ComEd's Smart Grid Innovation Corridor:

Piloting the Regulatory Environment in Illinois

Institute for Energy and the Environment
Vermont Law School

The Institute for Energy and the Environment (IEE) is a national and international resource for energy law and policy. The institute offers a full course curriculum and a certificate of concentration during the academic year and through its Energy Summer seminars; distributes scholarly, technical, and practical publications; provides forums and conferences for professional education and issue development; and serves as a center for graduate research on energy issues, with an environmental awareness.

The institute's research team is selected from top students in the energy and environmental programs at Vermont Law School. IEE student researchers work on some of the most pressing energy concerns the world faces today, including energy self-reliance, the smart grid, energy security and justice, carbon sequestration, and renewable energy sources. More information about IEE can be found at www.vermontlaw.edu/energy

Smart Grid Case Study Series – Case 4

October 2012

TABLE OF CONTENTS

US Department of Energy Acknowledgment and Disclaimer

Acknowledgment: "This material is based upon work supported by the Department of Energy under Award Number DE-OE0000446."

SMART GRID PROJECT OVERVIEW

The United States electric transmission and distribution system is on the verge of a transformation to a smart electric grid. At the center of this evolution is the introduction of new technology at the customer meter as well as the distribution and transmission system level. Unsurprisingly, the introduction of this new technology has presented new legal, policy, and regulatory challenges for state and federal regulators. The federal government has added additional momentum to this technological evolution by making a smart electric grid a central component of the US clean energy agenda and awarding $3.4 billion in smart grid investment grants to utilities and other entities as part of the American Recovery and Reinvestment Act.

THE SMART GRID CASE STUDIES SERIES

Vermont Law School's Institute for Energy and the Environment Smart Grid Project was initiated in 2010 through joint funding of the United States Department of Energy, with the support of Vermont Congressman Peter Welch, and Vermont Law School. Utilizing case study analysis of smart grid program implementation, the research project is examining the question: what legal, regulatory, and other policy changes can best ensure that Smart Grid implementation in the U.S. improves reliability, enhances consumer value, and meets our clean energy goals?

Our Smart Grid Case Study Series Includes:

- ✓ Central Vermont Public Service (Vermont)
- ✓ Commonwealth Edison (Illinois)
- ✓ Pecan Street Project (Texas)
- ✓ Sacramento Municipal Utility District (California)
- ✓ Salt River Project (Arizona)
- ✓ San Diego Gas and Electric (California)

PROJECT FOCUS 2012 AND BEYOND

FERC Chairman John Wellinghoff has noted that climate change and a smart electric grid are both key issues for the energy industry and the federal government, but rarely are these two issues linked in policy debates. The focus of the Institute for Energy and Environment's Smart Grid Project is to help better define this important link, and to promote smart policies that benefit both the climate and the electric grid. Research such as that conducted by Pacific Northwest National Laboratory (PNNL) and the Electric Power Research Institute have identified that a smarter grid is likely to be a significantly greener grid, which could lead to significant reductions in both energy usage and carbon emissions. PNNL's research suggests that a smart grid can lead to a 12% reduction in carbon emissions alone by 2030. Building on our case study research during the second phase of our project, we are producing up to five smart grid policy reports. These reports will examine best practices, lessons learned, and policy issues related to:

- Legal and regulatory challenges to smart grid implementation, including customer data privacy;
- Integration of electric vehicles into the grid;
- Supercharging efficiency and expanding demand response;
- Integration of clean distributed generation and storage; and
- Distribution optimization and conservation voltage reduction.

More about the Institute's Smart Grid Project is available at: www.vermontlaw.edu/smartgrid

HISTORY & BACKGROUND

For over 100 years Commonwealth Edison has provided electrical service to Chicago and Northern Illinois, operating as the State's largest electric utility. Established in 1881 by George H. Bliss, ComEd first operated as a subsidiary of Thomas Edison's company and sold Edison's generators and lighting systems to Chicago's burgeoning downtown commercial district. In 1907, Chicago Edison (one of nearly 30 electric companies operating in Chicago by that time) merged with Commonwealth Electric to form the Commonwealth Edison Company. Within six years the company acquired the Cosmopolitan Electric Company, effectively giving it a monopoly on electrical service in Chicago. [1]

In 1997 the Illinois legislature passed the Electric Service Customer Choice and Rate Relief Act requiring a transition to retail choice for electric service beginning first with industrial customers and later residential customers. While participation rates have been high for industrial customers, residential customer participation has been low resulting in ComEd remaining not only the distribution company but also the electric supplier for many residential customers. In 2000, ComEd's parent company Unicom merged with PECO Energy (formerly Philadelphia Electric Company) to form Exelon, one of the largest utilities in the United States serving over 5.4 million electricity customers and nearly 500,000 natural gas customers. As a subsidiary of Exelon, ComEd today delivers power to more than 3.8 million customers in Illinois. The utility works under regional operator PJM Interconnection and owns more than 70,000 circuit miles of transmission and distribution lines and 1,300 substations.[2] In 2010, the company employed over 5,800 people and enjoyed pre-tax income of almost $700

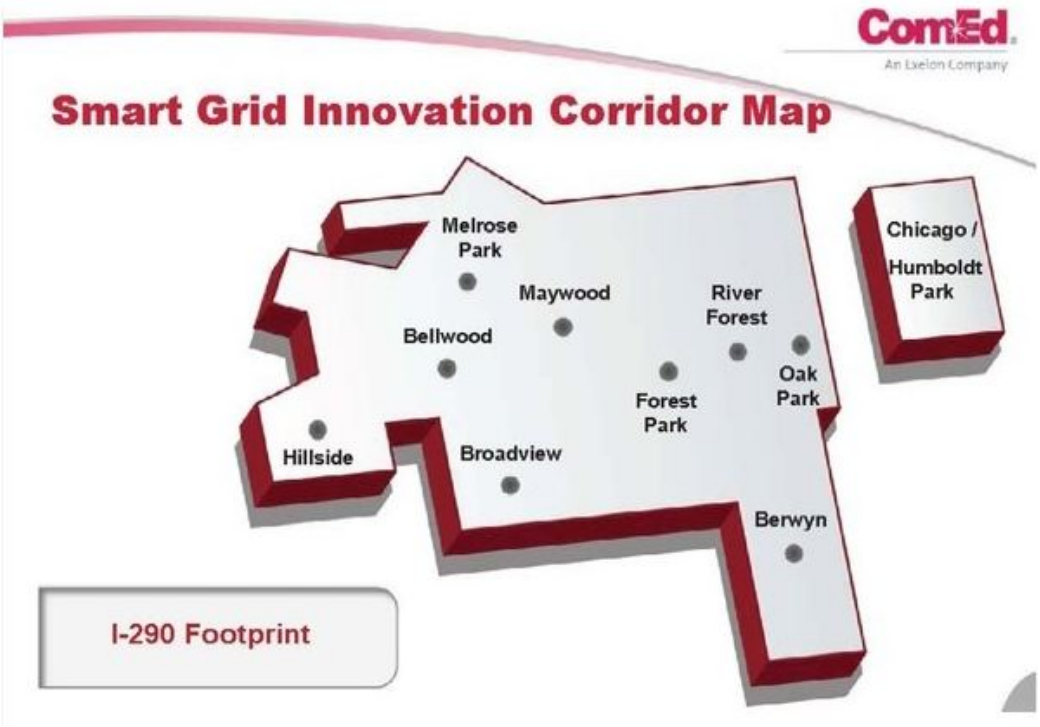
[1] Fitzgerald, John J. (1918). "Public Utility Corporations," *Burham's Manual of Chicago Securities.* Chicago: John Burnham and Company, p.173.

[2] Hoover's Commonwealth Edison Company Profile (2010). Available at http://www.hoovers.com/company/Commonwealth_Edison_Company/rfsftri-1.html

million.[3] On March 12, 2012 Exelon merged with Constellation, the parent company of Baltimore Gas and Electric, and became the largest competitive integrated energy company in the United States.

OVERVIEW OF COMED'S SMART GRID PROGRAM

ComEd has adopted a Smart Grid Vision that seeks to "enhance customer value with cost-effective technological advancements that empower customers and leads to more efficient utilization of electricity, reductions in future demand growth, improvements in the environment and a more reliable and secure system."[4] Its near-term strategy for achieving this vision includes expanding existing smart grid technology deployments and conducting limited pilot programs of smart grid technologies at the distribution and substation levels.



[3] Exelon Corporation Summary Annual Report, 2010. Available at http://www.exeloncorp.com/assets/newsroom/downloads/docs/Financial/dwlnd_annualreport.pdf

[4] Pramaggiorre, Anne (2010). "ComEd Smart Grid," *Presentation*, January 8, slide 2.

In 2009, ComEd launched its Smart Grid Innovation Corridor, one of the broadest collections of smart grid pilot projects in the nation. The corridor encompasses more than 10 Chicago-area communities and five pilot projects divided into three major areas: expansion of Advanced Meter Infrastructure (AMI), intelligent substations and integration of plug-in electric hybrid (PHEV) and all-electric vehicles.

