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Within the last decade, several states, including Illinois, began considering or adopting laws and regulations to enable utility investment in smart grid technologies. The Electricity Infrastructure Modernization Act of 2011 (EIMA) ushered in $3.2 billion in smart grid investments for the Illinois utilities, Commonwealth Edison (ComEd) and Ameren Illinois (Ameren). EIMA produced the largest electric infrastructure investment Illinois utilities will have made in a generation. The law was the product of negotiations and collaboration between several stakeholders, including the two utilities and consumer advocates. Ultimately, EIMA mandated performance

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rates, including express metrics for success, designed to ensure that the investments deliver consumer benefits within a 10-year time frame.

In 2012, advocates including the Citizen's Utility Board (CUB) and the Environmental Defense Fund (EDF) petitioned the Illinois Commerce Commission (ICC) to require that the Illinois utilities be required to report additional metrics. The ICC agreed and encouraged the utilities to work with EDF, CUB and other stakeholders to develop additional measures to describe how smart grid will bring value to Illinois.[1] This effort, which took place throughout 2013, included the development of environmental metrics to measure how smart grid can reduce greenhouse gas emissions (GHG) and electrical line losses. Environmental metrics, while on the vanguard because they are challenging to determine, are key to the promise of smart grid investment and, according to the ICC, go to the very heart of EIMA.[2]

The development of new standards and measures to provide an adaptive and evidenced-based approach to smart grid investment has become increasingly important. The conversation about the need for "new utility business models" includes but is not limited to tools like decoupling and is maturing among regulators and policy makers. This is in part due to the recognition that the US power infrastructure is both aging and polluting, and in dire need of modernization and reinvestment. New and evolving smart grid technology can make the grid more efficient, resilient, secure, and able to facilitate carbon reductions.

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In addition, the multi-billion dollar need to rebuild utility infrastructure in states like New York and New Jersey after Hurricane Sandy in 2012 brought smart grid and climate change into clearer focus. This article examines the development of environmental metrics in Illinois and how the legal framework for smart grid deployment in Illinois and other jurisdictions has impacted its implementation, including implications for post-Sandy resiliency investments.

I. Background

The emergence of smart grid in states like Illinois, California, Maryland and others has in part been in response to federal incentives and mandates. The Energy Independence and Security Act of 2007 (EISA) and the American Recovery and Reinvestment Act of 2009 (ARRA) both required states to consider smart grid technology and provided federal funding in support of grid modernization projects. These have included projects that

[1] *See,* ICC, Order, Docket 13-0285, ICC on its Own Motion v. Commonwealth Edison, Investigation Regarding Progress in Implementing the Advanced Metering Infrastructure Deployment Plan, June 26, 2013 (ICC Metrics Order).

[2] *Id.* At 11.

support advanced metering infrastructure, distribution automation, and demand response programs.

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The term "smart grid" is used in so many contexts that it can be difficult to pin down. The federal legal framework for smart grid as set out by EISA and ARRA, for example, defines the term as a collection of attributes intended to improve grid performance, increase consumer value, increase reliability and security, integrate distributed generation, facilitate more effective demand response and energy efficiency, and, through smart meters (collectively known as advance metering infrastructure), empower consumers with energy data and control options.

The smart grid vision is also meant to empower "disruptive" (or paradigm shifting) technologies and encourage wider participation in electricity markets by entities other than utilities on both sides of the meter. These liberalized markets are expected to increase innovation, private sector investment, and create jobs.

The attributes described above exist on a continuum; some of them are attainable in the near term, while others will be achieved later. In the face of this grand vision, however, utilities are tasked with securing regulatory approval for smart grid investments and implementing them now.

Challenges, however, stand in the way of the fully realized smart grid vision. First, the investments are large and may face skepticism from lawmakers, regulators and others concerned about upward bill pressures. Smart grid is also a significant operational endeavor that should be carried out prudently and efficiently.

While some aspects of the smart grid vision present clear cost-saving opportunities for incumbent utilities, others, such as more effective energy efficiency, demand response and peak load shifting by end users, may not immediately be in the utility's financial interest. In the absence of mechanisms like decoupling, deep end user efficiency efforts may reduce utility revenues and hurt profits.

