Smart grid growing pains

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Challenges emerge as smart grids shift from planning to full-deployment mode

Utilities are committing to modernizing the nation's power grid at an accelerated pace. Advanced metering infrastructure (AMI) and smart grid pilot and demonstration programs are under way in at least 33 states, and utilities are installing thousands of smart—or two-way communication—meters a day.[1] Early returns have been promising in some spots, yet utilities have also experienced some bumps. The sheer size and complexity of digitizing power grids should not be underestimated. It involves integrating renewable energy, enabling distributed energy and planning infrastructure around electric vehicles, to name a few of the moving parts. The challenges utilities are encountering, if not properly managed, could potentially hobble or derail ambitious, multiyear smart infrastructure build-outs, some estimated at hundreds of millions of dollars.

Smart grid spending Some of these emerging challenges are related to investments and project costs. Evidence of the pressure can be seen in the rise in rate case filings, as the utilities' appeals to publicly governed rate-setting commissions are called. They stand at a two-decade high, with many filed over the last year requesting mechanisms to recover smart grid project costs. The rise signals a new era in rate cases and alternative cost recovery efforts. At the same time, utilities are seeking to balance investment needs and cost controls, aware that early setbacks could test investor confidence or provoke customer backlash.

Managing closer customer relationships Another unknown at this early stage is how engaged customers will become with smart grid technology, which is premised on two-way communication. Will Americans respond eagerly to more information on their energy use? Early adopters, for example California homeowners with solar panels, are keen to send power back to the grid. Utilities are seeking to publicize—as well as manage—the expectations for greater control and lower costs as they help Americans get smarter about using energy. Clearly, utilities are playing catch-up in a push to develop customer-centric strategies and services, especially those aimed at younger, tech-savvy customers increasingly accustomed to real-time data and the ability to use that data to inform their consumer decisions.

New technology adoption Other challenges link to deploying technology that, in many cases, has never been put to work on the scale utilities envision. These range from securing cyber assets to forecasting demand for grid access and, just visible on the horizon, accommodating power and charging infrastructure for electric vehicles.

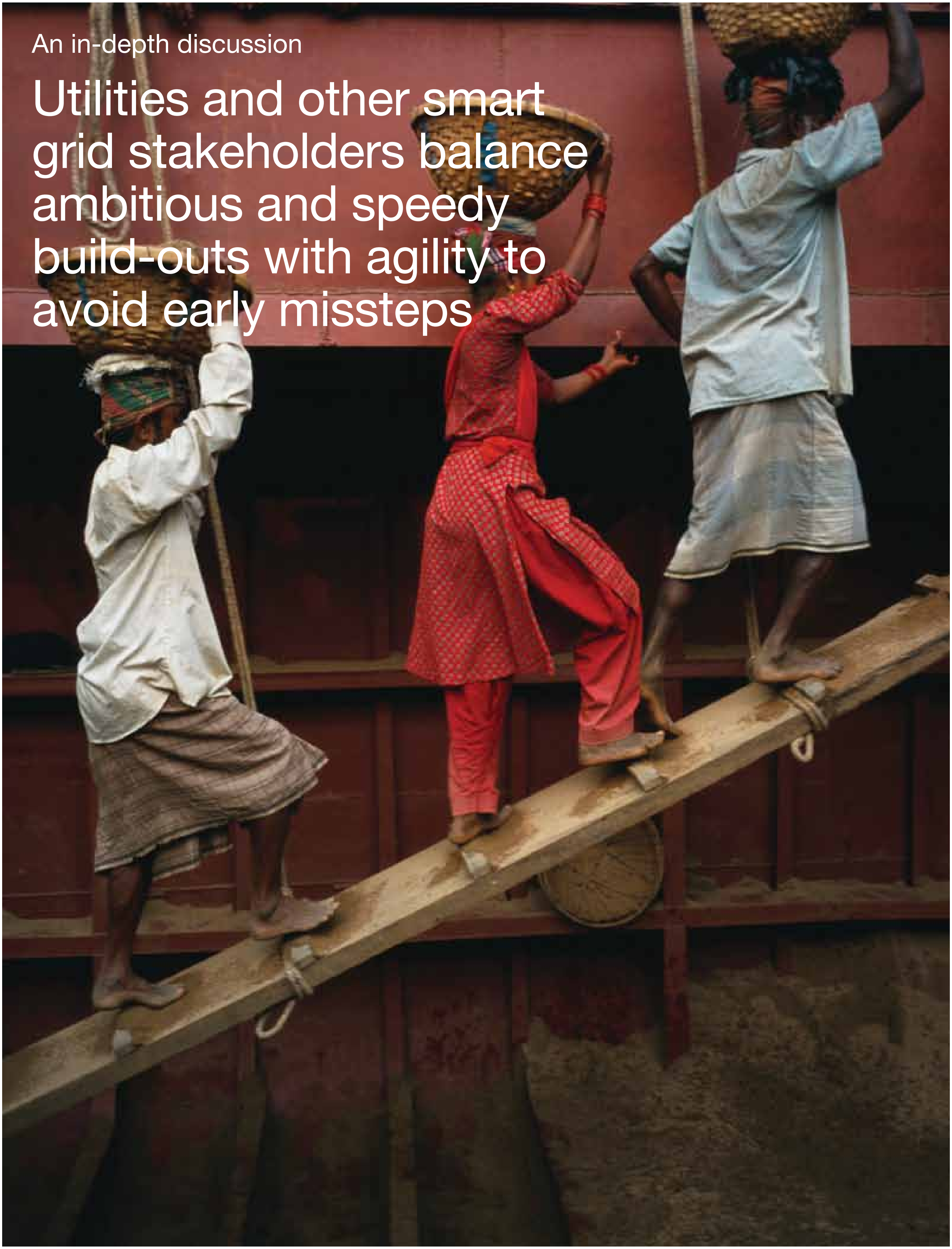
An expanded role for utilities Utilities are also forming alliances and working closely with companies outside of their industry as part of the transformation of the power grid. In doing so, they are sharing the growing financial and operational burdens as well as taking on added responsibility in a new, widened role of systems integrator.

Indeed, smart grid trial efforts and first steps in deployment are being closely watched. At this juncture, project governance, sound business cases and seamless systems integration are of paramount importance.

1 Electricity 2010: Opportunity Dressed as Hard Work, Remarks by Thomas R. Kuhn, Edison Electric Institute, February 10, 2010, New York City.

An in-depth discussion

Utilities and other smart grid stakeholders balance ambitious and speedy build-outs with agility to avoid early missteps



Smart infrastructure capital expenditure: A moving target

The American Recovery and Reinvestment Act (ARRA) of 2009, with $4.5 billion in smart grid-related provisions, has helped trigger a flurry of investment and deployment activity on several smart infrastructure fronts, moving from pilot to full-deployment mode going into 2010 and beyond. Driven also by a national push to mitigate and regulate greenhouse gas emissions, this investment will likely continue, with one estimate forecasting that the US smart grid market will double to $42.8 billion in 2014 from $21.4 billion in 2009.[2]

While smart grid schemes vary starkly, most utilities see an intelligent, digitized power grid as top-of-mind in an increasingly carbon-constrained world. In fact, 83% of utility executives surveyed globally viewed energy efficiency (including AMI, smart grids) as the “most important” or a “very important” strategy in dealing with climate change, carbon credits and other environmental issues, according to a recent PricewaterhouseCoopers survey.[3] At the same time, utilities are investing in a ramp-up of renewable energy generation in an effort to meet renewable portfolio mandates. Indeed, 61% of utilities executives globally cited renewable energy targets as “very pressing,” according to the same PwC survey.