ADVANCED METERING INFRASTRUCTURE (AMI)

In 2008, the Illinois Commerce Commission (ICC) issued Order No. 07-0566, establishing the Illinois Statewide Smart Grid Collaborative for the purpose of developing a strategic plan to guide the development of smart grid in Illinois and recommending smart grid policies that that the ICC should consider.[5] The order also authorized a series of stakeholder workshops to aid ComEd in a test deployment of an AMI pilot program. The order charged ComEd with engaging statewide stakeholders through a series of workshops beginning in late 2008 and with filing a formal plan, including requests for cost recovery, after receiving feedback from the community.[6]

In late 2009, after stakeholder feedback, the ICC issued Order No. 09-0263 that approved a two-part AMI pilot program: An AMI meter and support technology program, including installation of 131,000 smart

Approximately 30,000 meters in the border of Chicago Ave (S), Pulaski Rd (W), Fullerton Ave (N) and Sacramento Blvd (E)

ComEd AMI Pilot: City of Chicago Footprint

September 10.

in a Smart Grid World,

meters to evaluate operational benefits and costs and a Customer Applications Pilot (CAP) program designed to test how 8,000 ComEd customers would respond to smart grid consumer applications.[7]

ComEd began implementation of its meter program in October, 2009. The utility deployed approximately 128,000 meters with nearly 100,000 meters in nine communities within the I-290 Corridor, and nearly 30,000 meters in the City of Chicago. ComEd formally kicked-off its Customer Applications Pilot (CAP), a subset of the AMI pilot footprint, in May, 2010. ComEd notified customers by mail in March about new rate structures and how to access ComEd management tools via the internet. In April, CAP customers received in-home devices designed to work with their home area networks. CAP customers received monthly bills explaining the new rate structure and inserts from ComEd suggesting how to adjust usage during peak hours to save money. By June 2010, ComEd began providing CAP customers with next-day price notifications and gathering customer feedback. Throughout the pilot, customers were compensated for completing surveys, the results of which ComEd has added to the large amount of data it is using to evaluate the project's effectiveness in meeting the utility's smart grid vision.

INFRASTRUCTURE

For both projects of the AMI pilot, ComEd chose General Electric and Landis+Gyr solid state electric meters designed to communicate with Home Area Network (HAN) devices. The meters allow two-way communications with time-of-use measurement and thirty-minute interval data collection. They also support outage management, tamper detection, and bi-directional metering.

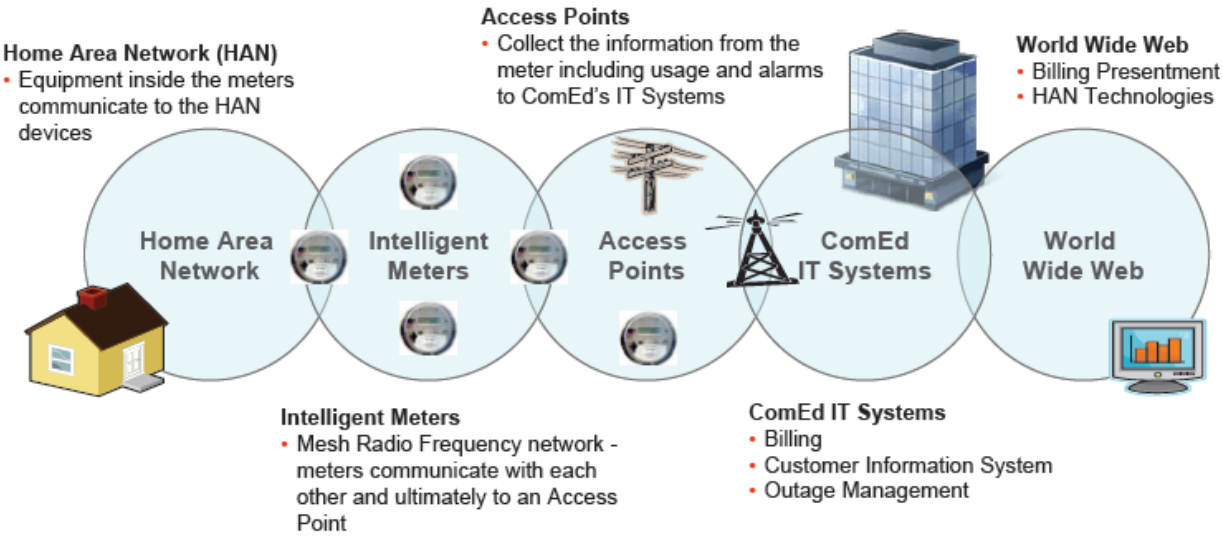
Under the larger AMI pilot, advanced meters communicate with each other and, ultimately, to ComEd access points in pilot neighborhoods using a Mesh Radio Frequency network. Access points collect information and communicate directly with ComEd Information Technology (IT) systems linked to ComEd's billing, customer information, and outage management departments. Billing and HAN activities are accessible by customers through the internet. Data acquisition and communication is handled by Silver Spring Network's (SSN) two-way

[7] Illinois Commerce Commission (2009). Docket No. 09-0263, *Commonwealth Edison Company Petition to approve an Advanced Metering Infrastructure Pilot Program and associated tariffs*, October 14.

communications solution, a robust smart meter communications platform also in use at Florida Power & Light, Pacific Gas & Electric and PEPCO.[8]

ComEd also deployed a number of IT tools, including a metering head-end telecommunications system, customer web presentment, a meter data management system and a business process management suite designed to integrate customer applications with ComEd's existing Asset Management System, Customer Information Management System, Outage Management System and Customer Data Warehouse.

Additionally, ComEd mailed two different types of in-home displays to two separate, randomly-chosen CAP study groups. One group received a basic in-home display, capable of providing basic cost information as well as real-time consumption information pulled directly from the customer's meter. Another group received a more advanced display, enabling customers to program multiple data formats as well as utilize "enhanced" in-home devices capable of being controlled remotely or preprogrammed to respond to information from ComEd's AMI infrastructure.[9]



ComEd Advanced Metering Infrastructure (AMI) Solution

[8] Pramaggiorre, Anne (2010). "ComEd Smart Grid," *Presentation*, January 8, slide 5.

RATE STRUCTURE

ComEd's CAP pilot employed an opt-out recruitment design whereby customers chosen randomly to participate were automatically enrolled in the program, informed of their new electrical service rate and the technology they would be using. Enrolled customers remained in the program unless they took actions to opt-out. ComEd adopted this pilot design despite its own focus group data that found that customers dislike opt-out approaches.[10] ComEd's pilot design, however, provided for the possibility that a large number of customers could elect to opt-out of a particular application, but would ensure that a statistically sufficient number remained to validate its testing.[11]

For its CAP pilot, ComEd informed customers that it would be changing their electricity rates from flat-rate pricing to one of two pricing schemes: "Shift-and-Save" or "Reduce-and-Save." "Reduce and Save" uses an Inclining Block Rate to provide incentives for customers to reduce their net electricity consumption. Under "Shift-and-Save," the price customers are charged for their electricity use varies from hour to hour. ComEd sent "peak day alerts" the day before it expected to experience substantially high demand from 1pm to 5pm. (The utility did, however, guarantee customers that it would declare no more than 10 peak days during the summer.)[12] The CAP pilot then tested customer response under various combinations of six different rate treatments:

(1) Real Time Pricing – hourly and daily prices conveyed through an hourly price schedule issued each day.
(2) Critical Peak Pricing – In addition to real time pricing schedules, customers are subject to event-specific prices that increase the price of electricity to $1.74 per kWh over the real-time price during peak periods (1:00pm – 5:00pm weekdays).
(3) Peak Time Rebate – Customers are paid $1.74 per kWh of reduced load during critical peak periods.
(4) Time of Use Pricing – Customers pay according to fixed time-of-use schedules issued diurnally.

[10] *Id.*, p.12

[11] Commonwealth Edison Company (2009). Post-hearing Brief, Docket No. 09-0263, *Petition to approve an Advanced Metering Infrastructure Pilot Program and associated tariffs*, p.11.

[12] Jensen, Val (2010). "The ComEd Customer Applications Program (CAP): Customer Engagement in a Smart Grid World," *ComEd Report*, December 14, p.11.

(5) Inclining Block Rate – Customers are charged different rates according to inclining levels of monthly consumption.

(6) Flat Rate – A control group of AMI-metered flat rate customers served as the basis for comparison.[13]

One unique provision of ComEd's AMI pilot program was its "hold harmless variable," which prevented customers from paying more than they would have had they not participated in the pilot program. The variable compared, on an individual customer basis, the costs to the customer as billed according to the new rate application to what the customer would have paid if billed according to the standard flat rate. For customers for whom the amount billed exceeded what they would have paid, ComEd credited the difference to the customer.[14]

In early 2011, the Electric Power Research Institute (EPRI) performed an initial assessment of the effect of CAP rates on electricity consumption. EPRI's hypothesis was that consumers with in-home displays would be more likely to pay attention to usage information and respond to price signals.[15] EPRI found that customers under Real Time Pricing (alone or in combination with the Real Time Rebate or Critical Peak Pricing) exhibited statistically significant responses. EPRI's preliminary analysis, for example, found that 5% to 7% of Critical Peak Pricing and Real Time Rebate customers reduced event-period load by 32% to 37%. However, while these customers shifted load significantly, EPRI did not find evidence that they reduced total energy consumption.[16]

When EPRI compared the impact of in-home displays on customer loads across pricing structures, it found no statistically significant effect attributable to technology or pricing applications. However, researchers caution that any effect may be hard to detect because of low technology adoption rates. For example, EPRI found approximately 15% customer adoption of basic in-home displays and less than 10% customer adoption of advanced in-home displays, far less than is required to detect scientifically robust causation.[17]

---

[13] Electric Power Research Institute (EPRI) (2011). "The Effect on Electricity Consumption of the Commonwealth Edison Customer Application Program Pilot: Phase 1 – Draft Report," *EPRI Report No. 1022703 draft*, March 2, p.1-1.