Smart grid does, however, offers clear value that can benefit both the utility and its customers, including capturing O&M efficiencies and optimizing grid operation. Peak shaving, grid optimization, renewable penetration and end user efficiencies also have the potential to lighten energy bills and curb GHG emissions and other pollutants that threaten air quality.

In light of these competing interests, a growing consensus has emerged among academics, policymakers, and even some utilities that the traditional regulatory compact and business models should be refocused to incent the desired behavior and performance by utilities. At the same time, and of more immediate importance and urgency, multi-billion dollar smart grid investments should look to maximize their value and capture the full range of benefits or "characteristics" as articulated by ARRA and EISA.

II. Metrics and Benchmarks Create Accountability

An essential step towards creating accountability for smart grid investments, which typically roll out over a three- to ten-year timeline, is the definition and monitoring of performance metrics. These metrics – essentially goals for specific utility performance elements, which should be transparent to all stakeholders – form a quantitative and qualitative foundation by which to evaluate how well utilities achieve the projected benefits of smart grid investments. They are the basis for rewarding or penalizing a utility for its performance, including the execution and optimization of smart grid deployments.

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Consumers and their advocates should be able to determine that utility smart grid investments are creating customer value – through improved access to actionable usage data through smart meters, smart thermostats and home energy management systems; enabling a cleaner environment and increased reliability – and an overall improved customer experience. The smart grid also includes technology that can optimize grid operations, e.g., through deployment of synchrophasors, which allow system operators unparalleled information about conditions on transmission lines. Other market participants also should be able to benefit through new business opportunities – energy management services, provision of ancillary services, and other opportunities.

Environmental groups and consumer advocates want to see that grid modernization encourages the integration of clean and renewable energy, including energy efficiency and demand response, while shrinking environmental impacts of the electricity sector.

III. Metrics in Illinois

Illinois utilities have picked up the metrics challenge. Both ComEd and Ameren Illinois have begun deploying smart grid infrastructure, pursuant to EIMA, with plans to invest $3.2 billion in smart grid infrastructure, including AMI. EIMA prescribes metrics, or measureable progress towards specific policy or operational goals -- which we viewed as benchmarks – for the utilities to earn performance-based rates. Metrics required by EIMA focus on measures such as overall energy savings, utility-led efforts to conduct customer outreach, and enrollment in energy conservation rebate programs.

In April 2013, EDF and CUB reached agreement with ComEd and Ameren on 20 additional measures to track environmental and other customer benefits from their smart grid deployments. These measures resulted from EDF and CUB's advocacy before the ICC, which directed the utilities to work with EDF and CUB on their development. EDF and CUB then partnered with the utilities to develop and track progress along the path to achieving the goals of these measures, as required by EIMA.

The metrics reflect utility performance on issues ranging from achieving reductions in peak energy demand and facilitating increased customer adoption of renewable energy to progress in fostering customers' use of smart energy devices. In addition, through stakeholder workshops throughout 2013, ComEd and Ameren worked with EDF, CUB and others to refine ways to measure how smart grid technology can help reduce greenhouse gas emissions and electric line losses. These types of measures are challenging to attribute to program actions and to measure, yet they are integral to unlocking some environmental and economic benefits of smart grid technologies. The ICC has said that these environmental metrics go to the heart of EIMA.[3]

Utility metrics to date have commonly focused on general measures to gauge customer benefits, such as customer awareness, customer survey completions, and number of outreach events customers attend. Metrics like those adopted by the Illinois utilities go further; they will allow the utilities to track and report where customers are realizing the benefits of grid improvements, including the number of customers who can directly access their energy usage data and the time the utility takes to connect customers' renewable energy resources, like rooftop solar, to the grid.

Metrics that can measure greenhouse gas emissions and line loss have the potential to go even further. Smart grid investments should make the electric system cleaner and more efficient. Tracking the ability of the smart grid to curtail greenhouse gas emissions can provide vital feedback.