Even during the recession, utilities braced themselves and carried on with smart grid projects, such as AMI, protection and control relays and substation automation. According to a recent study, 62% of utilities surveyed globally cited smart grid initiatives as the reason for increasing capital expenditure in 2010, and 64% said the same for 2011.[4] Areas of utilities’ highest concern regarding technology gaps in smart grid deployments, for example, are data management solutions, systems integration and electric vehicle integration, according to a recent North American utilities survey.[5]

Concerns over layering smart grid capital expenditures on top of already-expanding capital expenditure budgets are being raised in areas such as communications systems and smart meter installation and maintenance. These concerns come as overall capital investment by the utilities industry is estimated to reach $75 billion in 2010, more than double that in 2004 ($36 billion), according to one recent survey.[6] (See Figure 1.)

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2 Going Green Insights, Zpryme Research & Consulting, December, 2009.
3 Utilities Global Survey 2009, PricewaterhouseCoopers, 2010.
4 The Newton-Evans Research Company, “Global CAPEX and O&M Expenditure Outlook for Electric Power T&D Investments: 2010-2011 Funding Outlook for Smart Grid Development”, Newton-Evans Research Company press release, February 25, 2010.
5 The 2010 North American Utility Smart Grid Deployment Survey, GTM Research, GTM Research press release, February 10, 2010.
6 “Capital Expenditure Update”, SNL Energy, Financial Focus, March 25, 2010.

What is the smart grid?

In a nutshell, creating the smart grid means adopting technologies to transform the existing electricity grid—which is fitted largely with 20th-century infrastructure—to 21st-century standards to create greater efficiencies, reliability and the integration of renewable energy sources. This will leave its mark on the entire grid ecosystem—from electricity generation to transmission and distribution to consumers. The backbone of the smart grid is the integration of two-way communications between utilities and consumers through advanced metering infrastructure (AMI), or "smart meters", and sensors that discern where and how much electricity is being consumed. The AMI is designed to provide customers and utilities alike with the knowledge of energy information—pricing, demand, power and quality, for example—in real time or near real time.

With knowledge accessed through the AMI, customers could change energy consumption patterns with the incentive to save on electricity bills. For example, customers planning to wash and dry their clothes would be able to read their smart meter and notice demand for electricity is high and electricity is at a peak price point. When this occurs, some customers will delay their activity until the price of electricity comes down. The benefit for customers changing their consumption behavior in this way is a lower utility bill, and the utility avoids additional strain on electricity distribution during peak times. Utilities, in turn, would collect a new, rich stream of data, enabling a more seamless and swift rerouting of energy to where and when it is most needed as well as a more accurate and detailed prediction of future energy demand.

Building a smart grid entails initiatives going well beyond smart meters. These include laying new, advanced high-voltage transmission lines, modernizing substations and gathering and managing the prodigious amounts of data the smart grid will produce. The smart grid will also allow consumers with their own renewable energy sources to maximize the value of these assets by coordinating distributed output with that of the larger grid.

It will also likely require years or decades to fully modernize the existing electricity grid into an "intelligent" one. Indeed, the immensity and complexity of the US electricity grids are staggering, as will be the efforts and investment to implement 21st-century advancements. Fitting all US households—which number about 160 million—with advanced metering would alone mark an enormous undertaking.

Consider the sheer scope and breadth of a few of the central spines of the US electric grid ecosystem that would be affected through smart grid modernization:

- More than 3,100 electric utilities
- 10,000 power plants
- 5,600 distributed energy facilities
- 157,000 miles of high-voltage electric transmission wires[7]

7 US Department of Energy, Office of Electricity Delivery & Energy Reliability, "Overview of the Electric Grid", DOE Website, as of October 21, 2009.

Utilities capex on steady rise

According to one study, capital expenditures (for the 47 utilities tracked) are projected to rise to $75 billion in 2010, up from $68 billion in 2009. However, 19 of 47 companies are forecast to reduce capital expenditure compared to 2009.

Figure 1: US utility capital expenditure (2004–2012 estimate—$billion)

Source: SNL Energy Financial Focus, Special Report, Capital Expenditure Update, March 25, 2010 (based on expenditures of 47 US utility companies).

Smart grid capex: A peek under the hood

As early adopters forge ahead with smart grid programs, details of their capital expenditures show that spending earmarked for smart grid–related programs can account for well over 10% of total capital expenditure schemes. For example, as part of a broader effort to improve old infrastructure and reliability, Pacific Gas and Electric Co. (PG&E), which installed 4.5 million meters in 2009, plans to increase capital expenditure in 2010 to $535 million, or about 12% of total planned capital expenditure on a 3.5-million-meter deployment, not counting an additional $155 million on dynamic pricing initiatives. In 2011, capital spending for PG&E's advanced meter deployment is forecast at $165 million, lifting the total number of planned installed smart meters to 10 million by the middle of 2012.[8]

San Diego Gas & Electric Co. (SDG&E), too, sees significant smart grid spending. Its $6.9 billion capital expenditure plan over 2010–2011 includes $370 million earmarked to finish a smart meter deployment of 1.4 million electric meters by the end of 2011. An additional $700 million is planned for other smart grid projects (wind and solar projects, distributed solar energy generation, electric vehicle infrastructure and added smart meter upgrades).[9] SDG&E, selected in October 2009 to receive a $28.1 million matching grant toward implementing a wireless communications system to connect 1.4 million smart meters, is moving swiftly.

8 Lehmann, Jason, "PG&E to accelerate smart meter rollout in '10 as part of a larger CapEx effort", SNL, March 2, 2010.
9 Hodgkins, Jay, "SDG&E, SoCalGas set out on 5-year, $10.6B CapEx program", SNL, March 26, 2010.

Technology and cost overruns: Utilities learning from utilities No two utility smart grid projects are the same, and with each project come challenges in adopting new technology—and managing costs, which are often difficult to accurately project. Utilities select different types and combinations of technologies (such as smart meters, networks, head ends, meter data management, billing systems) that need to be seamlessly integrated. Utilities also plan to integrate different functionalities over different periods of time. One approach might be for initial meter deployment followed by additional technology layers adding functionality to those meters; alternatively, these steps might occur on parallel tracks.

The variable character of projects, technology adoption and partnering with other resources, such as other utilities, vendors, or consultants, makes it critical for utilities to collaborate and share experiences. Utilities that are highly collaborative are better able to capture and apply lessons learned into their overall project risk assessments and in many cases their own projects. They also benefit from the additional information, which will either support or recommend changes to their current business cases and costs. These lessons, when shared across the industry, will inform the next wave of utilities to avert issues and growing pains encountered by first movers.