[14] Commonwealth Edison Company (2009). Docket No. 09-0263, "Petition to approve an Advanced Metering Infrastructure Pilot Program and associated tariffs," *Post-Hearing Brief of Commonwealth Edison Company*, p.12

[15] EPRI, *supra note* 11, p.1-2

[16] *Id.*, p.6-15

[17] *Id.*, p.6-16

By late 2011, EPRI had concluded its evaluation of the CAP program's likely effect on electricity consumption.[18] In the final analysis researchers found statistically significant responses by customers to dynamic pricing applications, but warned that responding customers represented only about 10 percent of all CAP participants enrolled in a dynamic rate program.[19] EPRI noted, however, that researchers were unable to detect measurable event-day load reductions on aggregate load and speculated that ComEd's use of an opt-out enrollment method for CAP may explain why ComEd's results appear inconsistent with the results of other pilot programs. Indeed, pilot programs that utilize an opt-in enrollment scheme experience both low participation rates and, as one would expect, are populated largely by those predisposed to respond to inducements to reduce or shift load.[20]

EPRI itself acknowledged that the utility of its analysis is severely limited due to a number of problems with the available data set:

(1) Bias inherent in the composition of the control groups intended to represent customers who did not receive AMI metering precluded accurately testing whether AMI had any influence on customer usage.[21]

(2) Some dynamic rate groups were comprised of samples that tended to overrepresent high-usage customers.[22]

(3) The selection of customers for the inclining block rate (IBR) sample was restricted to those with at least five years of billing history, which also tended to under-represent low-use customers living in multi-family units and smaller homes who tend to move more frequently than the average ComEd customer.[23]

---

[18] EPRI (2011), "The Effect on Electricity Consumption of the Commonwealth Edison Customer Applications Program: Phase 2 Final Analysis," *Technical Report 1023644*, Electric Power Research Institute: Palo Alto, CA.

[19] *Id*., p.7-1.

[20] *Id*., p.7-2.

[21] *Id*., p.4-4.

[22] *Id*., p.4-3.

[23] *Id*., p.4-6.

(4) Because the in-home display (IHD) technology did not always operate properly for customers residing above the first floor, the IHD customer sample also under-represent low-usage customers who tend to live in multi-story apartment buildings.[24]

(5) Less than 10 percent of customers offered programmable controllable thermostats (PCT) actually installed the devices and very few customers offered IHDs for purchase chose to install them. This small sample size precluded EPRI from testing either the effects of customers' response to time-based rate or the effects of partial payment applications of IHDs.[25]

STAKEHOLDER ENGAGEMENT

In its order approving a limited AMI pilot project, the ICC required that ComEd include a workshop process to educate stakeholders about AMI technology, develop project goals, timelines and evaluation methods, and develop criteria for determining which technologies would be selected for pilot implementation. The ICC also selected R.W. Beck and Plexus Research (an industry-leading consulting firm acquired by SAIC in 2009) to facilitate the workshops. Over 125 individual stakeholder representatives participated in a series of workshops from December, 2008 thru May, 2009. ComEd also held separate meetings at which non-vendor stakeholders reviewed confidential materials relating to the technologies, capabilities, costs, and technical scoring of the competing vendor solutions.[26]

The ComEd stakeholder workshops resulted in a set of defined criteria for determining AMI technology vendors whose bids met minimum requirements. The criteria, ranked highest to lowest priority, included: (1) security; (2) capability; (3) flexibility and scalability; (4) network performance; (5) interoperability; (6) maturity; (7) obsolescence risk; (8) economic stimulus; as well as (9) demonstrated programs to protect the environment; and (10) support for minority and women-owned businesses. ComEd issued an RFP in February, 2009 to ten vendors with prior experience deploying AMI systems. By March, ComEd had received responses from eight. Applying

[24] *Id.*, p.4-6.

[25] *Id.*, p.4-8.

[26] Jensen, *supra note* 10, p.15.

the selection criteria, ComEd and participating stakeholders found that only three responding vendors met the minimum requirements. In the end, ComEd went with GE and Landis+Gyr.

COST RECOVERY

Arguably, ComEd's greatest hurdle in implementing its Smart Grid Innovation Corridor has been recovering the costs of its AMI pilot program in the context of Illinois' controversial experience with electricity deregulation and the energy price spikes that resulted. While cost recovery issues have a long history in Illinois, ever since Illinois began experimenting with deregulation, ComEd has faced greater regulatory and political hurdles when attempting to recover costs. In the late 1990's, Illinois initiated the transition to a deregulated electricity generation market designed to encourage competition, expand customer choice and reduce energy costs. The Illinois General Assembly passed the Electric Service Customer Choice and Rate Relief Law of 1997, ordering most Illinois utilities (including ComEd) to divest their generation assets and give their customers the option of purchasing generation from other suppliers. The law also reduced residential electricity prices by 20% by the year 2001 and froze that rate for ten years while the State's utilities developed a competitive market for obtaining their electricity.

As the end of the rate freeze approached in 2006, a fully competitive electricity market threatened residential customers with rate increases of nearly 33%, sparking a public outcry against deregulation and a spirited debate among state legislators about whether to extend the rate freeze for several more years while they decided whether to suspend the deregulation experiment altogether. Faced with an extension of the rate freeze, ComEd responded that it likely would bankrupt the company.[27] As part of a compromise, in 2007 ComEd devised a new rate plan that allowed customers to defer payment of any increases in the delivery portion of their electricity bills, subject to about 3% interest on any unpaid portion. The experience, however, left many Illinois ratepayers wary of price hikes and suspicious of ComEd's intentions.[28]

---

[27] Richard Miller (2006). "Despite bankruptcy threats, Illinoisans still want freeze," *CapitolFax.com*, October 30. Available at http://capitolfax.com/2006/10/30/depite-threats-illinoisans-still-want-freeze/

[28] Righter, Dale (2007). "Power customers need a long-term solution to higher costs," *Arthur Graphic-Clarion*, May 31, p.11.

On June 1, 2009, ComEd filed a petition with the Illinois Commerce Commission (ICC) seeking approval to recover from ratepayers certain costs associated with its AMI Pilot Program.[29] Cost recovery for smart grid deployment has been highly controversial in Illinois. Stakeholders disagree about whether ComEd's smart grid costs should be restricted to a traditional rate base method or whether the ICC should approve non-traditional riders (designed to recover the costs associated with specific smart grid deployments) to the base case. Some stakeholders worry that non-traditional cost recovery methods would shift the risk of smart grid investments from utilities to ratepayers and lead to substantially higher monthly energy bills.[30] Others, including ComEd, believe that the rider method of cost recovery is essential to accelerate deployment of smart grid technologies and leverage federal funding of smart grid demonstration projects.[31]

In its 2007 rate case, ComEd had proposed a Rider to act as a mechanism for recovering the costs of system modernization projects likely to occur between its general rate cases. However, the ICC approved only a subset of the proposed rider – renamed Rider AMP (for Advanced Metering Pilot) – which covered only limited deployment of the pilot program while ComEd further defined the project through stakeholder workshops. The ICC required ComEd to file an additional request seeking approval to recover costs associated with the final AMI project as defined through the workshops. Ultimately ComEd proposed an amendment to Rider-AMP to permit the utility to recover incremental operating expenses of the CAP study and also to attempt to procure matching funds from the U.S. Department of Energy smart grid development funds provided under the American Recovery and Reinvestment Act (ARRA). In 2009, the ICC issued its final order approving ComEd's AMI pilot program and a rider designed to recover most of the associated costs.[32]

Several stakeholders, including the State's Attorney General and the Citizens Utility Board (a consumer advocate), appealed the ICC's approval of AMI costs through a rider to the Appellate Court of Illinois. On September 30, 2010, a unanimous 3-judge panel of the Second District rejected the ICC's approval of the AMI

---

[29] State of Illinois Commerce Commission (2009). Order No. 09-0263, *Petition to approve an Advanced Metering Infrastructure Pilot Program and associated tariffs*, October 14.

[30] Illinois Statewide Smart Grid Collaborative (2010). *Collaborative Report*, September 30, p.25.

[31] *Id.*

[32] Illinois Commerce Commission, *supra note* 7.

rider on the grounds that it violated the State's prohibition on single-issue ratemaking.[33] The Court held that the ICC had discretion to approve a rider mechanism to recover costs if (1) they were imposed on the utility by external circumstances over which the utility had no control and (2) the cost does not affect the utility's rate of return. The Court found that the AMI rider did not meet these criteria since the expenses related to AMI and the adoption of smart grid technologies generally were not unexpected and that ComEd was pursuing the program precisely because the increased costs would be more than offset by corresponding savings. Since ComEd historically recouped the costs of distribution improvement through traditional ratemaking, the Court found no reason that ComEd's smart grid expenses should be treated differently.[34]

Ultimately, the ICC allowed ComEd to include many of the AMI pilot costs in its traditional rate case in an Order issued May 24, 2011.[35] The experience, however, motivated the utility to lobby hard in favor of HB14/SB1652, bills in the state legislature that would change the nature of smart grid cost recovery in Illinois. The legislation lays a groundwork for rolling out smart grid in Illinois, while capping customer rate increases at 2.5 percent per year. Under the proposal, ComEd's profit margin is limited to 10.25% and the current 11 ½ month ICC review process would be replaced with a quicker rate review process defined in the legislation.[36] Though the bill passed the both houses of the Illinois legislature, Governor Quinn vetoed the legislation. Intense lobbying on behalf of affected utilities, however, convinced the legislature to overturn the veto and the new cost recovery procedure became law in October 2011.[37]

BENEFITS

ComEd justifies its Smart Grid Vision by referencing the economic and environmental benefits that might accrue from the smarter provision of electrical service. It is ComEd's hope that its various smart grid pilot projects

[33] Appellate Court of Illinois, Second District (2010). Order No. 07-0566, *On Petition of Administrative Review from the Illinois Commerce Commission*, September 30.

[34] *Id.*, p.42-43

[35] ICC (2011). Docket 10-0467, May 24.

[36] Long, Ray & Wernau, Julie (2011). "ComEd scrambling to get its Smart Grid plan through legislature," *Chicago Tribune*, May 23.

[37] Wernau, Julie (2011). "Lawmakers override Quinn veto: smart grid becomes law," *Chicago Tribune*, October 26.

might validate the business, customer, and environmental cases for adopting smart grid technologies throughout the service area.

