PAYING FOR THE SMART GRID

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ABSTRACT

This paper will give detailed information on Power Systems applications that can be used to provide significant return on investments (ROI) from Smart Grid expenditures. Applications like:

Conservation Voltage Reduction that reduces generation costs, line losses and Greenhouse Gases

Distribution Automation that improves reliability indices i.e. SAIDI, SAIFI and MAIFI, facilitates utility rate increases through Performance-Based-Ratemaking and provides significant return on investment from reducing outage costs.

SCADA, including Outage Management, Volt/VAR, Fault Detection, Interruption and Restoration (FDIR) will be discussed in detail. Conservation Voltage Reduction is a method of reducing energy losses and demand that has been researched and implemented by utilities for over 25 years. Customer examples from Entergy and Nashville Electric Service (NES) will be used to describe this application and show significant ROI. For example, NES will implement a voltage conservation program on a system-wide basis to reduce peak demand and therefore, mitigate the impact of demand-based wholesale rates on residential customers. Distribution Automation can provide a significant ROI from improving reliability indices, facilitating rate increases in states that have PBR, reducing and eliminating outage costs. Outage study data from the Department of Energy (DOE) and a couple of customer examples will be presented. SCADA is the foundation of Power Systems automation and has provided utilities a significant ROI for many years. Examples of customers that used the aforementioned SCADA applications will be presented.

INTRODUCTION

Many customers have determined that automating their systems doesn't cost them money; it pays them money by providing a significant return on investment.

NASHVILLE ELECTRIC SERVICE, USA

NES will implement a voltage conservation program on a system-wide basis to reduce peak demand and therefore, mitigate the impact of demand-based wholesale rates on residential customers. TVA has traditionally charged an "energy charge" and a "demand charge" for commercial and industrial (C&I) customers within NES' service territory. That means those customers pay for their electricity use (energy charge) and a demand charge based on their peak use during a 15-minute interval during a given month. According to Vic Hatridge, Vice President and CIO of NES, "This puts us at risk because we are billing residential customers at a flat rate per kilowatt hour but our wholesale cost for that power will vary. If we happen to have a really hot day near the end of the month, like we did in May 2011, our wholesale power bill from TVA shoots up much more than what we bill to our residential customers. We are concerned about how such an unpredictable profit margin will affect our financial stability." Smart meters on every home could provide a means to bill each residential customer for energy charges based on their time-of-use (TOU) demand and/or demand charges reflecting their peak use, but that's too expensive for this municipal, distribution-only utility with about 360,000 customers. (While modest on paper, that profile makes Nashville one of the nation's top dozen municipal utilities, by size.)

Instead, NES will implement a voltage conservation program on a system-wide basis to reduce peak demand and, therefore, mitigate the impact of demand-based wholesale rates on residential customers. The American National Standards Institute (ANSI) standard calls for 114 to 126 volts per residential end-user. During peak load, NES will narrow that range to about 116-120 volts. It will use smart meters as "continuous voltage sensors" at key sample points on every circuit.

In this manner, NES can reduce its cost for peak-time energy use without the need to install a smart meter at every home in its entire service territory. Ultimately, the utility would like to install smart meters on every home to ensure that every customer's voltage stays within the ANSI standard and to achieve the many other benefits that smart meters provide. TVA and NES are cooperatively involved in this solution, which should be fully operational by this time next year.

ENTERGY, USA

Entergy has been testing two residential feeders, one with about 70 meters on the end and the other with about 30. The utility is seeing a consistent 4 percent to 6 percent savings in energy consumed. To reduce the voltage, Entergy is adjusting capacitor banks and adjusting setting for load tap changers at the substation. "Some of the secret sauce in the software is creating optimal settings so you're not creating feedback loops," said Paul Olivier, Director of Smart Grid at Entergy. In Louisiana, Entergy is adjusting capacitor banks or adjusting settings for load tap changers at the substation to achieve the reduction. The hard part is finding just the right balance so that two devices aren't fighting each other to get the reduction, Olivier said.