"The way we've planned the smart grid is to deploy the AMI as the first layer, but simultaneously are undertaking changes to the back office and operational structures, including our computing and IT infrastructures," said Jeff Reed, director of SDG&E market development and emerging technology. "We will see different capabilities function across various function points—for example, as the in-home energy management and smart appliances markets expand, our smart grid will evolve to incorporate that functionality. For example, smart grid functions will be added to our core system operations to increase reliability through wider use of sensors in the distribution and transmission network and automation of substations. We'll also be pacing our capabilities to bring on distributed energy resources, especially in residential photovoltaic [solar energy generation], to keep up with the cycles of demand. We do want to be an early adopter [of smart grid technology], but will do it at a pace that makes sense based on availability of technology and customer requirements.… Many people expected that the smart grid would take fifteen or twenty years to mature, but now with the ARRA push and attention at the Federal level, that period is being accelerated," added Reed.

Indeed, early adopters are balancing the benefits of aggressively rolling out a foundational metering infrastructure—to more

ARRA smart grid grant projects ramp up

Much of the smart grid capital expenditure plans have been triggered by matching grants from the 2009 ARRA's $3.4 billion Smart Grid Investment Grant (SGIG) program. After a lull since the award recipients were announced in October 2009 (partially caused by uncertainty surrounding tax treatments of the grant monies), the first grants were finalized between utilities and the US Department of Energy in March 2010. Since then, these have been followed by other SGIG finalizations at a swift pace, which is expected to continue unabated through early and mid-summer 2010.[10] In addition to the SGIG program, $620 million was earmarked for 32 smart grid demonstration projects.

On March 8, 2010, Glendale (CA) Water & Power announced it signed a contract with the DOE for a $20 million smart grid grant, the first such SGIG grant agreement finalized. NV Energy finalized in March 2010 its $138 million grant with the DOE for an AMI and demand response program as the first investor-owned utility to finalize an SGIG grant.[11]

In March, CenterPoint Energy Houston Electric signed its agreement with the DOE for a $200 million SGIG grant toward a planned two-million smart meter rollout expected to be installed in 2012 instead of the originally planned 2014.[12] In the same month, Midwest ISO announced it finalized an agreement with the DOE for a $17.3 million grant for substation automation, making it the first regional transmission organization (RTO) to finalize a SGIG grant.[13]

quickly capture expected benefits of a fully deployed smart grid—with the uncertainty of higher, unforeseen costs, especially given the often unpredictable hardware- and software-related challenges to connecting millions of homes and businesses with meters. "Part of the issue with smart grid cost overruns is simply due to the fact that the smart grid is so new, and still in the research-and-development, trial-and-error stage, where systems are being built from scratch," said Sandy Simon, vice president of global technology and systems deployment at EnergyGrid Networks, a smart grid services company. "Smart grids are not one-size-fits-all, and that makes it difficult to precisely estimate project costs.…Some utilities will find that they don't really need to do everything at once—perhaps you don't need to deploy sensors and monitors on every single transformer in a territory, for example," she added, noting that AMI and smart grid costs will come down over time, especially in the home area network sphere. "You don't have to deploy five million smart meters in 60 days. Right now, there is a bit of frenzy, and there certainly will be some overspending."

10 St. John, Jeff, "It's about Time: Glendale Gets First DOE Smart Grid Stimulus Contract", earth2tech.com, March 4, 2010.
11 Robison, Jennifer, "NV Energy Secures $138 million in stimulus funds", *Las Vegas Review-Journal,* March 13, 2010.
12 "CenterPoint Energy and DOE: $200 million Smart Grid Investment Grant", *RWE Australian Business News,* March 24, 2010.
13 "Midwest ISO Launches Smart Grid Project", Midwest ISO press release, March 30, 2010.

The takeaway

While much of the build-out of smart grids and electric vehicle infrastructure necessarily means added capital expenditure, utilities need to apply the same stringent project governance and deliberation as for any other infrastructure project. Given the enormous expectations of the modernized, digitized grid, the temptation to do too much too soon could translate into spending too much as well—especially as AMI and smart grid devices are likely to become less expensive through economies of scale. Utilities will also benefit by prudent selection of vendors and forward-looking negotiated terms for quality and security guarantees and controls. Including such controls in contracts will guard against ballooning maintenance and technology obsolescence costs over the life cycle of these smart infrastructures.

Additionally, given the popular hype surrounding smart grid technology and its anticipated benefits, utilities need to thoroughly assess whether or not a fast-tracked, ubiquitous deployment of smart grid technology is, in fact, best for their regions and customers, and to model their plans after useful experiences of their early-adopting peers while casting a keen eye on the needs and appetite for a smart grid amongst their regional customers. Naturally, what works in one region may or may not be successfully replicated in another, often for inexplicable reasons. Already, for example, some regions, such as California and Hawaii, have seen accelerated customer interest in distributed energy installations (for example, home solar or geothermal systems) and the net metering of that generation. These first-mover distributed energy programs will hold valuable lessons for other regions inclined to follow suit.

Some utilities are experiencing cost overruns related to technology adoption. Utilities that reach out and collaborate with their peer companies and share smart grid strategies —ones that work and ones that don't—will be best positioned to avoid missteps and cost overage.

Companies should also approach smart grid planning and implementation as a business transformation process and manage the effort through controlled milestones that include checkpoints. These checkpoint reviews should assess the project team's readiness to move to the next phase of the project, revalidate the benefit and cost assumptions associated with the overall effort, and provide management with additional details as to the risks associated with moving forward.

AMI and the smart grid are ushering in more than a new wave of costs for utilities. They are also necessitating a new approach to cost recovery and a closer and more collaborative relationship with regulators, principally with their respective public utility commissions (PUCs).

As these infrastructures mature and become more mainstream, the relationship between utilities and their customers, too, will become more interconnected. The current information gap between utilities and customers will likely—and necessarily—close rapidly through:

- two-way communication between utilities and customers;
- more pervasive demand response and dynamic price plans;
- more granular home energy networks;
- the integration of distributed energy such as home solar systems.

These technologies, as deployed, will alter the essential nature of utilities' relations, communications and collaboration with customers.

Rate case spate, smart grid plans, tighten utility–regulator relations The ramping up of renewable energy integration and modernization of aging infrastructure has contributed to a closer dialogue between utilities and regulators to resolve how to fund such projects. These trends also come at a time when many utility rate structures—previously frozen or capped over the last decade or so—are expiring. The result is a spike in the number of rate filings, and utilities are now wading into a new era of managing new types of costs and working with regulators to best recover those costs.

Indeed, this sea change has not gone un-noticed. US utilities executives rated rate cases as the number one focus over the next year, according to PwC's Utilities Global Survey 2009.[14] The number of rate cases filed by shareholder-owned electric utilities, for example, rose to 66 in 2009, the highest in two decades, according to the Edison Electric Institute (EEI). Base rate increases among all US electric utilities were $4.2 billion with 58 cases in 2009, up from $2.9 billion with 42 cases in 2008.[15] And as of February 2010, some 83 major US electricity or gas retail rate cases were under consideration.[16]

Meanwhile, average ROE (return on equity) rates have gradually slipped to about 10.5% in 2009, compared with about 12.5% in 1990.[17] Eric Ackerman, Director of Alternative Regulation at the Edison Electric Institute, said: "The recovery of smart grid costs is regulated at the state level, by public utility commissions. Utilities seeking to deploy smart grid-type infrastructures typically present a business case to their PUC, in which they compare expected benefits and costs. At the beginning of a project, utilities and regulators are necessarily dealing with engineering estimates. At some point after what is usually a multi-year deployment, the utility will start to have actual data on benefits and costs."