THE 2008 BUSINESS CASE

ComEd's AMI Pilot was designed, in part, to enable it to quantify the degree to which AMI can help moderate future electricity prices by quantifying operational cost savings, consumer load shifting, and avoided energy purchases. In its 2008 case to the ICC, ComEd estimated that that one-time capital costs to deploy AMI throughout its service territory would be $800 million ($720 million for AMI meters, network, installation and vendor costs, $74 million for IT software and hardware integration, $6 million in additional operation and management, and $2 million for miscellaneous project costs).[38]

ComEd's estimation of the cost savings resulting from system-wide AMI deployment (the business case) postulated six potential ways smart grid would reduce utility costs:

1. **Automated Meter Reading -** ComEd estimates that automated meter reading would reduce the number of meter reading positions, clerical labor, supervision and management, and related benefits, pensions, and incentives. Additionally, automated readings may reduce vehicle and fuel purchases, capital expenditures for fleet replacement, office and reimbursed expenses, recruitment and training costs, worker compensation claims, and overtime costs.[39]
2. **Remote Disconnect / Reconnect -** ComEd estimates that remote disconnect abilities would allow the utility to better manage past due receivables, increase the timeliness of collections and reduce its bad debt expenses.[40] Additionally, remote disconnect/reconnect abilities may avoid labor costs associated with field meter tests and investigations of high bills.[41]

[38] O'Toole, Richard D. (2009). Direct Testimony , Docket No. 09-0263, ComEd Ex. 3.0, *Petition to approve an Advanced Metering Infrastructure Pilot Program and associated tariffs,* p.5.

[39] *Id.*, p.3.

[40] *Id.*

[41] *Id.*, p.4.

3. **Reduced Calls** - ComEd estimates that its customer call center may experience reduced call volumes because AMI would increase the accuracy of usage data, reduce the number of estimated bills, and provide customers with access to usage and billing information on a self-service basis.[42]
4. **Digital Meters -** ComEd estimates that the increased accuracy provided by smart meters will reduce the number of corrected bills that its accounts receivable department must issue, resulting in marginal clerical cost savings.[43]
5. **Reduced Outage Calls -** ComEd estimates potential costs savings associated with unnecessary trips to investigate non-storm outage calls that turn out to be false.[44]
6. **Operational Efficiency -** ComEd estimates costs savings through real-time customer information in two ways: First, AMI meters will provide real-time power outage and restoration information, allowing better area-wide outage analysis and more effective crew deployment. Second, since AMI meters provide time-stamped, 30-minute interval data from each customer, ComEd can employ actual usage data rather than statistical samples to estimate the relationship between cumulative usage and coincident demand. ComEd's current Load Factor Method program uses bi-weekly readings from a statistical sample of metered transformers to compute monthly loads on distribution transformers. ComEd runs the calculations twice a year, in May and October. As a result, summer peaking transformer overloads in June are not identified until November. ComEd believes that AMI would facilitate daily load factor calculations and help to more quickly identify and replace overloaded transformers with optimal replacement sizes for the identified loads.[45]
7. **Avoided Energy Purchases -** ComEd estimates that AMI would reduce its purchases of energy required to supply unbilled, unaccounted-for, stolen, and un-metered electricity. Unbilled energy is supplied where a customer has terminated service but electricity is still flowing to the residence or business. Currently, it is not economical for ComEd to manually disconnect service to every customer who cancels service, resulting in significant amounts of unbilled usage. Unaccounted-for

---

[42] *Id.*, p.4.

[43] *Id.*

[44] *Id.*

[45] *Id.*, p.7-8.

energy is associated with slow, stopped or tampered meters. The automated communication features of AMI meters will allow ComEd to detect meter tampering and remedy it more quickly. In addition, the improved accuracy of solid-state digital meters should allow ComEd to reduce un-metered energy costs and increase cost-recovery.[46]

THE CUSTOMER CASE

Most ComEd customers pay an average flat rate for a system of electrical service whose primary costs are driven by peak demand, which occurs only a few hours of each year. Since base load electricity cannot effectively be stored using current technology, generators have built peaking plants designed to meet these few hours of demand. These plants, however, impose substantial costs that are reflected in higher average prices for all customers. ComEd's business case for a proposed AMI build-out suggests that, if customers were provided with financial incentives to reduce their electricity use during periods of peak demand, these marginal reductions would result in significant decreases in every customer's electricity costs.[47]

THE ENVIRONMENTAL CASE

ComEd believes that its smart grid build-out could have a substantial effect on the utility's carbon emissions in two ways. First, since AMI should reduce its purchase of energy to supply unbilled, unaccounted-for, unmetered and stolen electricity, ComEd believes AMI should also result in avoided energy generation and, therefore, reduce CO_2 emissions.[48] Additionally, ComEd believes that AMI would reduce the need for meter readers and, thus, decrease the number of required field visits. The resulting reduction in vehicle miles driven should, therefore, decrease the utility's net CO_2 emissions.

THE 2011 BUSINESS CASE: BLACK & VEATCH'S EVALUATION

In 2011, at the request of ComEd, Black & Veatch performed an evaluation designed to validate ComEd's business case to determine whether future full scale AMI deployment within ComEd's service territory would be

[46] *Id.*, p.5.

[47] State of Illinois Commerce Commission (2009). Order 09-0263, *Petition to approve an Advanced Metering Infrastructure Pilot Program and associated tariffs*, October 14, p.8.

[48] O'Toole, *supra note* 10, p.9.

justified from a cost-benefit perspective. From January 2011 through April 2011, Black & Veatch worked with the ComEd AMI project team and ComEd customer operations, distribution operations, regulatory, and finance managers to refine the scope of potential AMI investments, identify and resolve some key questions about ComEd's formulation of its business case, and to gather pertinent information from AMI's pilot project that would help the consulting firm construct an independent view of the business case. Black & Veatch issued its final report in July 2011.[49]

Black & Veatch's evaluation found that ComEd would expect to invest $996 million in new capital and incur $665 million of operation costs to run the new AMI system-wide. However, Black & Veatch concluded that cumulative benefits over the 20-year evaluation period would significantly exceed cumulative costs. In fact, according to Black & Veatch, ComEd should expect benefits to result from improved operational efficiencies ($1,625 million), reduced power purchase costs ($707 million), reduced bad debt expenses ($791 million), new energy revenues ($1,051 million), and new delivery service revenues ($564 million). Admittedly, a large majority of the benefits Black & Veatch expect to result from a system-wide AMI deployment are driven by reductions in theft and tamper conditions and reduction in consumption on inactive accounts.[50] Using these assumptions, however, and taking into account all costs and benefits, and assuming adjustments to customer rates, Black & Veatch estimated that the Net Present Value (NPV) of the AMI program to ComEd customers would be $1,296 million over 20-years.[51]

While the Black & Veatch evaluation (B&V) finds that the cumulative benefits of AMI deployment exceed costs by almost a factor of three, its evaluation makes a number of significant assumptions that may substantially alter the actual costs and benefits of a system-wide AMI roll-out. For example, Black & Veatch assumed that system-wide AMI could recover 100% of ComEd's losses due to consumption on inactive meters and otherwise unaccounted for energy consumption.[52] Given this assumption, Black & Veatch calculated that ComEd could

[49] Black & Veatch (2011). *Advanced Metering Infrastructure (AMI) Evaluation Final Report*, Overland Park, KS:Black & Veatch Holding Company, Version 1.0, July.

[50] *Id.*, p.1

[51] *Id.*

[52] *Id.*, p.62.

recover nearly $2 billion in revenue over a 20-year period.[53] However, Illinois State Administrative Code ("Part 280") currently requires an in-person notification before ComEd (or any Illinois provider) may disconnect service. While Part 280 disconnection rules are being re-written, it remains uncertain whether they will be clarified to allow remote disconnection. Black & Veatch also assumed that Illinois regulators will allow the company accelerated depreciation on investments it has already sunk into old analog meters.[54] But the ICC has yet to approve a rate recovery plan consistent with these assumptions. Adding to this uncertainty is whether the results from ComEd's AMI pilot program – representing less than 3% of ComEd's total meter population – can even be extrapolated to system-wide customer base of almost 4 million.[55]

CHALLENGES

Illinois stakeholders have articulated major concerns with the cost of replacing older meters, the effect of time-of-use pricing on low-income customers, the security of private customer data, and the elimination of manual meter reading.[56]

METER REPLACEMENT COSTS

Some stakeholders view smart grid merely as an acceleration of routine investments ComEd must take as part of its on-going grid modernization.[57] Since some perceive that the potential benefit of smart meters accrue to the utility (or society), it may be difficult for many ratepayers to understand how the utility justifies passing on to ratepayers the costs for meter replacement. The Black & Veatch evaluation is, therefore, instrumental in demonstrating that the sum total of consumption on inactive meters and other unaccounted for consumption currently is passed onto the consumer. In theory, therefore, an effective AMI system will reduce these losses, leading to reductions in the rates customers would have paid otherwise. In fact, under the ratemaking process included in the approved legislation, changes in the utility cost structure will result in benefits passed back to consumers on an annual basis.

---

[53] *Id.*, p.47.

[54] *Id.*, p.65.

[55] *Id.*, p.47.

[56] O'Toole, *supra note* 10, p.61.

[57] Illinois Statewide Smart Grid Collaborative, *supra note* 13, p.165

TIME-OF-USE PRICING

Illinois stakeholders have raised significant concerns that customers may put their health or safety at risk by overreacting to time-variant rates.[58] Opponents of time-variant rate structures worry that they could reduce or eliminate the intra-class cross-subsidization inherent in flat rates. Under a flat retail rate, customers who use more energy during off-peak periods subsidize the cost of customers that tend to use energy during peak periods. While load-shifting from peak to non-peak periods is one of the major driving forces behind time-variant rates, some stakeholders worry that customers who must use electricity for health or safety related purposes during peak periods could be penalized by their inability to shift their energy usage to non-peak times.[59] One potential area of concern involves ComEd's marketing of competitive retail rate structures that may become available after system-wide deployment of AMI. ComEd has elected to become an Independent Distribution Company (IDC) under Illinois' quasi-regulated market. According to Illinois Administrative Code 452.240(a), however, qualifying IDC's may not "promote, advertise or market with regard to the offering or provision of any retail electric supply service."[60] While this provision does not preclude ComEd from "advertising or marketing permissible IDC services other than retail electric supply services," it seems clear it would limit ComEd's marketing of various rate structures it could offer with widespread deployment of AMI.

