UNDERSTANDING AND APPLYING RESEARCH RESULTS FROM OVER 13 CASE STUDIES INTEGRATING DER FROM EPRI'S SMART GRID DEMONSTRATION INITIATIVE

Matt WAKEFIELD, EPRI – USA, mwakefield@epri.com
Gale HORST, EPRI – USA, ghorst@epri.com
Dr. John SIMMINS, EPRI – USA, jsimmins@epri.com
Jared GREEN, EPRI – USA, jgreen@epri.com
Brian GREEN, EPRI – USA, bgreen@epri.com

ABSTRACT

The Electric Power Research Institutes (EPRI) seven-year Smart Grid Demonstration Initiative is obtaining a rich set of research results from numerous case studies conducted in 2012 and 2013. of the research project. The Initiative, which is as it entering its 6th year has 23 utilities from 5 countries collaborating on 15 demonstrations. This paper provides an overview of case studies from 2012 and 2013 that are contributing to the knowledge base resulting from the successes and challenges from real deployments from around the world.

INTRODUCTION

An assessment done four years into this seven-year initiative produced 13 case studies in 2012. The case studies confirmed demand-response effectiveness and identified challenges with the business case for technologies such as In Home Displays. The case studies have shown that Conservation Voltage Reduction is proving to be an unanticipated cost-effective beneficial resource while energy storage is found to be technically effective but still at the outer boundary of cost-effectiveness. During the final two years of this initiative in 2013 and 2014, the EPRI demonstration initiative will assess Virtual Power Plants and encourage more rapid Smart Grid standardization.

Results and lessons learned from Smart Grid investments are beginning to yield insights as to how emerging technology can optimize electric grid performance, how consumers respond to prices and new technology, and what research challenges still need to be addressed. As detailed in a recent report, EPRI's Smart Grid Demonstrations 4-Year Update, Case Study Brief[1] , EPRI and the member utilities are producing a steady stream of research results. The update includes results from thirteen case studies involving ten electric utilities and references over 100 deliverables.

The EPRI Smart Grid Demonstration Initiative began in 2008 with a goal of evaluating and advancing the integration of distributed energy resources (DER) by developing scientific research plans to be evaluated in large-scale demonstration projects where utilities were making significant investments. By collaborating with 23 utilities, EPRI is able to leverage multi-million dollar Smart Grid investments in the electric utility industry to perform research to understand beneficial Smart Grid applications with a common goal of sharing learnings that cover a wide breadth of technology deployment and program results..

The case study overviews cover a range of activities relating to the integration of DER, including energy storage, renewable generation, demand response and consumer behavior.

KEY TAKEAWAY'S FROM 4-YEAR UPDATE

To provide a glimpse of the breadth of research results produced from the case studies in the 4-year update, the following key findings or "takeaways" from each of the 13 case studies from the 4-year updates are provided:

American Electric Power: Community Energy Storage Simulation
"Dispatch of energy storage based on monitored kW will reduce the number of battery charge/discharge cycles needed to shift peak demand."

Con Edison: Remote Dispatch of Customer-Owned Resources
"Distribution operators can quickly and remotely activate customer generation resources. This has occurred within 3 minutes, and faster response is anticipated when customer acknowledgement is fully automated."

Con Edison: Assessment of Achieving Increased Reliability with Distributed Energy Resources
"Using distributed energy resources to achieve greater reliability at the Jamaica substation may be possible for about 2/3 the cost of adding additional capacity."

Electricité de France: Response Precision of PREMIO Virtual Power Plant
"Distributed energy can be aggregated in an optimized way in order to respond to load reduction requests during peak periods."

ESB Networks: Smart Green Circuits
"A 'self healing' circuit has operated successfully in over 12 separate incidents, with faulted sections isolated and supply recovered to remaining customers within seconds."

ESB Networks: Distribution Volt-VAR Control Integrated with Wind Turbine Inverter Control
"The reactive power capabilities of modern wind turbines can be used for a range of objectives, such as loss

reduction, local voltage control and reactive power export."

ESB Networks: Smart- Meter Customer Behavior Trial
"The deployment of TOU rates and energy information services were found to reduce overall electricity usage by 2.5% and peak usage by 8.8%."

Exelon: Commonwealth Edison
"Critical peak price and peak time rebate customers provided the largest demand reduction—up to 20%--while technology treatments added no measureable improvement."

FirstEnergy: Integrated DER Management
"Eighteen load-reduction events showed that aggregated resources can support distribution operations and achieve revenue goals for participating in the PJM power market."

Kansas City Power & Light: Customer Acceptance and Technology Adoption
"Opting in to receive a free device or information service does not, in itself, translate into customer engagement."

Public Service Company of New Mexico: Use of Storage for Simultaneous Voltage Smoothing and Peak Shavng
"A 1-second data capture rate of PV output proved essential to use storage for smoothing functions."

Sacramento Municipal Utility District: Conservation Voltage Reduction and Volt-VAR Optimization
"Volt-VAR optimization enabled efficient operation of the distribution system while conservation voltage reduction reduced peak demand by an average of 1.7%."

Southern Company: Capacitor Bank Health Monitor
"AMI capacitor bank health monitors identified over 650 problems in the first 6 months and changed the inspection schedule from once a year to once a day."

CONSUMER BEHAVIOR RELATED RESULTS

Three of the case studies produced in 2012 provide insights into consumer behavior related research results—those from ESB Networks in Ireland, ComEd in Chicago and Kansas City Power & Light.