14 Utilities Global Survey 2009, PricewaterhouseCoopers, 2010.
15 "Financial Focus: RRA Utility Securities Monthly, 2009—Year in Review", SNL Energy, January 15, 2010.
16 Regulatory Focus: The rate Case Process: A Basic Guide, SNL, February 17, 2010.
17 "Rate Case Summary, Q4 2009 Financial Update, Quarterly Report of the U.S. Shareholder-owned Electric Utility Industry", Edison Electric Institute, 2010.

Locking in cost recovery before spending a dime The sluggish pace of finalizing ARRA smart grid grants is to some degree a product of utilities' reluctance to commit to investments without the assurance or approval by regulators that those smart grid investments will be recoverable. And not surprisingly, the rise in the number of rate cases accompanies a strong push by utilities to argue for new cost recovery mechanisms aimed at smart grid projects, including rate increases, customer surcharges and tariff riders. Some of these mechanisms—compiled by the Edison Electric Institute—are included below in Figure 2.

Figure 2: Some recent smart grid/AMI cost recovery actions

Based on an analysis by the Edison Electric Institute, rate recovery mechanisms and the states approving them:

Cost recovery mechanisms and trends	States
Reconcilable tariff riders	IL, OH, OK, OR
Customer surcharge mechanisms	MD, NY, TX
Base-rate recovery opportunities	CA, IN, TX
Reconcilable balancing account mechanisms (cost/benefits are tracked and net amount is consolidated into rates periodically)	CA
Deferred cost recovery	DE, ID
Rate-basing of some capital investment	CA, MA, OR
Linking rate proceedings to smart grid projects that have stimulus funding	IL, OH, NY

Source: Edison Electric Institute, October 2009.

Paving the road with interim rates Utilities and regulators, in some cases, have worked closely on initiating interim rate policies to ensure that AMI and smart grid deployments go ahead without cost recovery delays caused by "regulatory lag." The Federal Energy Regulatory Commission (FERC) in July 2009 approved an interim rate policy as guidance for utilities to jump-start smart grid pilots. According to FERC: "Waiting for all technical issues to be resolved before beginning investment in smart grid deployment would frustrate the development of those very standards. Smart grid resources deployed with appropriate protections in the interim period could increase our body of knowledge and ultimately assist the standards development process."[18] In March 2010, the Colorado House of Representatives passed a bill enabling the PUC to approve interim rates for utilities. The bill stated that the provision gives, for example, the PUC "additional tools and more flexibility in its regulatory authority" to meet the state's targets for greenhouse gas emissions reductions and its renewable energy portfolio standards.[19]

"We need to demonstrate to investors, in advance of many of the major capital investments called for in our resource plan, that Portland General Electric (PGE) can be expected to recover both the cost of these major investments and the cost of ongoing operations and maintenance to operate the system.... If PGE cannot earn a fair return then investors will go elsewhere."[20]

—Excerpted statement from Portland General Electric Co. The announcement related to a filing for a 7.4% rate increase, which included smart meter capital expenditures of $132 million.[21]

18 128 FERC ¶ 61,060, Federal Energy Regulatory Commission, 18 CFR Chapter I [Docket No. PL09-4-000] Smart Grid Policy, Issued July 16, 2009.

19 Davis, Jim, "Emissions/interim rate legislation passes Colorado House", SNL Financial, March 25, 2010.

20 Quotation excerpted from a testimony included for a rate revision filing; Rate Case Direct Testimony as filed to the Public Utility Commission of Oregon, regarding "Advice No. 10-04, Portland General Electric General Rate revision", Portland General Electric Company, February 16, 2010.

21 Stanfield, Jeff, "Portland General Electric seeks general rate increase effective January 2011", SNL Financial, February 16, 2010.

The customer: Smart grid's central stakeholder

At the core of a fully optimized smart grid are customer adoption and satisfaction. As smart grid technologies (and their costs and attached premiums) are unveiled, utilities will become more obligated to educate customers about the smart grid and how it translates into long-term savings, reliability and improved service. In some ways, deployment of meters and smart grid technology is outstripping conventional recognition surrounding them.

Customer adoption of demand response and home energy management is likely to be more popular in certain regional clusters and grow in varying rates within these clusters. At a national level, though, the concept of smart grid has yet to fully sink in. A recent study found that 68% of Americans have never heard of the smart grid, and 63% have never heard of the smart meter. In addition, 22% of respondents said they did not want utilities to know their electricity use in real time. But, of those who have heard of the smart grid, 51% said they would be willing to pay a premium of 10% on their electrical bills now in return for future savings.[22] "At first, ATM machines made people nervous, but they got used to them. It'll be the same thing with smart meters," said Sandy Simon, vice president of global technology and systems deployment at EnergyGrid Networks, a smart grid services company.

A seismic shift: From utility-centric to consumer-centric The utilities industry, not having to compete on the basis of sophisticated or cutting-edge customer relations in the past, will soon be thrust into a new landscape of customer relationship management.

"Customer feedback is necessary for the effective implementation and communication of energy efficiency and demand response management programs to maintain sustained levels of reduction. Central to effective feedback is to understand and reduce the uncertainty associated with consumer behavior and response in order to design effective feedback mechanisms."

—*The Smart Grid: An Estimation of the Energy and CO_2 Benefits,* Pacific Northwest National Laboratory, prepared for the US Department of Energy, December 2009.

Many smart grid projects being carried out now had their developmental roots set half a decade ago. Those projects lacked a sharp focus on consumer-centric strategies and used speculative assumptions about customer adoption rates. Additionally, the rapid digitization and real-time access to data have raised—and will likely continue to raise—consumer expectations appreciably, most notably among younger consumers. Utilities, then, will increasingly need to meet this expectation curve, if not position themselves ahead of it. Just as industries such as telecommunications, finance and health care have done in the last decade, utilities will need to get closer to the consumer. Specifically, electric utilities will need to

22 The Harris Poll of 2,576 adults surveyed in January, 2010, Harris Interactive, Business Wire, March 2, 2010.

provide greater information about smart grid programs and their proposed costs and benefits and, eventually, about demand response and time-of-use pricing plans. The very essence of smart grids is two-way communication, and customer centrism is integral to achieving this.

Much of the consumer education will hinge on informing and shaping behavior—changing decades of a one-way, nontransactional relationship between utilities and consumers. In fact, the American Council for an Energy-Efficient Economy (ACEEE) has identified the need to create closer utility–customer relationships and announced the establishment of its Behavior and Human Dimensions of Energy Use Program, in which “initial projects will focus on advanced metering and consumer feedback…and identifying exemplary programs for behavioral change,” according to the ACEEE.[23]

The failure to put in place strong and effective marketing plans to educate consumers and provide transparency around smart grid projects could provoke consumer backlash, and worse—including litigious activity prompted by claims of smart meter–related billing inaccuracies, as in recent cases in California and Texas.

