Smart Grid Demonstration Overview
Product ID 1021418

KCP&L Smart Grid Demonstration Host-Site Project Description
Product ID 1020892

Methodological Approach for Estimating the Benefits and Costs of Smart Grid Demonstration Projects
Product ID 1020342

PNM Smart Grid Host Site Progress Report January 2010
Product ID 1020353

Public Service Company of New Mexico Smart Grid Host Site Progress Report September 2010
Product ID 1021490

Regional Profiles for Distributed Resource Integration
Product ID 1020312

Smart Grid Demonstration Two-Year Update
Product ID 1021497

Smart Grid Leadership Report: Global Smart Grid Implementation Assessment
Product ID 1021417

Smart Grid Technologies Report
Product ID 1020415

Southern California Edison (SCE) Smart Grid Demonstration Host-Site Project Description
Product ID 1021398

Southern Company Smart Grid Demonstration Host-Site Project Description
Product ID 1021400

Southern Company Smart Grid Demonstration Project
Product ID 1021422

Strategic Intelligence Update: Smart Grid Conferences and Events January 2010
Product ID 1020566

Strategic Intelligence Update: Smart Grid Conferences and Events July 2010
Product ID 1021444

Strategic Intelligence Update – Smart Grid Conferences and Events November 2010
Product ID 1021471

Tennessee Valley Authority/Bristol Tennessee Essential Services Smart Water Heater Pilot: Summary of Data Analysis and Results
Product ID 1020674

Utility Reference Guide to the National Institute of Standards and Technology Smart Grid Standards Effort
Product ID 1020343

2009 Smart Grid Deliverables

AEP Smart Grid Demonstration Host-Site Overview
Product ID 1020226

American Electric Power (AEP) Smart Grid Demonstration Host-Site Project Description
Product ID 1020188

Assessment of Wholesale Market Opportunities for Participation and Aggregation of Distributed Resources
Product ID 1020314

Bristol Tennessee Essential Services (BTES) / Tennessee Valley Authority (TVA) Smart Water Heater Project – Technology Description and Installation Lessons Learned
Project ID 1020213

Con Edison Smart Grid Demonstration Host-Site Overview
Product ID 1020227

Con Edison Smart Grid Demonstration Host-Site Project Description
Product ID 1020190

Development of a Standard Language for Photovoltaic and Storage Integration
Product ID 1020435

Distributed Resource Integration Framework
Product ID 1020313

Electrite de France (EDF) Smart Grid Demonstration Host-Site Overview
Product ID 1020228

EPRI Pre-Conference Workshop: Active Distribution System Management for Integration of Distributed Resources Research, Development and Demonstration Needs: Workshop Proceedings, Nice, France, December 9, 2008.
Product ID 1018926

Electrite de France (EDF) Smart Grid Demonstration Host-Site Project Description
Product ID 1020191

FirstEnergy Smart Grid Demonstration Host-Site Overview
Product ID 1020229

FirstEnergy Smart Grid Demonstration Host-Site Project
Product ID 1020189

Integration of Requirements and Use Cases into an Industry Model
Product ID 1020384

Methods to Firm Distributed Energy Resources: EPRI Smart Grid Demonstration Project Task 1.3
Product ID 1020385

PNM Smart Grid Demonstration Host-Site Overview
Product ID 1020230

PNM Smart Grid Demonstration Host-Site Project Description
Product ID 1020187

Smart Grid Demonstration Overview
Product ID 1020225

Smart Grid Distributed Energy Resources (DER) Projects Assessment
Product ID 1018945

Strategic Intelligence Update – Smart Grid Conferences and Events
Product ID 1020214

Summary of Potential Use Cases for Distributed Solar (PV) Integration
Product ID 1019584

Use Cases (August 2010 – Present)

Use Cases Available for Download at: http://www.smartgrid.epri.com/Repository/Repository.aspx

AMI Network

B2G - DR Load Profile Management Via Pricing Mechanisms

B2G – DR Load Profile Management Via Reliability Based Signals

B2G – Load Management with Dynamic Tariffs, DR and DER

CES Energy Dispatch

Circuit Reconfiguration

Configuration of a CES Controller

Configuration of a CES Unit

Customer Portal

Data Warehouse

Direct Load Control

Dispatch of Customer Load Controllers for Compact Network Load Alleviation

Distributed Energy Resource Controller Generates and Executes Substation Blackstart Sequence

Distributed Energy Resource Controller Reconfigure Systems in Response to Faulted Segments with Islanding

Distributed Energy Resource Forecasting

Distributed Energy Resources Controller Configures EPS Equipment Based on Daily DER and Load Forecasts

Field Meter Programming and Firmware Update

Functions of the Work Management System (WMS)

CAISO - IC-1 Demand Response Providers Adjust Consumer's Energy Consumption in Response to ISO Dispatch Instructions

CAISO – IC-2 – ISO Publishes Indicators of Grid Conditions with Expectations Consumers Will Adjust Usage

CAISO – IC-3 – Non-Dispatchable Distributed Energy Resources (DER) Changes ISO Forecast and Unit Commitment Decisions

CAISO – IP-1 – ISO Uses Synchrophasor Data for Grid Operations, Control, Analysis and Modeling

CAISO – IS-1 – ISO Uses Energy Storage for Grid Operations and Control

IVVC Centralized

IVVC Decentralized

Last Gasp Message

Methodology for Volt/Var Optimization on a Substation Basis

NEDO – BEMS Control of DERs and HVAC Equipment in a Commercial Building Which Enables Islanding Operation

NEDO – Equipment Control within Smart House by HEMS

NEDO – PV Output Forecasting

NEDO – S1 Cooperative Control Among Smart Grid and External Area EPS Energy Management Systems

OMS On-Demand Poll

OMS Ping

On-Demand Meter Read from CIS

PAP03 – Specifications for Common Electricity Products and Pricing Definition

PAP07 – Key Energy Storage and DER Use Cases

PAP08 – Distribution Grid Management (Advanced Distribution Automation) Functions

PAP11 – Different Utility Plans to Identify the Basic Customer Attributes

PAP11 – Electric Vehicle Load Management

PAP11 – Electric Vehicle Network Testing and Diagnostics

PAP11 – Electric Vehicle Roaming

PAP11 – Impact of PEV as Load and Electric Storage on Distribution Operations

PAP11 – PEV as Storage Scenario

PAP11 – PEV Default Charge Mode

PAP11 – PEV Participates in Utility Events

PAP11 – Plug-In Electric Vehicle Diagnostics

PAP11 – Utility Provides Accounting Services to PEV Use Case

PAP12 – System Engineer Configures IEC 61850 Gateway to DNP3 Substation

PAP13 – Harmonization of IEEE C37.118 with IEC 61850 and Precision Time Synchronization

PEV Charging at Premise

Real Time Pricing

Remote Connect-Disconnect

Remote Meter Programming of Smart Meter

Remote NIC-ESP Firmware Upgrade

Scheduled Bulk Read from AMI Head End

Software Demonstration of Intentional Islanding

Voltage Regulation

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