DATA PRIVACY

A key feature of the smart grid is the ability to capture and transmit data about how customers are using electricity in near real-time. ComEd's AMI meters, for example, record customer usage data and transmit it to the utility in 30-minute intervals. Some stakeholders have been concerned that unsecured customer data could be used by unauthorized individuals in ways not known or approved by customers.[61] By one estimate, the average AMI-connected home generates from 750 to 3,000 points of data a month.[62] Some stakeholders worry that utilities, not accustomed to handling large amounts of customer data, will now know a great deal about people's

[58] *Id.*, p.89.

[59] *Id.*, p.161.

[60] *Id.*, p.150.

[61] *Id.*, p.146.

[62] Greising, David (2011). "Promise and Peril in Utilities' Smart Grid," *New York Times*, May 28. Available at: http://www.nytimes.com/2011/05/29/us/29cncgreising.html

lives. An AMI system that records when customers turn down their thermostats might create a theft risk by determining when people are out of town or a system that records when and where a wayward spouse recharges his or her plug-in electric vehicle could prove tempting fodder for an enterprising divorce lawyer.[63]

Many issues associated with customer data security are being addressed at the national level. In 2007, for example, Congress directed the National Institute of Standards and Technology (NIST) to develop interoperability standards for smart grid technologies, many of which will help in the development of privacy protocols.[64] But loopholes in statewide privacy standards raise serious concerns. Illinois State law prohibits utilities from disclosing customer-specific data to electricity retailers. But it is silent on whether utilities may provide customer data to third parties. As a result, some customers are concerned that ComEd will mine the AMI data, package it and sell it for millions of dollars to everyone from appliance vendors to home security companies.[65] For its part, ComEd insists it is strongly committed to customer privacy and does not disclose personal information about customers without prior approval, except as required by law and regulation.[66] However, its official privacy policy leaves some room for interpretation:

> "We do not disclose or sell any personal information about you to third parties without your prior approval, except as required by law, requested by regulatory agencies and governmental authorities, arises from the sale of all or a portion of any of its businesses, or is used for legitimate business purposes."[67]

ELIMINATION OF MANUAL METER READING

Some stakeholders have been concerned that, by eliminating manual meter reading, hazardous conditions at customer sites could go undetected. Automatic service disconnection also raises some concerns that ComEd could curtail electrical services to low income or prepaid service customers most burdened by any

[63] *Id.*

[64] Illinois Statewide Smart Grid Collaborative, *supra note* 13, p.146.

[65] Greising, *supra note* 33.

[66] ComEd (2012). "Frequently Asked Questions," ComEd > Smart Meters > FAQs. Available at: https://www.comed.com/technology/smart-meters/Pages/smart-meter-faqs.aspx.

[67] ComEd (2012). "Privacy Policy," ComEd > Home > Privacy Policy. Available at: https://www.comed.com/Pages/privacy-policy.aspx.

increases in electricity prices. Currently, ComEd must prioritize disconnections, taking into account the costs associated with visiting the premises to disconnect service at the meter. Some stakeholders worry that automated disconnection could risk the health and safety of some customers if the utility no longer makes visits to premises or interact with residents present during meter disconnections.[68] A site visit, for example, might reveal medical or mental health situations or other mitigating circumstances that might render a delay in disconnection appropriate.

Additional concern is that Section 280 of the Public Utilities Act requires that, "a utility shall attempt to advise the customer that service is being discontinued by directing its employee making the disconnection to contact the customer at the time service is being discontinued." It is unclear how ComEd will comply with this provision when employing remote disconnection of service. However, the ICC has held that the regulation clearly contemplates a site visit by a utility upon disconnection and has prohibited ComEd from remotely disconnecting customers unless the disconnection is made in accordance with PUA provisions.[69] As noted, efforts are underway to rewrite section 280. Their outcome will have a substantial impact on whether a system-wide AMI roll-out is likely net beneficial.

SMART GRID AMI DEPLOYMENT PLAN OVERVIEW

On April 23, 2012, ComEd filed with the Illinois Commerce Commission for approval of its Smart Grid Advanced Metering Infrastructure Deployment Plan, pursuant to theIllinois Public Utilities Act ("PUA"), as amended by the Energy Infrastructure Modernization Act ("EIMA"). The EIMA required ComEd, to file with the Commission a Smart Grid Advanced Metering Infrastructure Deployment Plan ("AMI Plan"), "within 180 days after the effective date of this amendatory Act of the 97th General Assembly or by November 1, 2011, whichever is later.". According to ComEd's AMI Plan, the "EIMA provides the blueprint for Illinois electric utilities, working with the Illinois Commerce Commission and stakeholders, to accomplish this decade-long transformation. The EIMA establishes policies and goals, calls for utilities to make the investments necessary to achieve them, defines investment timetables and performance metrics to measure that achievement, and provides the means to

[68] Illinois Statewide Smart Grid Collaborative, *supra note* 13, p.153

[69] State of Illinois Commerce Commission, *supra note* X, p.34

fund those investments."[70] While this case study focuses on the implementation of ComEd's smart grid pilot projects the regulatory issues related to ComEd's AMI deployment plan pursuant to the requirements of the EIMA are relevant to the lessons learned for this case study.

ComEd's AMI Plan provides for investment over a 10-year period that is sufficient to implement the AMI Plan across its entire service territory in a manner that is consistent with subsection (b) of Section 16-108.5 of this PUA. As required by the statute, ComEd's AMI Plan contains:

- A Smart Grid AMI vision statement that is consistent with the goal of developing a cost-beneficial Smart Grid;
- A statement of ComEd's Smart Grid AMI strategy that includes a description of how ComEd evaluates and prioritizes technology choices to create customer value, including a plan to enhance and enable customers' ability to take advantage of Smart Grid functions beginning at the time an account has billed successfully on the AMI network;
- A deployment schedule and plan that includes deployment of AMI to all customers of ComEd;
- Annual milestones and metrics for the purposes of measuring the success of the AMI Plan in enabling Smart Grid functions, and enhancing consumer benefits from Smart Grid AMI; and
- A plan for the consumer education to be implemented by ComEd.

According to ComEd, The present value of the total benefits of the AMI Plan exceeds the present value of the total costs of the plan. Therefore, the implementation of the AMI Plan will be cost-beneficial, as that term is defined in the PUA, consistent with the principles established through the Illinois Smart Grid Collaborative, giving weight to the results of the Commission-approved ComEd AMI pilot designed to examine the benefits and costs of AMI deployment. Importantly to ComEd, it anticipated that the plan as filed would allow ComEd to recover the reasonable costs it incurs in implementing the AMI Plan, including the costs of retired meters through its tariffs, pursuant to the performance-based formula rate tariff within the PUA.

On June 22, 2012 the ICC approved, with minor modifications, ComEd's AMI Plan. The ICC found that the ComEd AMI Plan met the conditions of the EIMA and was cost beneficial. The ICC's modifications to the plan

[70] ComEd AMI Plan, p1.

included adopting additional tracking measures and a requirement that ComEd work with the Smart Grid Advisory Council and other stakeholders to explore how to maximize adoption of dynamic pricing rates including a possible ComEd Time of Use Rate. The ICC order also reiterated what it considers current commission rules requiring a site visit prior to service disconnection for non-payment. Issues related to remote service disconnection, which are a significant anticipated cost savings of the ComEd AMI Plan, are subject to a separate ICC proceeding. While the ICC largely approved the ComEd AMI Plan, the ICC approval does not address the ongoing controversy of ComEd cost recovery, which is addressed in a separate proceeding on ComEd's formula rate. The formula rate is meant to allow distribution utilities such as ComEd to recover prudently incurred costs. On May 29, 2012 the ICC issued an order on the ComEd formula rate that cut customer rates by approximately $179 million, which was over four times what ComEd had proposed for a rate decrease. While the ICC's changes to the formula rate plan addressed issues such as the recovery of pension assets and did not directly involve the recovery of costs from the AMI Plan, ComEd has asked for a rehearing of the formula rate order and these actions continue the controversy in Illinois over AMI cost recovery.

On July 6, 2012 ComEd filed with the ICC for rehearing of their AMI Order. In its filing, ComEd sought rehearing on three aspects of the AMI Order arguing first and foremost that "the plan approved by the Commission in the AMI Oder for ComEd's AMI deployment schedule is no longer sustainable in light of the Commission's Order in Docket No. 11-0721 ("the Formula Rate Order")."[71] According to the ComEd Application for Rehearing "ComEd simply cannot make $2.6 billion of new investments – including nearly $1billion in AMI – while being denied the total revenues that are needed to fund them."[72] In its filing ComEd noted that it "has been forced to delay the AMI deployment originally scheduled for 2012 and to reevaluate its participation in the scheme enacted by the EIMA." ComEd also stated that "even if the Commission grants relief in the formula rate proceeding, however, the AMI deployment schedule will need to be revised to account for the delays that have occurred as a result of the uncertainty." If the Formula Rate Order is not revised, according to ComEd, the schedule will require "more sweeping changes" including the possibility of "withdrawing from EIMA altogether". The two other issues addressed in ComEd's Application for Rehearing to the ICC related to concerns regarding

[71] Commonwealth Edison Company Application for Rehearing in Docket No. 12-0298 of the Illinois Commerce Commission, Petition for Statutory Approval of a Smart Grid Advanced Metering Infrastructure Deployment Plan pursuant to Section 16-108.6 of the Public Utilities Act, p. 1

[72] Id, p. 2.

statements in the AMI Order about remote disconnection issue and whether onsite contact ("door knock") should be required and concerns with the AMI Order's various proposals regarding "at-risk" and "vulnerable" populations.