But even more difficult than achieving the right balance using the AMI system and just the right devices is getting regulators on board. "Our challenge is to get CVR to be included in energy efficiency for recovering lost revenue," Olivier said. "The good news is, I don't think these are insurmountable hurdles."

The following are additional examples of results from utility studies and pilot projects on CVR:
1. A 1987 study at Northeast Utilities showed a 1% energy savings for each 1% voltage reduction.
2. A distribution efficiency initiative was commenced in 2003 by the Northwest Energy Efficiency Alliance and completed in 2005. In it the results of independent work by 13 utilities showed an average of 0.8% energy savings for each 1% voltage reduction.
3. Results of a recent EPRI study of 6 distribution feeders over a one year period showed energy savings ranging from 0.66% to 0.92% for each 1% voltage reduction.
Recent pilot studies conducted by Dominion Virginia Power showed a 0.8% energy savings for each 1% voltage reduction.

Voltage Management Benefits:

1. Savings can pay for itself and other automation projects
2. Peak Load reduction that is dispatchable by utility
3. Deferment of capital expenditures for generation and T&D Infrastructure
4. Minimization and or elimination of rolling brown-outs and black-outs
5. Reduction in overall energy consumption and associated costs
6. Reduction in greenhouse gases produced

DISTRIBUTION AUTOMATION

Distribution Automation can provide a significant ROI from improving reliability indices, facilitating rate increases in states that have Performance Based Ratemaking (PBR), reducing and eliminating outage costs. We'll examine the Distribution Automation plan of Commonwealth Edison, a division of Exelon and Outage Study data from the US Department of Energy (DOE).

Commonwealth Edison, USA

In December of 2011, Commonwealth Edison filed a "first-of-its-kind utility performance metrics program with financial penalties" with the Illinois Commerce Commission.1 As part of series of filings in its grid modernization program, the initial filing "triggered a process that should lead to a $44 million reduction in ComEd's current rates."2 The metrics outlined in the filing focus on "improving system reliability, reducing estimated bills, reducing customer costs associated with unaccounted for energy consumption and theft, and increasing support for minority- and women-owned businesses. Among the performance standards are:3
1. Reducing the frequency of outages by 20 percent over 10 years resulting in 700,000 fewer outages per year. This will save consumers a projected $100 million in outage-related costs.
2. Reducing annual average outage duration by 15 percent over 10 years.
3. Reducing ComEd's Southern Region frequency of outages by 20 percent over 10 years. This area includes the southern suburbs, which have traditionally lagged other regions in service reliability.
4. Reducing ComEd's Northeastern Region frequency of outages by 20 percent. This area includes the north and northwest suburbs, which were devastated by storms this past summer. This metric assumes that HB 3036 (trailer bill) is signed by the Governor.
Improvement in the total number of customers who exceed the service reliability targets by 75 percent over the 10 year period.

1-4 http://www.smartenergyil.com/update/comed-files-historic-utility-accountability-standards-benefit-consumers

5. Reducing the number of annual estimated electric bills by 90 percent over 10 years.
6. Reducing consumption on inactive meters, a cost borne by all customers, by 90 percent over 10 years.
7. Reducing electricity theft, a cost borne by all customers, by 50 percent over 10 years.
8. Reducing bad debt expenses, a cost borne by all customers, by $30 million over 10 years.

Here again, in addition to the financial benefits enumerated above the ComEd announcement projects a societal benefit by "Increasing opportunities for minority- and women-owned businesses by 15 percent over a 10 year period, representing millions in additional spending every year for these businesses."4
ComEd is one of many utilities taking an aggressive approach to its Smart Grid implementation plans. A number of other examples are available on the Smart Grid Information Clearinghouse website: http://www.sgiclearinghouse.org/businesscases.