Greenhouse gas metrics, which ultimately should be customer-, industry-, and utility-facing, have the potential to, for example, provide customers with information about their own carbon footprint and signal possible value propositions to energy managers. They can also provide regulators with information on how utilities are performing with respect to state energy goals. It can be difficult to attribute GHG reductions to specific grid improvements, but doing so is worth the effort. Existing data points regarding emissions in any particular service territory lie with various entities. In Illinois, they include PJM (ComEd), MISO (Ameren), the US Environmental Protection Agency, state agencies and, of course, the utilities themselves. Techniques to measure GHG performance include measuring emission intensity at different times of day, and also comparing the performance of newly rolled out smart meters to that of traditional meters.

The Energy Information Administration estimates that annual electricity transmission and distribution line losses average about 7%

[3] ICC Metrics Order at 11.

of the total electricity transmitted in the US.[4] Smart grid presents a huge opportunity to reduce those losses, which would also reduce energy waste, pollution, and the marginal cost of electricity.

System operators, regulators and utilities use line loss calculations to try to optimize grid operations. Utilities also use line loss factors in order to determine the marginal cost of energy. Line losses may impact either the consumers' or the utility's bottom line. Reducing line loss and, thus, pollution, including GHGs, while optimizing grid operations, is an essential components of the smart grid promise.

But because smart grid investments are rolled out incrementally, the line loss reductions the smart grid investments create may occur in amounts that can be small and challenging to determine. For example, investments in more efficient power lines and increased use of volt/var technology (that increases the efficiency of energy transmission) can reduce line loss. Efficient distributed generation, which may lessen the distance electricity has to travel, can also reduce line loss. The improvements that can be measured at any particular location, however, may be very small. Unless calculated in aggregate, they will not appear to make a substantial difference. They should, however, be measured in aggregate, where practicable, in order to develop some idea of the new investments' performance and potential.

[4] See the EIA web site at http://www.eia.gov/tools/faqs/faq.cfm?id=105&t=3 (last viewed on March 30, 2014).

In addition, new smart meters should be capable of measuring lighter loads (and, by inference, associated GHG emission rates) more precisely than older meters. As the new meters are deployed, these attributes can be examined and their measurements compared to those of the old meters.

The need to measure how line loss can be reduced on both the transmission and distribution systems is urgent. The work that EDF and CUB are doing to develop reportable metrics, per the ICC's direction, are first steps that can create accountability while acknowledging that ongoing efforts will be needed to perfect and use the measures.

Ameren and ComEd should be applauded for their efforts to tackle these problems with EDF, CUB and others in order to deliver important smart grid benefits to Illinois customers. As discussed below, however, regulatory requirements can provide obstacles to advancement in these types of tracking methodologies.

IV. Specificity, Including Accountability and Performance Metrics, Should be Included in State Enabling Legislation and in Regulatory Processes

The EIMA metrics in Illinois emphasize the importance of "carrots and sticks" embedded in the enabling legislation or otherwise imposed by regulators. EIMA provides for formula rates that would (1) allow the "utility to recover its actual costs" and (2) "include a return on equity (ROE) equal to the average yields of 30-year U.S. Treasury bonds for the applicable year plus 6%." Formula rates are a carrot because they allow for a utility to earn a predictable and attractive ROE.

In order to receive formula rates, however, EIMA requires the utilities to make specific investments over a ten-year time frame. The utilities must also embrace performance metrics to ensure that the value of the investments improve over time. Specifically, the utilities were required to develop and file metrics designed to make performance improvements over 10 years on items including: (1) System Average Interruption Frequency Index (SAIFI) indices, (2) unaccounted for energy, (3) uncollectable expenses and (4) opportunities for women- and minority-owned businesses. EIMA provides that failure to perform on these metrics will result in penalties to be reflected in an adjustment in ROE.[5]

Post-storm measures – building a more flexible, self-healing grid to increase reliability and performance – are subsumed in the larger 'smart grid' vision described by EISA and ARRA.