On October 3, 2012 the ICC issued its Order on Rehearing in ComEd's formula rate tariff which determines the specific level of cost recovery for smart grid infrastructure investments. The order sets rates through the end of 2012 and represents a $133 million reduction in ComEd revenue, but is approximately $35 million in additional revenue compared to the ICC's previous order.[73] Following the ICC order, ComEd announced in a news release that "[b]ecause the ICC is not fully funding the grid deployment program, ComEd is forced to make modifications to its program to align the deployment of key infrastructure with the ICC decision. ComEd must delay installation of additional smart meters until 2015…"[74] In its news release, ComEd stated that the ICC's decision will result in the under-recovery of revenues by nearly $100 million per year starting in 2014. The loss of these revenues will cause the delay of more than $2.3 billion in customer savings and the creation of 2,000 jobs. ComEd will appeal the rate order in court.

Interestingly, the dispute between the ICC and ComEd is not about the merits of the costs of the smart grid infrastructure build out (which were determined by the EIMA and approved by the ICC order on ComEd's implementation plan), but mostly about how ComEd is allowed to calculate its return on the investments in the formula rate. Of specific dispute are how infrastructure investment balances are calculated, to which a rate of return is applied, and additionally, the interest rate applied to annual adjustments to those investment balances.

Part of the controversy as acknowledged by the ICC decision is that:

> "the rate setting process put in place by the [EIMA]… is quite different from the traditional rate setting process known by the Commission. Although some aspects of traditional ratemaking … are still applicable, the input data, the formula rate itself, and the reconciliation practice specified in the Act do not fit neatly into the traditional ratemaking paradigm. Each of the parties argues that the new provisions support their position …. While some claim to know what was intended when [the EIMA was]… enacted, the Commission is not bound by the views of a few as to what the statute requires. The record in this case warrants the finding that the language used in the statute leaves room for interpretation by the Commission."[75]

---

[73] State of Illinois Commerce Commission (2012). Order on Rehearing in Docket No. 11-0721, Commonwealth Edison Company, Formula rate tariff and charges authorized by Section 16-108.5 of the Public Utilities Act, October 3.

[74] Commonwealth Edison News Release, October 3, 2012.

[75] State of Illinois Commerce Commission (2012). Order on Rehearing in Docket No. 11-0721, Commonwealth Edison Company, Formula rate tariff and charges authorized by Section 16-108.5 of the Public Utilities Act, October 3, p.16-17.

Underlying the controversy is the fact that in the EIMA the Illinois legislature laid out in significant detail how the ICC is to treat these smart grid infrastructure costs and it did so in a manner that was not consistent with previous ICC policy. In doing so the ICC and various parties believe that the legislature left some discretion with the ICC. The fact that there is significant tension on intended cost recovery of smart grid investments is highlighted in the comments of Jonathan Feipel, the ICC's executive director. According to the Chicago Tribune, Feiple stated that the legislature's "resolution was hyper-specific" and amounted to the legislature taking over the ICC's role as regulator[76]. These are unusually critical words by a regulator toward a legislature, since the ICC's statutory authority is determined by that legislative body.

ELECTRIC VEHICLE INTEGRATION

By the end of 2012, most major domestic and foreign car manufacturers intend to bring plug-in electric vehicles (PEVs) to market. Projections from the Electric Power Research Institute (EPRI) found that potential U.S. market share could range anywhere from 3% to 11% of new vehicle sales by 2020.[77] However, using Prius adoption patterns as a leading indicator of potential PEV adoption, ComEd has concluded that PEVs are not likely to be distributed evenly across the U.S. during early years of market development. Further information from EPRI suggests that total cumulative PEVs on the road in ComEd's service territory by 2020 will be between 75,000 and 280,000.[78]

In anticipation of the emerging PEV market, ComEd has adopted an Electric Vehicle Strategy designed to achieve four key objectives:

1. Gain first-hand experience with PEV technology and charging infrastructure;
2. Study vehicle impacts on the system and utilize advanced methods to mitigate them;
3. Prepare the Chicago region by collaborating with stakeholders to address factors that will affect consumer adoption; and

[76] Chicago Tribune, "ComEd: Rate formula ruling puts smart grid, jobs at risk", October 3, 2012.

[77] EPRI (2010). "Plug-In Electric Vehicle Adoption Forecasts," *EPRI Report 101992,* December, p.4-1 to 5-2.

[78] *Id.*

4. Assess the impacts of electric vehicles on the electricity grid and their interaction with Smart Grid technologies.[79]

ComEd has pursued these objectives, in part, through several initiatives, including demonstration of PEVs in its own vehicle fleet and participation in and support of the Illinois Commerce Commission's Initiative on Plug-In Electric Vehicles.

COMED ELECTRIC VEHICLE DEMONSTRATION PROJECTS

COMED'S "GREEN FLEET"

ComEd has been supporting the development and deployment of alternative fuel vehicles since 2002, when the utility first began using soy-based diesel for its on-site fueling of its diesel-fueled fleet. It was also one of the first utilities in the country to deploy electric hybrid bucket trucks in 2006.[80] Since then, the company's hybrid fleet has grown to the 7th largest Green Fleet in the country, including 20 hybrid bucket trucks, 40 hybrid sedans, 142 hybrid SUVs and 10 converted Toyota Prius plug-in hybrid electric vehicles (PHEVs) and 10 Chevrolet Volt extended range electric vehicles (EREVs).

In 2009, ComEd converted 10 Prius hybrids into PHEVs. This conversion involved adding a second battery pack capable of being charged with a 120 volt outlet. These 10 PHEVs plus two Prius PHEVs in the I-Go car sharing fleet were then equipped with smart charging technology consisting of a vehicle control module that communicates directly with the vehicle's on-board computer, wireless communications and back-end software that allows remote acquisition of vehicle performance data as well as the ability to manage vehicle charging using a variety of advanced methods. Two of these method were (1) using real-time price signals to manage charging times, and (2) dynamically controlling the charging of a group of vehicles so that the aggregate load remained below a predetermined threshold.[81]

ComEd is participating in a project under a Transportation Electrification grant from the DOE with EPRI and over 40 other utilities across the U.S. to demonstrate PHEV utility vehicles in fleet applications. ComEd

---

[79] Commonwealth Edison Company (2009). "ComEd Electric Vehicle Strategy," *ComEd Presentation*, November 15, slide 6.

[80] Commonwealth Edison Company, *supra note* 32, p.5.

[81] *Id.*, p.12.

expects to deploy its PHEV vehicles in 2012 and to evaluate the costs and benefits of PHEV work trucks, in particular the benefits of using vehicle mounted aerial equipment powered by the PHEV's battery.[82]

GM VOLT DEMONSTRATION

ComEd has partnered with EPRI, General Motors (GM) and several other utilities to demonstrate Cheverolet's Volt in two separate studies running over three years, beginning in 2010. First, ComEd deployed 10 GM Volts in its fleet to validate PEV performance in a commercial fleet application and to help educate consumers on PEVs and charging. Second, ComEd will deploy one additional Volt to demonstrate the ability to manage vehicle charging using on-board original equipment manufacturer (OEM) smart charging technology.

ICC INITIATIVE ON PLUG-IN ELECTRIC VEHICLES

In 2010, the ICC launched its Initiative on Plug-In Electric Vehicles to create a statewide forum to determine the impact on the State's electric grid of the initial deployment of PEVs, determine potential regulatory considerations, establish consistent statewide policies for managing PEV infrastructure, generate accelerated

A ComEd Green Fleet Chevrolet Volt

interest by auto manufacturers for introduction of PEVs into the Illinois market, and craft consumer education and outreach programs. ComEd and the other Illinois electric utilities submitted initial assessments of these issues to

[82] *Id.*, p.14.

the Initiative in December, 2010. Since then, the ICC has held public meetings and stakeholder working groups to further understand and address policy issues related to consumer adoption of PEVs.

GRID IMPACTS OF PEV CHARGING

The majority of PEV charging is expected to take place at home. Currently, ComEd provides two options for charging EVs at home:

1. Level 1 charging requires access to a standard, grounded, three-prong 120-volt outlet with a ground fault circuit interrupter. It has an electrical load of 15 to 20 amps, or about the same as a large microwave oven. Most PHEVs can be fully charged using a Level 1 charging station in eight to ten hours. Because of their larger batter size fully battery-powered EVs can take 12 to 24 hours to charge at Level 1.
2. *L*evel 2 charging requires installation by a licensed electrician of a 240-volt charging station. A Level 2 charging load is similar to what is needed to operate an electrical stove or central air conditioning system. Level 2 charging typically will charge an EV in about half the time of Level 1 charging. However, Level 2 charging may require upgrading a home's electrical service. ComEd's analysis shows that the use of Level 2 charging can pose a potential risk to local distribution equipment if even a small number of charging stations are located in close proximity. The company anticipates that early PEV adoption is likely to be geographically clustered in certain areas, similar to the patterns seen in early adoption of hybrid vehicles. In such a situation, multiple PEVs charging concurrently at Level 2 can quickly overload local distribution equipment (such as service transformers) if not managed properly.