DOE Outage Study Data

The U.S. Department of Energy examined over 1000 customers and determined the following outage costs by outage type and size of customers:

Outage	Large C&I (> 1MW)	Small C&I (<1 MW)	Residential
Voltage sag	$15,601	$203	$
1-2 seconds	$23,097	$1,230	$5.84
1 minute	$12,944	$543	$
15 minutes	$18,245	$831	$
30 minutes	$70,238	$2,367	$5.81
4 hour	$119,715	$4,220	$7.14
8 hours	$88,224	$7,361	$5.15
Average	$70,634	$2,735	$6.59

Information from **A Framework and Review of Customer Outage Costs: Integration and Analysis of Electric Utility Outage Cost Surveys (November 2003)** – written by Leora Lawton, Michael Sullivan, Kent Van Liere, and Aaron Katz (Population Research Systems, LLC) for US Department of Energy

These outage costs are significant and can cost utilities and their customers millions of dollars in lost revenue, especially for industrial loads like microchip processing plants where a one second outage can cost the loss of the entire production run. Also, with the advent of deregulation, these types of outages can result in lost customers for utilities.

SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA)

SCADA is the foundation of Power Systems automation and has provided utilities a significant ROI for many years. Southern Company is an excellent example of a utility that is achieving a significant ROI on their SCADA system.

Southern Company, USA

In 2010, Southern Company signed a Smart Grid Investment Grant (SGIG) agreement with the U.S. Department of Energy (DOE), formally accepting a $165 million award to be dispensed throughout the company's four-state service territory over a three-year period. This federal funding, which is matched by Southern Company, enables us to continue our long history of investment in the company's transmission and distribution (T&D) infrastructure, ensuring that our robust electric grid becomes smarter, more resilient, and more efficient through the application of intelligent electronic devices.

SGIG Projects

The SGIG award emphasizes ensuring a smarter grid through upgrades to T&D infrastructure at Alabama Power, Georgia Power, Gulf Power and Mississippi Power.

Transmission projects focus on transmission line automation and smart substations that enhance monitoring, protection and control capabilities.

Distribution enhancements include distribution automation, energy efficiency and fault location. Much of the work involves installation of advanced hardware, including:

Automated transmission and distribution line devices enabled with SCADA (Supervisory Control and Data Acquisition) technology.

Remote monitoring devices and electronic relays in substations.

Integrated Distribution Management System (IDMS), which includes automatic fault isolation and service restoration.

Our SGIG projects are on schedule and will conclude on or before April 28, 2013.

Cost of SGIG Projects

Distribution Energy Efficiency Program	$73
IDMD / SCADA / Fault Locating	$45
Distribution Automation	$69
Transmission Line Automation	$21
Smart Substations	$122
Total	$330

(in millions)

SGIG Benefits

Southern Company planned and budgeted for these improvements before applying for the SGIG. The grant is allowing us to:

Dramatically accelerate the deployment of smart grid technologies.

Optimize grid performance and reliability by using electronic data, intelligent devices and integrated systems.

Minimize the loss of energy as it travels across the grid.

Improve reliability, safety, power quality, and operating resiliency to natural disasters.

Virtually all of our more than 4,600 distribution breakers are SCADA-enabled. This system has been in place in various forms for more than 30 years.

Self-healing networks include applications to automatically isolate faulted sections on a circuit and restore service to areas that are not directly impacted by the problem. These have been in place on a limited basis for more than five years.

Outage Management System (OMS), a geospatial and tabular system that utilizes a dynamic electrical model that is a near real-time representation of the distribution system, has been in place for more than 10 years.

A Sensus Flexnet system has been deployed for Southern Company's Advanced Metering Infrastructure project. The system includes 280 tower-mounted radios to reach more than 4 million meters.

CONCLUSION

Power Systems Automation should be considered a prudent investment versus a significant expenditure, based on the information provided in this paper. The customers listed above have proven that implementation of automation products and services pays for it.

REFERENCES

[1] Phil Carson, June 6, 2011, “Nashville Electric Service Pursues Voltage Conservation”, Intelligent Utility

[2] Katherine Tweed, January 27, 2012, “Entergy Tests AMI Voltage Optimization,” Greentechgrid

[3] Southern Company Website, http://www.southerncompany.com/smart_energy/smart_grid_sgig.html