Early adopters have shown a degree of success in smart grid advocacy and consumer education. Take Salt River Project, which has more than 480,000 customers served by smart meters. Almost half, or 222,000 have elected the utility’s Time-of-Day™ price plans, making it the nation’s third largest program of time-of-use pricing. According to the company, time-of-use pricing limits peak-period electricity use and lowers customers’ bills by up to 7% or more.[24] In one of its plans, called EZ-3, customers are charged peak electricity rates between 3:00pm and 6:00pm on weekdays, but discounted rates during off-peak hours. The EZ-3 participants—who can monitor online their savings, electricity usage and pricing—save an average of 4%.

Efforts to educate customers on smart grid operations have been as scattered and disparate as the development of the smart grid itself. There are calls, however, to roll out more cohesive and clear customer education initiatives—even in the form of a national smart grid campaign of sorts to raise customers’ awareness and assurance. Consider the written comment by the State of New York Department of Public Service on FERC’s National Action Plan on Demand Response: “The Commission should encourage and assist States in taking proactive approaches to developing and refining demand response programs.…The NYPSC supports a national communications program, similar to that used for “Energy Star” appliances, to educate customers on ways that they can benefit from demand response programs, and to increase participation in those programs.”[25]

23 Larsen, Kathy, “Our Energy Behavior: What’s it all about?” Platts.com, December 15, 2009.
24 Navigating Change: SRP 2009 Annual Report, 2009.
25 Excerpt from State of New York Department of Public Service to FERC, comments on Docket No. AD09-10-000—National Action Plan on Demand Response.

The takeaway

To adapt to new pressures placed on utilities and state governments, utilities and regulators are now more inclined toward closer collaboration to ensure that smart grid deployments go forward and that costs are recovered. Collaboration will also help meet ambitious greenhouse gas emission targets, renewable energy portfolio standards, and state mandates to deploy AMI and smart grid infrastructure projects. A major factor driving smart grid projects is that they are designed to manage energy consumption during periods of peak demand efficiently enough to reduce or altogether eliminate the need for building new power plants.

Utilities will have to work more closely with regulators to shorten the “regulatory lags” (now averaging almost a year from filing to rate implementation) to ameliorate cash flow issues by shrinking the time gap between investment and recovery. Another emerging issue that all stakeholders are wrestling with—and will continue to do so increasingly—is the notion that stakeholders carrying cost burdens are, indeed, the direct beneficiaries of those capital expenditures.

Smart grid business cases that are the most consumer-centric and deliver on consumer expectations (especially in providing real-time energy data and the management tools to make energy use decisions based on that data) will likely be the most successful. This will be especially relevant given the shifting demographics in the utility customer base from primarily baby boomers to Gen-Xers and Millennials, who expect real-time, consumer-centric information.

To satisfy these expectations, utilities will need to reengineer their thinking and assumptions about providing customers granular data and encourage two-way communication. Utilities are also wading into an era of supplying customers with new services that smart grid technologies will enable—such as home surveillance systems layered upon a home area network. They will also be inclined to bundle new services, not unlike the way cable companies bundle voice, television and Internet services around the central cable-enabled infrastructure.

As utilities gain a better understanding and more data on consumer preferences and interests in the smart grid offerings, they will better gauge how to proceed—either more aggressively or perhaps much more slowly—in their future deployments. Identifying who will own utility customer data has already risen as a significant issue among utilities and Congress. In April 2010, California’s PUC, for example, decided that its utilities will hand over customer energy use data to customers, or their customers’ third-party providers, by the end of the year.[26]

To these ends, utilities will likely benefit from cues taken from others—such as the banking and telecommunications industries or health advocacy groups—on developing robust customer education and relationship campaigns to explain what the smart grid is, how it can be leveraged to cut electricity bills, and why it has potentially long-term benefits for utilities and those they serve. This transition will involve crossing a threshold from a decades-old transactional monthly billing relationship to a real-time, interactive relationship offering customers granular energy-use data and enabling choices to change their usage patterns.

26 Kanellos, Michael, “California Orders Utilities to Give Up Consumer Data”, Greentech Media, April 21, 2010.

The smart grid cost-benefit equation: Getting it right

Estimating future costs and the benefits of AMI and smart grid technologies has proven to be a prickly endeavor. There have been numerous X-factors involved in making cost estimates—running the gamut from unforeseeable installation and device cost overruns and problems with new technology performance to the difficulty of predicting customer sentiment and behavior. Unknowns also occur on the benefits side of the equation, with utilities expected to forecast savings benefits over years or even decades drawn from areas such as improved reliability and outage management, lower labor costs linked to fewer trucks rolled for service calls and a reduction in meter readings from the field or cancellation of projected new plant builds.

"Total cost savings from a ubiquitous smart grid right now are still speculative. First of all, some smart grids will be more costly to build than others, based on variable regional costs. Also, it's critical that customer behavior drive the savings, and that can't happen until you have rate structures that are based on dynamic pricing. Some customers will be more active in taking advantage of the smart grid than others, and the extent of that is apt to differ on a regional level as well."

—Rick Weston, director of the Regulatory Assistance Project and former economist and hearing officer at the Vermont Public Service Board.

Mastering the art of smart grid costs

As utilities press on with smart grid pilots, lessons on costs and benefits are filtering in. Department of Energy Secretary Steven Chu said when the DOE's smart grid demonstration grants were announced in late 2009: "These demonstration projects will further our knowledge and understanding of what works best and delivers the best results for the Smart Grid, setting the course for a modern grid that is critical to achieving our energy goals."[27] Utilities are still midstream in making such determinations, and the results will do much to shape the ultimate fate of these programs. For example, Oklahoma Gas and Electric Co. (OG&E) began installing 42,000 smart meters in businesses and residences in February 2010 as part of its pilot program. OG&E, which received a $130 million SGIG to expand the rollout, will use pilot results to study smart grid technology, customer response, and the effect of demand response pricing plans on electricity usage and customer participation.[28, 29]

To date, there is no shortage of estimates of the savings that a fully integrated smart grid could bring. But as the smart grids move from theoretical projections into the nuts and bolts of deployment, real effectiveness and attendant savings will come to bear. It is this gray area of fine-tuning—the art and science of calculating smart grid cost-benefit analyses—that utilities are currently stuck in, and which the early adopters, clearly, will ultimately inform the followers.

27 "Secretary Chu Announces $620 Million for Smart Grid Demonstration and Energy Storage Projects", *Transmission & Distribution World,* November 4, 2009.
28 "OG&E To Install Smart Meters In Norman To Monitor", Oklahoma Department of Commerce, July 31, 2009.
29 "Stimulus Money Helps Underwrite Oklahoma Smart Meter Expansion", www.smartmeters.com, March 16, 2010.

“Many utilities have cost-justified smart meters with demand response. But those programs require customer participation before they start to deliver benefits. They also require customer education, customer marketing and customer support—areas where utilities have never had to specialize before. We may see smart grid cost over-runs…but we may also see benefits under-runs. That is, we may see programs that fail to deliver the promised savings because customers did not participate in sufficient numbers.”