Many consumer behavior studies are underway, some resulting in part from US Department of Energy Smart Grid grants. The findings, in some cases, confirm the results of prior pilots but in others provide new and important insights into how consumers and businesses use and value electricity. One large (in scale and scope) demand response pilot employed an opt-out recruitment strategy by ComEd to see if an opt-out enrollment strategy would result in greater participation and response. The study found that only 5-10 percent of enrollees responded to high prices or other inducements to reduce load. However, those customers who responded reduced usage 10-20% on event days which is in line with what other opt-in programs report.

Differences in the kinds of demand response programs employed, the types of customers recruited, and variations in how pilots were designed and evaluated make comparing studies challenging. An important research goal is to either reduce the variance of the performance metrics, or develop more precise ways to explain them. EPRI is assisting in the design of utility demand response pilots with rigorous protocols employed to ensure that behavioral-induced effects can be distinguished from other influences during analysis.

The pilots include tests of the effectiveness of the program, the impact on electricity usage, response to home energy reports, and response of devices that provide customers with information and feedback such as in-home displays (IHDs). There are challenges associated with these tests, including low acceptance of technologies like IHD's – in one study, acceptance was less than 30 percent when provided for free and much lower when customers have to purchase them. Another challenge is to improve reliability of devices so they are easily commissioned and work continuously in all types of home and building environments. These challenges also impact the business case. Customers that adopt the technology do reduce energy consumption another couple percent below what they otherwise would have. But the annual benefits to society from that behavior are estimated at only $10-20 per year, while the cost of each display could exceed $100. We need to either make these devices more effective or look for lower- cost ways to give consumers feedback. Though there is still a lot of optimism about consumer response mechanisms in the Smart Grid world, practically speaking, we have a lot of work to do if expectations are to be met.

CONSERVATION VOLTAGE REDUCTION RESULTS

EPRI's Conservation Voltage Reduction (CVR) research suggests that this technology can provide substantial benefits from reduced distribution losses and lead to consumer savings. This approach has been used for decades, but what is changing with the Smart Grid is the ability to optimize performance by integrating data from new communications infrastructures, lower-cost voltage sensors being deployed along distribution feeders, smart meters, and flexible operational strategies.

Preliminary results from a conservation voltage reduction field trial that was part of the EPRI Distribution Green Circuits project suggest that energy savings of 1.2 to 2.4 percent can be achieved. Since performance varies depending on the unique characteristics and loads of each feeder, careful analysis is needed to anticipate performance as technology deployment decisions are made.

In Sacramento Municipal Utility District's (SMUDs) demonstration, initial tests reported reducing peak demand by an average of 1.7 percent. Additional testing is needed among a larger pool of substations to determine the predictability of this performance, but these beneficial results are consistent with similar projects. Some of the challenges associated with this technology deployment have to do with how to perform measurement and verification economically and reliability.

GAPS WHERE RESEARCH IS NEEDED

Gaps identified in the EPRI initiative are resulting in new collaborative R&D projects to perform targeted research. A dimension of energy storage is one example. The technical impacts of energy storage are proving to be beneficial, as shown in modeling done American Electric Power's (AEP's) demonstration, but the economic value of those benefits does not as yet outweigh the costs. EPRI's Battery Storage Systems and Application Demonstration[2] is helping fill that gap with additional research.

A second instance of this is the question of how to obtain value from all the data being generated from Smart Grid technologies. Southern Company's case study uses Advanced Metering Infrastructure (AMI) to monitor the health of capacitor banks, so as to cut the capacitor bank inspection schedule from annual to daily. Innovative approaches of turning existing systems and data into value may provide significant benefit to the electric utility industry. The gap of understanding how to turn newly available data into value has resulted in EPRI's Distribution Modernization Demonstration on Big Data[3], a new 5-year demonstration project.

CONCLUSION

In the final two years of this Smart Grid demonstration program, we will continue to focus on the "Integration" aspects of distributed energy resources and associated benefits assessment. The vision has been to understand how a "Virtual Power Plant" can aggregate distributed resources so they are treated on the same plane as conventional generation by system operators to optimize utilization of these beneficial resources. Although we are making progress in this front, there is still a lot of work to be done in the industry. Efforts in standards development and adoption have been slower than anticipated, but efforts such as those by the NIST Smart Grid Interoperability Panel, as well as related international efforts are making a difference to accelerate adoption of standards. By collaboratively applying standards-based integration techniques and performing case studies in demonstrations, successes can be readily shared in the utility industry, while key gaps can be identified to prioritize future research.

Acknowledgments

American Electric Power, B. Schell
Consolidated Edison, J. Giacona
Electricité de France, C. Tranchita
ESB Networks, T. Fallon
Exelon (ComEd), J. Eber
FirstEnergy, E. Gardow
Kansas City Power & Light, G. Allen
Public Service New Mexico, S. Willard
Sacramento Municipal Utility District, M. Ellis
Southern Company, D. Lewis

REFERENCES

[1] M. Wakefield, G. Horst, J. Simmins, J. Green, B. Green, 2012, "EPRI Smart Grid Demonstration 4 Year Update Case Study Brief", EPRI, Palo Alto, CA 2012, Product ID 1025781 (http://my.epri.com/portal/server.pt?Abstract_id=000000000001025781)

[2] EPRI's Battery Storage Systems and Application Demonstration Project Overview, EPRI, Palo Alto, CA 2012, Product ID 1025118 (http://my.epri.com/portal/server.pt?Abstract_id=000000000001025118)

[3] EPRI's Distribution Modernization Demonstration on Big Data, EPRI, Palo Alto, CA 2012, Product ID 1025705 (http://my.epri.com/portal/server.pt?Abstract_id=000000000001025705)