In addition, EIMA required utilities to: (1) fund an innovation trust (now the Energy Foundry,[6] (2) set aside funds for smart customer engagement and education (including funds for low-income customers) and (3) provide "test beds" to enable new technologies to be evaluated at grid scale. By prescribing specific policy and program performance goals, EIMA built a measure of accountability into Illinois utilities' smart grid investments. A diverse group of stakeholders, including advocates, the ICC and the utilities themselves were then able to leverage EIMA's guidance to develop even broader measures to evaluate smart grid investments.

California's smart grid legislation, AB 17, replicates the "characteristics" approach of EISA and ARRA without mandating specific performance incentives or metrics. Instead, the California Public Utility Commission (CPUC) and other stakeholders are required to monitor the impact of deployments with regard to a list of policies and initiatives. The CPUC and stakeholders did develop a set of 19 consensus metrics to track, including ones related to the System Average Interruption Duration Index (SAIDI) and SAIFI, demand response, and storage enabled by the grid and electric vehicles.[7] Attempts to develop goals

[5] The penalties are capped at no more than a total of 30 basis points in each of the first 3 years, of no more than a total of 34 basis points in each of the 3 years thereafter, and of no more than a total of 38 basis points in each of the 4 years thereafter. It should be noted that critics of this cap comment that it does not put enough utility "skin in the game" to incent robust performance.

[6] The Energy Foundry, a private impact venture capital fund designed to promote energy technology entrepreneurship, was initially funded by ComEd and Ameren per EIMA. *See* http://www.energyfoundry.com.

[7] See CPUC, R08-12-009, Order Instituting Rulemaking to Consider Smart Grid Technologies Pursuant to Federal Legislation and on the Commission's own Motion to Actively Guide Policy in California's Development of a Smart

and metrics on environmental issues in California through CPUC-guided workshops, however, have stalled. As one result, California, where there is near universal smart grid deployment, does not currently have metrics in place that require utilities to evaluate how smart grid reduces GHGs as related to other state environmental or policy goals.

Critics of mandates like those included in EIMA say that the required metrics do not impact enough of a utility's earnings to have a true incenting effect. This argument has merit. Smart grid enabling statutes, often the result of political compromise among stakeholders, should strike a balance between accountability and flexibility in deployment. In any case, regulators should also seek to implement evidenced-based approaches, such as metrics and benchmarking, to provide effective oversight over the largest electric and gas infrastructure investments being made in a generation.

V. Metrics in the Resiliency Context

The need to develop new metrics to evaluate grid performance in the face of extreme weather events has come into focus on the East Coast. Devastating storms, including Superstorm Sandy that struck the region in the fall of 2012, have resulted in multi-billion dollar utility proposals to both harden and "smarten" grid infrastructure to better withstand such events.

The focus of these post-storm measures – building a more flexible, self-healing grid to increase reliability, security and performance – are also subsumed in the larger "smart grid" vision described by EISA and ARRA. Utilities have announced multi-billion dollar spending plans to make immediate investments, over 1-5 years, designed to improve inadequacies that were laid bare during Sandy and other extreme weather events. Some of these investments involve switching systems to create contingent grid configurations that can prevent grid-wide disruptions by isolating problem areas; also, to use assets that remain operational to help areas experiencing outages by providing black start capacity. These are positive investments that have the potential to reinforce resiliency.

The urgency of "getting something done" quickly to respond to extreme weather events, however, could result in less resilience in the long run. Creating a truly resilient grid, particularly in coastal areas, involves multiple factors and levels of complexity. These include, for example, the need to assess the effects of more extreme weather on equipment and of sea level rise on build levels and locations. Planning for greater resilience would also, ideally, incorporate new building codes and leave open the possibility of new technologies to add resilience.

Grid System, Decision 12-04-025, Apr. 19, 2012, available at: http://docs.cpuc.ca.gov/PublishedDocs/WORD_PDF/FINAL_DECISION/164808.PDF.

The macro-level planning needed to redesign a grid that can best adapt to and mitigate the effects of increasingly powerful storms is a large and complex task. A rush to adopt a quick solution could lead policy makers to embrace a false value proposition. A 2013 DOE report notes that, absent planning to continuously adapt to increasingly strong weather events, weather is likely to outpace utility efforts to harden the grid.[8]

Like AMI deployments, grid hardening should include a vision for success and value added for customers, starting with goals and then specific metrics to create accountability.