—Jesse Berst, founding editor, SmartGridNews.com

According to an Electric Power Research Institute study synthesizing past and current research, direct, real-time feedback on energy consumption realized savings of between 5% and 10%. In a January 2010 study, the Pacific Northwest National Laboratory estimated, based on existing smart grid pilot programs, that electricity use and greenhouse gas emissions would be reduced by 12% by 2030, assuming a ubiquitous smart grid.[30]

US DOE’s Northwest GridWise Demonstration Project found that on average, customers who participated saved 10% on electricity bills and achieved 15% peak-load reduction using smart meters, smart thermostats, and grid-enabled water heaters and dryers.[31] In the pilot, 112 homeowners were able to customize the use of their appliances, gauge energy use in response to near-real-time electricity price signals, preset thermostats to cut consumption during peak periods, and monitor home usage online.

Companies, too, have released smart grid business cases, quantifying costs and benefits. Some include:

- Southern California Edison Co., which began installing the first of a planned five million meters in late 2009 under its five-year $1.6 billion SmartConnect program, estimated that the program will realize cost savings of $4.6 billion, assuming all meters are installed by 2013. Nearly $4 billion is estimated to come from operational gains—including savings from reduced meter reading labor costs and the avoidence of energy purchases at times of peak demand. The company also estimated that the program will reduce demand by 1,000 megawatts.
- NV Energy Nevada announced that its smart grid infrastructure plan, expected to be finished by 2012, will cut customers’ bills by as much as 15%.[32]

30 *The Smart Grid: An Estimation of the Energy and CO_2 Benefits,* Pacific Northwest National Laboratory, prepared for the US Department of Energy, December 2009.
31 “Field test documents big consumer savings”, grist.org, January 15, 2010.
32 Robison, Jennifer, “NV Energy secures $138 million in stimulus funds”, *Las Vegas Review-Journal*, March 12, 2010.

- The Fayetteville Public Works Commission in North Carolina found that a smart grid pilot with home area network connections with 100 residential and commercial customers led to a 20% cut in electricity consumption.[33]

- Sacramento Municipal Utility District (SMUD) started its Home Electricity Report program in 2008, providing energy use data to 35,000 customers showing how their usage compares with that of similar neighbors, and reported a 2% drop in energy use in the program's first year.[34]

When cost-benefit estimates raise eyebrows Pressure is now on utilities to secure cost recovery through new rates or other, nontraditional mechanisms, while being mindful of the potential for rate shock and consumer (and regulatory) backlash. There are several cases in which utilities and regulators have been unable to agree on smart grid cost-benefit projections.

- Duke Energy reportedly scaled back on smart meter rollout in Indiana involving 800,000 meters in the wake of regulator concern over costs and benefits to customers.

- In January 2010, the Florida Public Service Commission (FPSC) denied Progress Energy's request for a revenue increase of $500 million. Separately, the FPSC rejected, in the same month, Florida Power & Light Co.'s request for a $1.27-billion rate increase, instead granting the utility $75.5 million.

- Dominion Virginia Power decided in early 2010 to delay a 2.3 million advanced meter deployment, opting instead to expand its AMI demonstration program by installing an additional 30,000 advanced meters in urban areas for more testing and data collection before launching a full deployment. Dominion had proposed to launch demand-side management programs, which it estimated would translate into savings of $400 million over 15 years.

33 Woody, Todd, "Smart Grid Project Cuts Electricity Use", *The New York Times,* September 21, 2009.
34 "Utilities Finding Peer Pressure a Powerful Motivator", *The New York Times,* February 22, 2010.

The takeaway

The difficulty of estimating costs for any large infrastructure project is no new challenge. However, as utilities plan multiyear smart grid deployments that in some cases approach $1 billion, cost overruns could well test the patience and support for those programs by all stakeholders: customers, regulators and investors. Solid estimates and accountability to those estimates will become increasingly crucial for smart grid projects going forward.

Keeping projects for building smart grid infrastructures on budget and on time is a project governance issue, one exacerbated particularly in projects that enlist a corps of vendors, many of whom are partnering with power companies for the first time and in some cases are deploying novel and relatively untested technologies and services. Additionally, with the flurry of new players aggressively entering the smart grid space, utilities are well positioned to hold their vendors accountable—not only to the proper installation and working order of infrastructure components, but also to manage ballooning costs.

In terms of estimating smart grid benefits, utilities need to be mindful that certain assumptions may be overestimated—particularly those regarding customer and regulatory buy-in, satisfaction and participation. Furthermore, operational benefits, such as optimization of real-time energy consumption and outage data, may be very difficult to project.

An overarching and fundamental issue is to identify those stakeholders who will directly benefit from smart grid programs, and to incentivize those stakeholders to make investments in the development of the parts of the smart grid ecosystem from which they benefit. Clearly, smart grids potentially hold benefits for myriad stakeholders, including transmission owners, ISO/RTO/TSO[35], conventional generation providers, renewable generation providers, energy retailers, energy traders, regulators, third-party service providers, and customers.

Therefore, as smart grid projects develop and generate enormous capital requirements, it will become critical for all smart grid stakeholders to open dialogue on collaborative efforts, including identifying investment opportunities for all relevant stakeholders.

35 I.e., Independent System Operators (ISO), Regional Transmission Organizations (RTO) and Transmission System Operators (TSO).

Securing cyber assets: An exponential task?

The grave new world of cyber vulnerability As smart infrastructures expand, so too will the urgency to safeguard against cyber-attack—be they accidental and petty, or malicious and devastating. The number of successful cyber-attacks against supervisory control and data acquisition (SCADA) systems at power generation, petroleum and nuclear plants and at water treatment facilities grew tenfold since 2000.[36]

Indeed, company executives are acutely aware of the collateral damage stemming from cyber vulnerabilities. In a joint study by PricewaterhouseCoopers, and *CIO* and *CSO* magazines, 42% of security and IT professionals surveyed globally ranked financial loss as the most significant impact of security breaches, and 30% cited compromised brand or reputation.[39] Securing against cyber-attack does not come cheap. One Pike Research study estimates that smart grid cybersecurity investments will reach $21 billion globally by 2015.[40]

"The Federal Bureau of Investigation has identified multiple sources of threats to the critical electric infrastructure, including foreign nation states, domestic criminals and hackers and disgruntled employees."

—Excerpted from the Critical Electric Infrastructure Protection Act of 2009 (introduced in the Senate April 30, 2009, 111th Congress, 1st Session, S. 946).

The National Institute of Standards and Technology (NIST) in February 2010 issued its second draft of Smart Grid Cyber Security Strategy and Requirements, identifying more than 120 top-priority interfaces linking devices and systems in two-way communications and classified them according to degree of damage that could stem from a security breach at those interfaces. Smart grid applications subject to these breaches included electric transportation, electricity storage, AMI, distribution grid management, energy management in homes and businesses and grid management.[37, 38] As the smart grid is built out, the number of accessible nodes that can potentially be breached will rise by many multiples at newly introduced points—smart meters, sensors and an increased number of people—beyond the current utilities employees, who will be working on the expanded systems, including people from communications and networking companies.