Since the PEV owner is the cause any additional service upgrades, he or she would also incur the costs, including installation of any additional meters. However, planned smart grid technology, with its two-way communication coupled with time-variable rates may help provide ComEd with real-time information about loading on the distribution system and notify ComEd when the load on individual system components reaches levels that require attention. This automatic notification facilitates load balancing and ensures reliability on a system-wide level. Thus, the costs of identified upgrades would be socialized across the entire rate base.[83]

[83] *Id.*, p.54

ELECTRIC VEHICLE TARIFF

Section 1305 of the Energy Independence and Security Act of 2007 directs the National Institute of Standards and Technology ("NIST") to establish protocols and standards to increase the flexibility and use of the smart grid. Among several priority action plans NIST has defined is development of data standards to enable charging of PEVs. NIST standards will cover charging at home or away from home under special rate schedules, discharging of PEV energy storage for demand response purposes, and administration and monitoring.[84]

In considering whether ComEd , which operates as an integrated distribution company, may choose or be required to offer electric service for PEV charging , Illinois' Public Utilities Act (PUA) states that, "the Commission shall not require an electric utility to offer any tariffed service other than the services required by [the Act], and shall not require an electric utility to offer any competitive service."[85] Nevertheless, certain provisions of the PUA and ComEd's own rules suggest that the utility may amend its current offerings to include a tariff for PEV charging. For instance, the PUA expressly provides that, "nothing in this subsection shall be construed as limiting an electric utility's right to propose, or the Commission's power to approve, allow or order modifications in the rates, terms and conditions for such services pursuant to [the Act]."

However, should ComEd choose to offer a PEV charging tariff, one hurdle it faces is that Illinois' rules for integrated distribution companies do not permit electric utilities to "promote, advertise or market with regard to the offering or provision of any retail electric supply service."[86] Thus, ComEd's ability to promote, advertise or market a pricing structure for PEV charging services may be limited unless the ICC grants it a waiver under the PUA. This concern is hardly academic. While PEV charging stations will be outfitted with technology that uses real-time pricing to automatically detect the cheapest times to charge, the technology is useless unless consumers sign up for it. But preliminary data suggests that marketing pricing options may be critical. Most ComEd residential customers, for example, continue to pay flat rates for electricity and may not know that real-time pricing even exists.[87]

---

[84] *Id.*, p.41

[85] *Id.*, p.42

[86] *Id.*, p.43

[87] Wernau, Julie (2011). "Electricity prices could be impacted by when electric vehicles charge up," *Chicago Tribune,* March 10.

STAKEHOLDER ENGAGEMENT

ComEd has leveraged its relationships with several key stakeholders and business partners, including the Chicago Area Clean Cities coalition, to educate consumers about its electric vehicle strategy. In fact, ComEd's Manager of EV and Technology serves on the coalition's board, which holds seminars every year to encourage companies to use clean fuels and vehicle technology, including hybrid and plug-in electric vehicles. The company also launched a Green Vehicle webpage to further educate the public on ComEd's efforts related to PHEVs. In 2009, ComEd joined the City of Chicago's Climate Task Force aimed at reducing transportation-related greenhouse gas emissions through improved transportation options, public transit, green fleets, fuels, and freight.[88]

CHALLENGES

In order for many PEV drivers to charge their vehicles more quickly, they will need to use Level 2 or DC Fast Charging stations. However, who may provide and install these charging stations raises a legal issue concerning whether or not providing PEV charging services is part of ComEd's service obligations under Illinois's Public Utilities Act (PUA). Under PUA, ComEd must continue to offer each tariffed service that it offered on the effective date of the Electric Service Customer Choice and Rate Relief Act of 1997, which restructured the State's electricity market. The law also requires ComEd to offer electricity delivery services and real-time pricing as a tariffed service. The ICC cannot, however, require ComEd to offer any other service.[89]

Because distribution and installment of PEV charging stations is not part of any existing ComEd tariffed service, the issue becomes whether or not deployment of PEV charging infrastructure is considered part of delivery services. The PUA defines delivery services generally as those "necessary for the transmission and distribution systems to function so that retail customers . . . can receive electric power and energy . . ." Because customers will be capable of charging their PEVs through the standard 120v electrical outlet, it seems clear that additional PEV charging stations are not a "necessary" delivery service obligation required of ComEd.

---

[88] Edison Electric Institute (2009). *Industry-Wide Plug-In Electric Vehicle Market Readiness Initiatives*, August, p.9.

[89] Commonwealth Edison Company, *supra note* 32, p.25.

Instead, the sale and installation of PEV charging stations appear to fall within the PUA's definition of a competitive service, "related to, but not necessary for, the provision of electric power and energy or delivery service." In that case, it is unclear if the ICC would have regulatory authority over the deployment of PEV charging stations in ComEd's service territory.

Should the ICC choose to regulate PEV charging stations, therefore, it must address whether ComEd is required to offer the service, and if so, what rates the utility may charge for it. Resolution of these regulatory decisions has the potential to delay deployment of faster PEV charging infrastructure in the greater Chicago area. Ultimately, ComEd believes that the competitive model is "the most effective and efficient method to promote the development of the necessary charging infrastructure to support the deployment of electric vehicles. Attempts to regulate either the charging infrastructure or the pricing for charging services will likely cause market uncertainty, which could delay the development of this market."[90]

DISTRIBUTION AUTOMATION

Intelligent distribution automation constitutes a substantial part of the future of the smart grid. ComEd, along with many utilities, is exploring technology designed to monitor, measure and track key substation equipment performance and to move toward a more condition-based maintenance program that calls for equipment to be worked on only when needed and triggered by information provided by monitoring devices.[91] As part of its Smart Grid Innovation Corridor, ComEd embarked on three interconnected demonstration projects. First, the utility constructed its first truly intelligent substation to pilot a suite of advanced substation devices and software designed to significantly automate substation monitoring and analysis. ComEd chose a substation that encompasses Chicago's near western surburbs and some neighborhoods within the city.

[90] COMMONWEALTH EDISON CO., ILLIONOIS COMMERCE COMMISSION INITIATIVE ON PLUG-IN ELECTRIC VEHICLES: SUPPLEMENTAL COMMENTS 3 (2011) [hereinafter COMED SUPPLEMENTAL COMMENTS], *available at* http://www.icc.illinois.gov/Electricity/PEV.aspx.

[91] Davis, Kathleen (2011). "The Knowledge Foundation of a Good Substation," *POWERGRID International*, April 29. Available at: http//www.vision-systems.com/content/up/en/articles/print/volume-8/issue-1/product-focus/substation-management-maintenance/the-knowledge-foundation-of-a-good-substation.html

This intelligent substation was equipped with digital asset monitoring devices linked to microprocessor relays serving as substation data collection gateways. These relays then report to operations control rooms via digital SCADA control systems. Operations and maintenance personnel utilize online analysis tools to monitor substation assets and deploy maintenance resources when conditions warrant.[92]

An Automated Circuit Recloser

Second, ComEd installed a system of smart electricity delivery automation, sensors and controls to test their ability to provide real-time reporting of distribution status and outages. The demonstration also included automated control of relays and reclosers as well as field force management.[93] Not only was this project intended to demonstrate the viability of these smart grid components, it will also help validate the expansion of system-wide voltage regulation and selective conservation voltage reduction.

OBSERVATIONS AND CONCLUSIONS

ComEd has made remarkable efforts to achieve its Smart Grid Vision. The sheer scale of the Smart Grid Innovation Corridor project and ComEd's attempt to expand its Advanced Metering Infrastructure (AMI) system wide provides valuable insight into the challenges and opportunities presented when implementing smart grid innovations.

LESSONS IN SMART GRID PILOT STUDY METHODOLOGY

ComEd's experience with its pilot projects raises several issues likely faced by other utilities seeking to experiment with smart grid technologies.

---

[92] Pramaggiorre, *supra note* 7, slide 21.

[93] Pramaggiorre, *supra note* 7, slide 18.

VOLUNTARY PARTICIPATION

ComEd's experience raises the possibility that voluntary participation in smart grid pilot projects may encourage self-selection by those customers most interested in responding to smart grid price signals and potential environmental benefits. EPRI's evaluation of ComEd's CAP program, for example, found that a small number of self-selected project participants accounted for a large proportion of observed load reductions. Not only does this self-selection skew pilot studies, it complicates efforts to extrapolate the results of pilot projects to widespread adoption of smart grid technologies. Since those customers whose behavior is most dramatically affected by smart grid technologies may self-select for voluntary participation in pilot programs, they represent 'low-hanging fruit' whose load shifting behavior may not be representative of larger, random samples of utility customers.

OPT-OUT VERSUS OPT-IN

ComEd's experience allowing randomly selected customers to opt-out rather than opt-in to smart grid pilot programs highlights an important problem utilities may face when attempting to avoid the self-selection problem. ComEd's own focus group data revealed that customers resented opt-out procedures that required program participants to affirmatively act to avoid inclusion in the program. The customer backlash that may result from imposition of an opt-out scheme risks stakeholder support for expanding smart grid programs after the initial pilot and may outweigh the value of an opt-out provision in expanding the sample of pilot participants. EPRI, for example, concluded that even with its opt-out provision, the sample size of ComEd's CAP pilot did not provide sufficient data upon which it could accurately project how system-wide adoption of AMI and dynamic pricing schemes might affect customer behavior. However, as the program progressed, ComEd found opt-out rates to be quite low and is not considering an opt-out provision when pursuing full system-wide AMI deployment.

HOLD HARMLESS VARIABLE

Similarly, ComEd's 'hold harmless variable' may induce greater program participation while sacrificing accurate examinations of customer reactions to more immediate price signals. It is unclear, for example, how program participants respond to price signals given foreknowledge that they may never have to pay higher prices.

It is equally unclear that participant behavior under a 'hold harmless variable' can be extrapolated to valid conclusions about customer behavior without one.[94]

LOAD SHIFTING VERSUS REDUCED CONSUMPTION

After EPRI issued its initial assessment on the effects on electricity consumption of ComEd's CAP pilot, some media outlets and stakeholders pounced on the information to report that the AMI program largely failed to achieve its objectives. This conclusion may be attributed to a fundamental confusion about load shifting versus reduced net consumption. While it is true that EPRI's initial assessment found little evidence that in-home displays had a statistically significant effect on consumer usage, it did find that customers served under the most dynamic pricing options exhibited statistically significant responses. EPRI found, for example, that pilot participants substantially decreased energy consumption during peak periods, if largely by shifting consumption to off-peak.