To support continued AMI deployment by utilities and progress toward a broader, cleaner, more resilient and more democratized industry model, it is necessary to develop appropriate milestones for AMI deployment and smart "grid hardening." In the first instance, this means that, like AMI deployments, "hardening" should include a vision for success and value added for customers. This vision can start by developing goals and then specific metrics to create accountability.

It is important to note that evaluating metrics to track resiliency spending opens a new dimension of consideration. Utilities must begin to examine their risk methodologies for investing in grid infrastructure. Consider that some models for planning any particular grid system's needs are "deterministic," or based on known variables. Inputs could include, for example, the number of parts needed for a particular project, the useful life of a part or plant, for labor and for other costs. Within this model conclusions can be made based on current conditions and past behavior of these variables. Other models are "probabilistic" and may include random elements and distributions of probability. In other words, the start may be known but the outcome may take different paths, with some being more probable than others. Currency exchange rates, for example, are based on probabilistic calculations.

As detailed in the DOE Report,[9] climate change is expected to introduce increased risk of severe weather events, so there is a need to understand probabilities and prioritize potential response actions. However, as explained by DOE, "the economic implications of energy sector vulnerabilities to climate change and extreme weather have not yet been adequately characterized. There is no commonly accepted methodology, no set of indicators to compare and prioritize risks and

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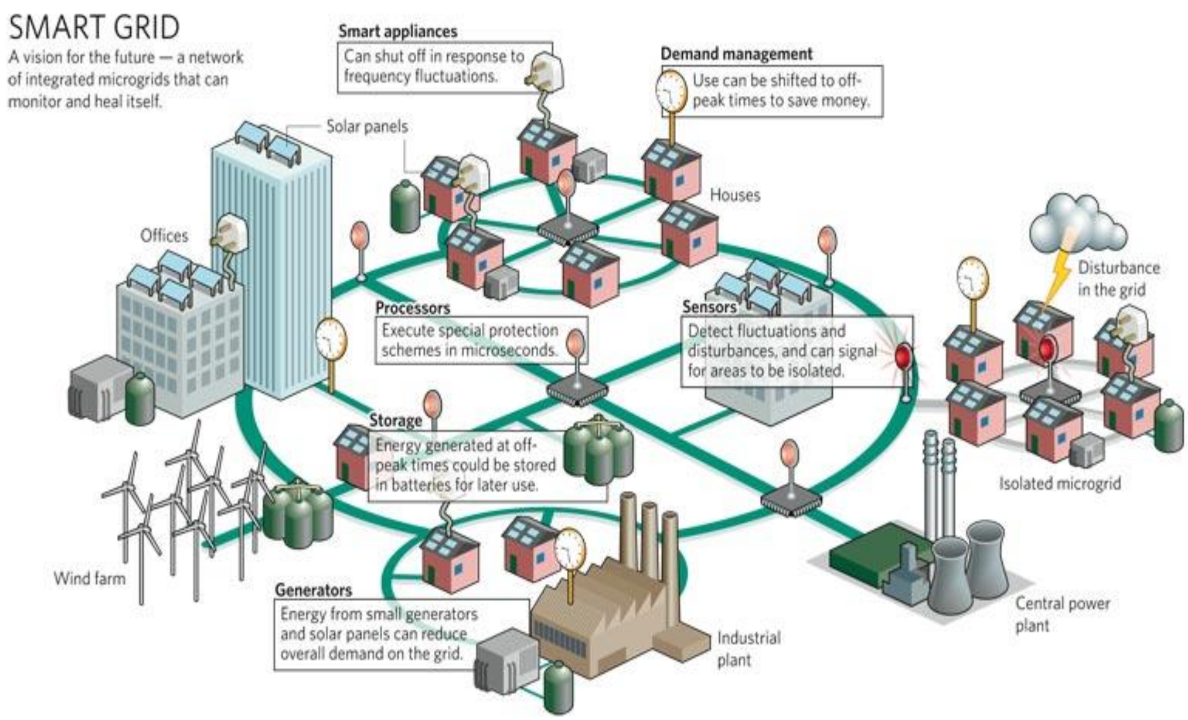
[8] DOE, US Energy Sector Vulnerabilities to Climate Change and Extreme Weather, July, 2013 ("DOE Report"), at 43, stating that "the magnitude of the challenge posed by climate change on an aging and already stressed U.S. energy system could outpace current adaptation efforts, unless a more comprehensive and accelerated approach is adopted, available at: http://energy.gov/sites/prod/files/2013/07/f2/20130710-Energy-Sector-Vulnerabilities-Report.pdf.