Complying with federal standards to guard against cyber-attack, too, is becoming a significant cost for utilities. Indeed, 69% of investor-owned utilities expect cost increases of over 10% to comply with critical infrastructure protection (CIP) security standards, compared with 34% that expected such increases in 2006.[41] For utilities, the result of hacking could translate into lawsuits, power outages, blackouts, reputational damage, customer backlash or other losses. In the period from March 2009 to February 2010, the Federal Energy Regulatory Commission (FERC) found more than 300 violations of CIP standards, nearly half relating to personnel and training. (See Figure 3.)

36 *Cyber Attacks: Is your critical infrastructure safe?* PricewaterhouseCoopers, 2010.
37 "NIST Issues Expanded Draft of Smart Grid Cyber Security Strategy for Public Review, Comment", US Fed News, February 4, 2010.
38 DRAFT NISTIR 7628, Smart Grid Cyber Security Strategy and Requirements, The Smart Grid Interoperability Panel—Cyber Security Working Group, February, 2010, National Institute of Standards and Technology, U.S. Department of Commerce.
39 The Global Information Security Survey, PricewaterhouseCoopers, *CIO* and *CSO*, *CIO Magazine*, 2009.
40 "Putting a price on smart grid cyber security", SmartGridNews.com, February 4, 2010.
41 2009/2010 Fourth Annual Strategic Directions in the Electric Utility Industry Survey, Black & Veatch.

"It is paramount that smart grid devices and interoperability standards include protections against cyber intrusions and have systems that are designed from the start (not patches added on) that prevent unauthorized persons from gaining entry through the millions of new access points created by the deployment of smart grid technologies."

—Patricia Hoffmann, acting assistant secretary for Electricity Delivery and Energy Reliability, US Department of Energy.[42]

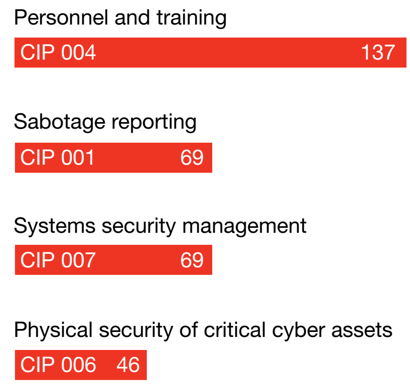
Making cyber security as smart as the grid
Cyber security has gravitated from the fringe to the fore in the minds of many company leaders, especially amidst the growing use of shared networks, Internet use and cloud computing—and as reports of hackers attacking private and public networks raise suspicions that vulnerabilities may well be more pervasive and deep than conventionally believed. "Seven years ago, I spoke to a CEO about the possibility of cyber-attacks on his company's SCADA, and he said, 'That could never happen'; he was in a state of denial. There still is lingering denial, and there needs to be more resources devoted to cyber security," said Joel Gordes, an independent energy consultant with Environmental Energy Solutions. "The problem is, in the world of cyberspace, we cannot identify the threat with absolute certainty, so deterrence and retaliation aren't much of an option. There are critical infrastructures that are linked by the web and we are all dependent upon certain utilities, so the damage brought on by a major cyber-attack on a large metropolitan area could be quite pervasive, wreaking havoc beyond just residences and companies. How does a cyber-attack affect hospitals, nuclear power plants, the telecom companies? Telecoms and power utilities are becoming so intrinsically linked that when a problem occurs with one, it can spread to another. And this is true about all critical infrastructures dependent upon the power grid."

As it relates to AMI deployment, each smart meter is like a computer in that its software can be subject to corruption, and the network of meters will effectively need to be protected with the rigorous security protocols that typically protect computers on standard enterprise networks. In the same way a company protects data from theft or hacking, meters will need to be protected from an infiltration of malware or physical tampering. Such breaches could result in energy use data being spied upon, or smart meters being corrupted with the aim of shutting down electricity access to a single customer, or even on a neighborhood or city-wide scale. "Utilities and smart grid device makers will benefit from new

42 Excerpt from statement before the Energy and Commerce Committee and Environment Subcommittee, US House of Representatives, October 27, 2009.

standards which provide more clarity and specificity on compliance requirements, and will also benefit with third-party assurance and testing of their cyber assets so that they meet or, better, exceed standards," said Gordes. "With the enormous number of data and messages being sent between utilities and customers in the future, there is a critical need for utilities to guard against accidental or malicious corruption of the system, either through the utilities, or intrusion through the smart meters," added Gordes, also noting a special need to build in security at the utilities' customer service representative level—where accidents can happen such as sending information to multiple residents instead of just one.

Figure 3: Violations of Federal Energy Regulatory Commission Critical Infrastructure Protection (CIP) enforceable standards (3/1/2009–2/28/2010)



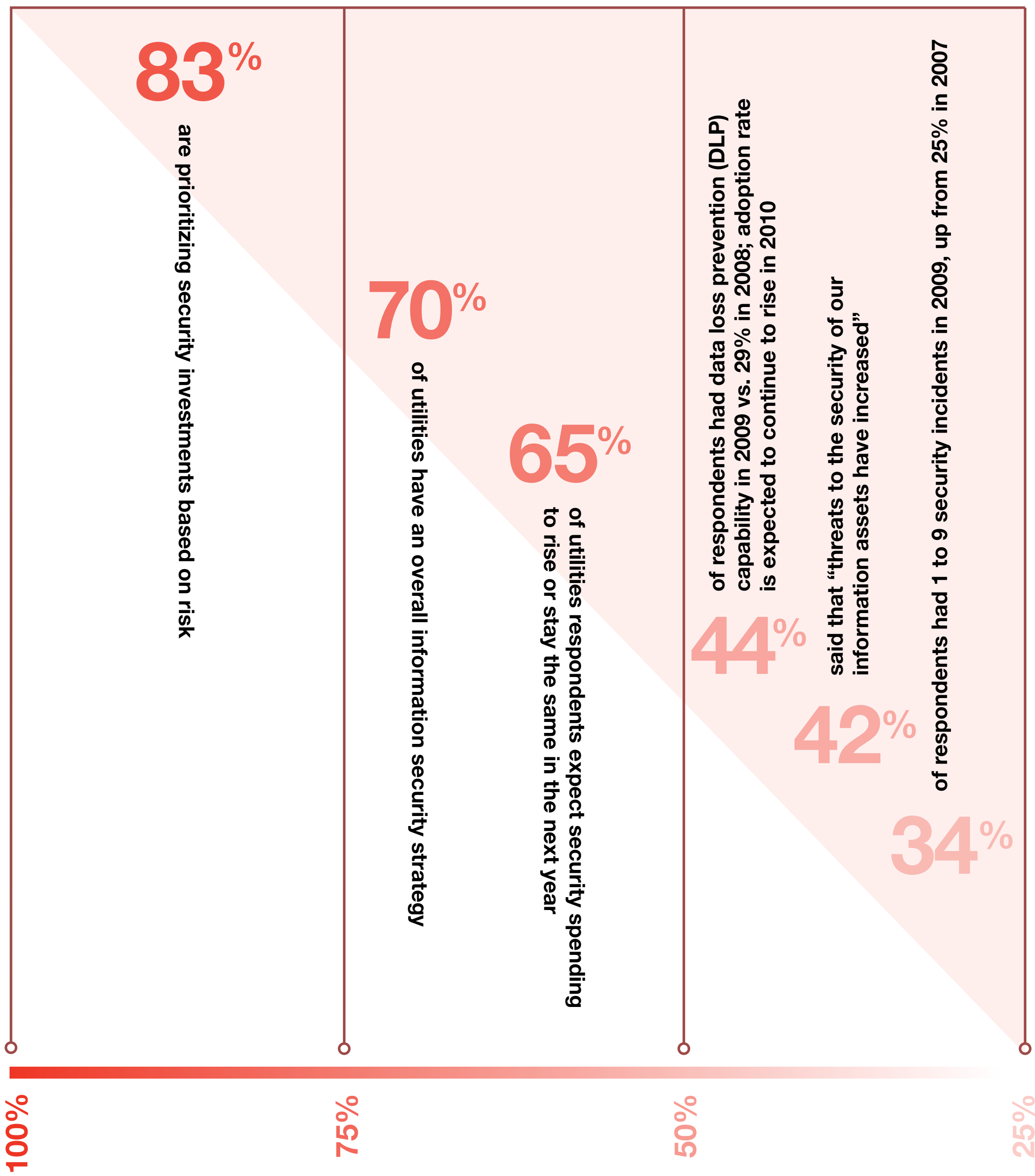
Source: North American Electric Reliability Corporation (NERC) Website. www.nerc.com Report date: 3/3/2010