ComEd's business, customer, and environmental cases for smart grid implementation rest largely on benefits achieved without substantial changes in net energy consumption. Ideally, service area-wide AMI will reduce ComEd's net electricity purchases as a result of increased operational efficiency and a reduction in unbilled, unaccounted for, and stolen electricity. What efficiency benefits ComEd does intend, accrue mostly through customers shifting their load to off-peak periods rather than reducing their net energy consumption. Unfortunately, a simplistic understanding of electricity markets and utility operating procedures may obscure public perception of this important distinction.

ComEd's experience highlights the delicate balance between marketing smart grid programs as utility efficiencies that will eventually be passed through as cost savings to consumers and the direct benefits of decreased customer consumption. Broad public engagement with messages that raise unrealistic expectations will backfire. Marketing the true benefits of smart grid requires a direct, intensive, and sustained public conversation that involves individuals and organizations with credibility that the utility may lack with certain constituencies.

[94] We assume that ComEd does not intend to continue the 'hold harmless' variable with its system-wide AMI roll-out.

INEQUITABLE BURDEN OF TIME-VARIANT RATES

Several stakeholders were concerned that ComEd's time-variant rates risked an overreaction by consumers responding to peak period rate increases. These stakeholders worried that increased peak period rates might disproportionately be borne by low-income customers who, for reasons of health or safety, may be unable to shift consumption to off-peak periods. Should involuntary dynamic pricing schemes be adopted system-wide, the most vulnerable customers may end up facing the highest prices. But voluntary programs might risk diminishing the business case for AMI by reducing the cross-subsidization of peak period usage.

ComEd's experience with its AMI pilot program, however, suggests that this concern may be unfounded. Internal data from ComEd's AMI pilot demonstrates that a higher percentage of low-income customers saved money under dynamic rates than any other income group. In fact, ComEd's data suggests that low energy users (often lower income customers) generally subsidize higher energy users under a flat pricing system. Because the number of customers that actually responded to AMI price signals was so low, however, ComEd's experience suggests that there is a case to be made that lower income customers might be relative winners under an AMI program with a properly designed dynamic rate.

LESSONS IN SYSTEM-WIDE SMART GRID IMPLEMENTATION

ComEd's experience demonstrates that clearly articulated state smart grid policies are essential to achieving the full benefits of smart grid investments. When regulated utilities initiatives are ahead of legislative and regulatory policy, their efforts are likely to get tangled in a morass of unclear laws and regulatory goals that delay progress, limit benefits, and ultimately cost ratepayers. After working to integrate smart grid technologies for well over 3 years, ComEd continues to face several hurdles involving how to maneuver around existing state laws and regulations that were adopted long before a smarter grid became a technological reality. These hurdles include policies that prevent remote disconnection of electrical service, provide for the competitive provision of electric service, and limit rate recovery mechanisms that ensure that smart grid investments reap their full economic and environmental benefits.

REGULATIONS PREVENTING REMOTE DISCONNECTION

ComEd's business and environmental cases for smart grid deployment rest substantially on its ability to capitalize on remote connection and disconnection of electrical service. ComEd's projection of reduced electricity

purchases, for example, assumes its ability to recover unbilled and unaccounted for electricity through remote disconnection. Additionally, ComEd's projection of reduced carbon emissions rests largely on reduced vehicle miles from suspension of site visits.

However, pending a re-write, the ICC has clearly interpreted Illinois Administrative Code Part 280 to require a site-visit, at least before disconnection of residential service. Presumably, this interpretation originally was motivated to avoid potential inequitable impacts of suspended service on those who, for economic, health, or safety reasons, may be incapable of shifting or reducing load. Indeed, in 2012 a Health Impact Assessment written by the National Center for Medical Legal Partnership, the Citizens Utility Board and leading energy consultants recommended that the ICC disallow remote disconnection because Illinois' most vulnerable populations – the sick, the poor, and the elderly – may be unlikely to receive the benefits of the smart grid reforms they are paying for.[95]

In part to address this issue, the final smart grid legislation passed over Governor Quinn's veto included a provision that would require peak-time rebates be offered to all customers with meters. Since the value of the rebate would be based on the market value of capacity, it should provide lower-income customers with the ability to shift load under a dynamic pricing scheme. It does little, however, to address the problem of those whose load shifting is restricted by health and safety concerns. However, this problem may be one more of perceiving an opportunity lost than the reality of a cost incurred. While some customers, for health or safety reasons may be incapable of taking advantage of time-based pricing, for example, they would remain under their current rate structure and, presumably, be no worse off than before AMI deployment. Additionally, the Citizens Utility Board has recommended ComEd survey vulnerable populations in its service territory and design the smart grid to automatically notify a family member when their elderly or ill relative has lost power.[96]

[95] Wernau, J. (2012). "For many, ComEd's smart grid needs an explanation," *Chicago Tribune*, April 24. Several states, including New York, Ohio and Maryland, have mandated that utilities visit a home before disconnection.

[96] *Id.*

RETAIL CHOICE AND RESTRICTIONS IN ADVERTISING NEW RATE STRUCTURES

Since the introduction of retail choice for electric service, Illinois' regulated utilities have operated with restrictions on advertising rate structures and specific services. Arguably, the PUA prohibits ComEd from advertising voluntary smart grid electricity supply rate programs. Nevertheless, ComEd sought and achieved a special waiver allowing it to market its CAP pilot program and may need either an additional waiver or an amendment to the PUA in order to market any optional electricity supply rates as it seeks full AMI deployment. As AMI is more fully deployed there is uncertainty in how successful dynamic pricing programs will be achieved with both low levels of customers selecting competitive retail suppliers and restrictions on ComEd's ability to develop and market such pricing alternatives. Perhaps, the new dynamic pricing options available when smart meters are deployed will be the catalyst that ultimately fuels retail choice in Illinois.

REQUIREMENTS TO PROVIDE EV CHARGING SERVICES

ComEd, like all regulated utilities in Illinois, are subject to provisions of the Public Utilities Act that require it to supply all necessary electrical services. There is some uncertainty whether the ICC should determine that PEV charging stations are a "necessary" provision of electrical service and whether ComEd would be required to supply these services under the PUA. ComEd argues that deploying charging infrastructure is not a utility obligation, and would instead be considered a "competitive service" under the PUA. Uncertainty surrounding who should provide this service could slow adoption of electric vehicles.

LIMITATIONS ON COST RECOVERY

ComEd's struggle to clarify cost recovery policy for its smart grid pilot programs have been dramatic and public, significantly impacting the perception of both the company and the benefits of smart grid investments with both the Illinois news media and the public it serves. The utility has faced significant challenges in reaching a balanced cost recovery approach that ComEd, state regulators, the legislature, and the courts could all accept. This public controversy has clearly reduced the momentum of ComEd's smart grid technology leadership. Following the passage of the EIMA it was anticipated that the controversy regarding the investment in and recovery of AMI costs would be lessened, unfortunately the experience to date appears to be the opposite. ComEd's experience suggests that something as far-ranging in impact as smart grid deployment requires a solid policy foundation based on clear policy leadership from state legislators and regulators. Legislation that

establishes a basic policy for recovery of smart gird investments may avoid sparking substantial public opposition and protracted litigation. When cost recovery is uncertain and subject to expensive regulatory lag, utilities may observe ComEd's experience and decide against making the types of investments required to achieve the full benefits of the smart grid. In the case of the State of Illinois, there are meaningful impacts to customers, the local economy, and the business and physical environment to continued dispute and litigation over the recovery of investments that parties seem to agree are publicly beneficial. In ComEd's view, the result has been the delay in more than $2.3 billion in customer savings and 2,000 new jobs.

The Electric Power Research Institute has estimated that, nationally, fully implementing a smart electric grid will cost between $1.3 and $2.0 trillion, with benefits likely exceeding costs by a factor of three or more.[97] This represents a significant amount of additional investment to be made in future years and will involve ongoing negotiation with regulators and other parties.

Research from Pacific Northwest National Laboratory has estimated that with full implementation of a smart electric grid by 2030 U.S. energy consumption and carbon emissions could be reduced by 12 percent.[98]. Yet, as noted previously, it will take time to develop and offer additional technologies and rates to customers. In some areas, however, the smart grid will likely spur greater electricity use, such as smart charging of electric vehicles, in order to achieve efficiencies in total energy use across the economy.

Continued investment in automation of the utility distribution system will offer future opportunities for improving reliability and optimizing energy use. In order for electric vehicles to reach the levels of consumer adoption included in PNNL's analysis, there will need to be significant new policies at all levels of government and the build-out of new infrastructure. Furthermore, as renewable energy reaches higher levels of development across the utility service territory, greater investment in smart grid technologies will be needed in order to reliably and cost-effectively manage these resources. In Illinois these longer term benefits will be delayed while controversy continues at the state policy level on how ComEd should recover the costs of the installation of the customer meters and related investments.

---

[97] Elec. Power Research Inst., Estimating the Costs and Benefits of the Smart Grid 1–4 (2011).

[98] Pacific Northwest Nat'l Lab., The Smart Grid: An Estimation of the Energy and CO2 Benefits 3.3 (2010).

www.vermontlawschool.edu/smartgird

About the authors:

Chris Cooper, JD candidate 2013, is a Senior Research Fellow, member of the Energy Security and Justice Team and the lead researcher for the ComEd case study. He can be reached at: ccooper@vermontlaw.edu.

Kevin B. Jones, PhD, leads the Smart Grid Project team and is Associate Director and Senior Fellow for Energy Technology and Policy at the Institute for Energy and the Environment. He can be reached at: kbjones@vermontlaw.edu.

For further information contact:

Institute for Energy and the Environment
Vermont Law School
PO Box 96
South Royalton, VT 05068
802-831-1054
www.vermontal.edu/energy