[9] *Id.*

adaptation measures across the energy sector."[10] It is, however, important to work toward new methodologies while continuing to study and adapt to current conditions. One example is the difficulty of insuring against major storms.

In a novel and creative, if controversial, example, in August 2013 the New York Metropolitan Transit Authority bought a three-year, $200 million catastrophe bond (cat bond) to avoid storm surge losses (which totaled $4.7 billion after Hurricane Sandy).

August 5, 2016, the bond buyers lose their investment. If surge levels are not met, investors receive their initial investment, plus 13.5%. Cat bonds are risky, exotic instruments which some may find morally repugnant. They are not likely to be recommended for widespread use in the electric sector. Still, they represent new ways to dealing with risk and resiliency in the context of multi-billion dollar grid hardening plans, like those at play in New York and New Jersey.



Bond payment triggers are based on storm surge data received by tidal gauges installed by the United States Geological Survey and the National Oceanic and Atmospheric Administration. Under the MTA bond, if certain levels of storm surge are met before

New or adjusted reliability metrics are needed to assess how effective utilities' hardening investments perform during extreme weather events. Traditional "blue sky" utility metrics like CAIDI and SAIFI usually focus on the duration and frequency of outages but do not go far enough to evaluate grid resilience and its related utility investment. This is because

10 *Id.*

they typically focus on normal operating conditions and undervalue the impact of large-scale, if improbable, weather events. They also price the value of lost load at a flat rate when, in reality, the value of lost load tends to soar the longer it is lost. Also, events such as "Acts of God" typically are omitted from CAIDI and SAIFI as being beyond utility control. One approach to consider would require a larger effort in determining the true cost and value of service to customers under a cost-benefit analysis.

Novel approaches to cost/benefit studies, however, face increased scrutiny as they are introduced in high stakes multi-billion dollar plans. As reported by NARUC, the PSE&G study introduced in its post Sandy hardening docket is an example of a study that attempts to take a broader look at the benefits of resiliency. The newness of the approach, however, paired with the vast scope of the utility's multi-billion dollar proposal, created some cynicism among the environmental and consumer advocacy communities.

Accountability in the resiliency context is even more urgent given the short time tables that some commissions – New York and New Jersey, for example – have adopted for approval of their utilities' hardening plans. These utilities should, at the very least, begin to track the progress of their deployments,' installation and performance.

VI. A Look Forward Toward Performance Based Regulation

While US jurisdictions are making headway, some regulators in Europe, particularly Ofgem in the UK, have taken a much more proactive stance towards performance-based regulation. Ofgem is implementing a model called "Revenue set to deliver strong Incentives, Innovation and Output" or RIIO. RIIO is a price-control framework that focuses on outputs, with network companies being required to deliver service in response to commercial incentives. Utility success is rewarded with the potential to earn a higher rate of return, while failure can result in increased scrutiny or penalties. RIIO is an explicit recognition by the UK that to meet investment needs and reduce carbon emissions, the regulatory framework needed to change. The idea of performance-based rates has picked up steam in the US as well.

With all the talk of new business models to align utility incentives in ways that – arguably appropriately – allocate more risk to utilities, many utilities will want to see more than a theoretical upside. Consumers and other stakeholders, however, also want to see that a smarter, more resilient grid brings value, including environmental benefits.

There is an explicit and immediate need for accountability in achieving the promise of smart grid investment. Benchmarking metrics can be a step one in this process. They can also build a bridge, based on accountability, to transition to performance-based incentive regulation. Incentive regulation, in turn, may be a pathway to new utility business models that could delivers a value proposition for customers and for utility investors. □