"Registered entities need to be particularly diligent when it comes to revocation of access. There have been numerous incidents, including known incidents within the electric utility industry, where failure to promptly terminate both physical and electronic access to an entity's CyberAssets has resulted in a successful malicious attack by a disgruntled former employee or contractor."

—Excerpt from North American Electric Reliability Corporation Compliance Analysis Report, CIP-004-1—Personnel and Training, December 8, 2009.

Casting a closer eye on cyber security: Findings from a PwC survey

Following are findings from PwC's *Global State of Information Security Survey,* October 2009, PricewaterhouseCoopers, CSO and CIO, surveying global security executives:



"Recent federal funding support for smart-grid investments has incentivized the deployment of hardware in advance of the development of standards for cyber security, among other issues. Commissions may be confronted with expenditures on cyber security for which no specific standard has yet been reached....Commissions therefore have had to become more expert in their understanding of prudent smart grid and cyber security investments."

—Congressional testimony of Garry Brown, Chairman, NY PUC, on Protecting the Grid, the Bulk Power Protection Act of 2009, page 5.

The takeaway

Securing the physical and cyber assets from tampering or attack will likely become a daunting task for utilities, especially those that do not properly spot security inadequacies early in the infrastructure's development cycle. And with utilities enlisting vendors to carry out much of the build-out, utilities would benefit from holding all links in the supply chain accountable not only for the efficacy of the systems and devices that are used, but also for the high level of security protecting those assets. Additionally, utilities will likely be held to higher standards in their security efforts, as new cybersecurity standards emerge.

Regulators and customers alike will likely be increasingly critical of any security breaches, especially if they result from weak protection. Security will loom as an ever-growing concern as the smart grid extends beyond smart meters and into customers' home area networks, distributed energy generation and electric vehicles and charging infrastructures. Some utilities' operational systems will need updated security controls, ideally adhering to Information Technology Infrastructure Library (ITIL) or the Control Objectives for Information and related Technology (COBIT) frameworks. These utilities will likely benefit in the long term by vigorously testing smart grid systems with forensic analysis for security breaches that otherwise may go undetected by conventional and commercially available virus protection or intrusion-detection software.[43]

43 *"Cyber attacks: is your critical infrastructure safe?"* PricewaterhouseCoopers, 2010.

The data quandary: Making the most of a wealth of information

As millions of meters are deployed, utilities will need to prepare for a deluge of data gathered from those meters. Questions persist over how that data will be used and who will own and have access to it, as well as the IT expense of data storage and analysis. Will utilities follow other industries and outsource IT or billing systems, for example, or the storage and analysis of customer data? On the customer side of the smart meter, will utilities shoulder the costs and responsibilities (as well as potential commercial opportunities) of the home area network? Or, rather, will utilities encourage new players such as home energy management device and services companies—as well as grid-enabled appliance makers—to develop and control the home area network market?

Harnessing smart grid data: a steep learning curve? While data management and optimization may not lie squarely on utilities' radar screens as a current growing pain, it will likely present significant challenges sooner rather than later. As data from millions of smart meters streams in—and streams back out to customers—utilities will potentially have, at one end of the spectrum, an embarrassment of riches to optimize the grid—or, at the other, an underutilized overload of data. Inevitably, ever more energy-usage data will need to be managed as smart meter–enabled home appliances and devices equipped to send data become mainstreamed. Beyond smart meters, data, in a ubiquitous smart grid, will be emitted from points along the entire power grid ecosystem—sensors, networking routers, transformers, automated substations and digitized transmission, distribution and generation facilities.

The challenges to utilities are many—mainly for managing, analyzing, storing and protecting this data. Additionally, utilities will need to optimize this data by applying it to dynamic pricing plans for customers and using it for predictive energy-use analysis, especially to anticipate usage during peak times of power use and during exceptional situations, such as heat waves. "Data management has the potential to cause major headaches, with utilities potentially having 3,000 to 10,000 times the amount of data compared to what they are currently managing," said Jesse Berst, founding editor of SmartGridNews.com. "Will utilities be able to manage such huge volumes? And will they be able to mine it and analyze it to create business value?"

To address this challenge, utilities need to "bake in" an integrated information system as they build out the AMI and smart grid—especially as billing systems go from monthly to near-real-time, as layers of complexity are added on top of energy management and dynamic pricing that will be introduced to utilities' information networks. To accommodate these added layers, utilities will require enormous computing power in order to fully leverage the value of data smart grids will collect.

Data deluge can overload some billing systems Utilities are also gauging the robustness of their legacy billing systems and making the tough decisions about whether these systems are, in fact, compatible with potential demands from a data deluge generated by fully integrated smart grids.

Of particular concern is ensuring that utilities' billing systems are seamlessly coordinated with the rest of the information network. For some utilities, legacy billing systems can be upgraded to handle such a deluge of data—and the ability to integrate dynamic pricing plans down the road. For other utilities, however, an overhaul of the billing system may well be in order to keep up with the river of data and customer information. Properly implementing customer information systems (CISs) and billing systems has important implications for other functions such as customer service, field operations, regulatory operations, compliance and others. Because it can typically take from 18 to 26 months to configure and implement a CIS, utilities are fast approaching the need to determine to what degree and when they expect to see benefits from AMI-compatible billing systems. Some CISs are decades old and are ill-equipped to process time-of-use rate structures. Utilities also need to ensure that the timing of an updated redesign agrees with the maturity of their smart grid infrastructure, in ensuring benefits sooner rather than later. And as prices of these systems can run into the tens (or even hundreds) of millions of dollars, proper financial planning is vital to ensure that smart grid business cases are realistic.

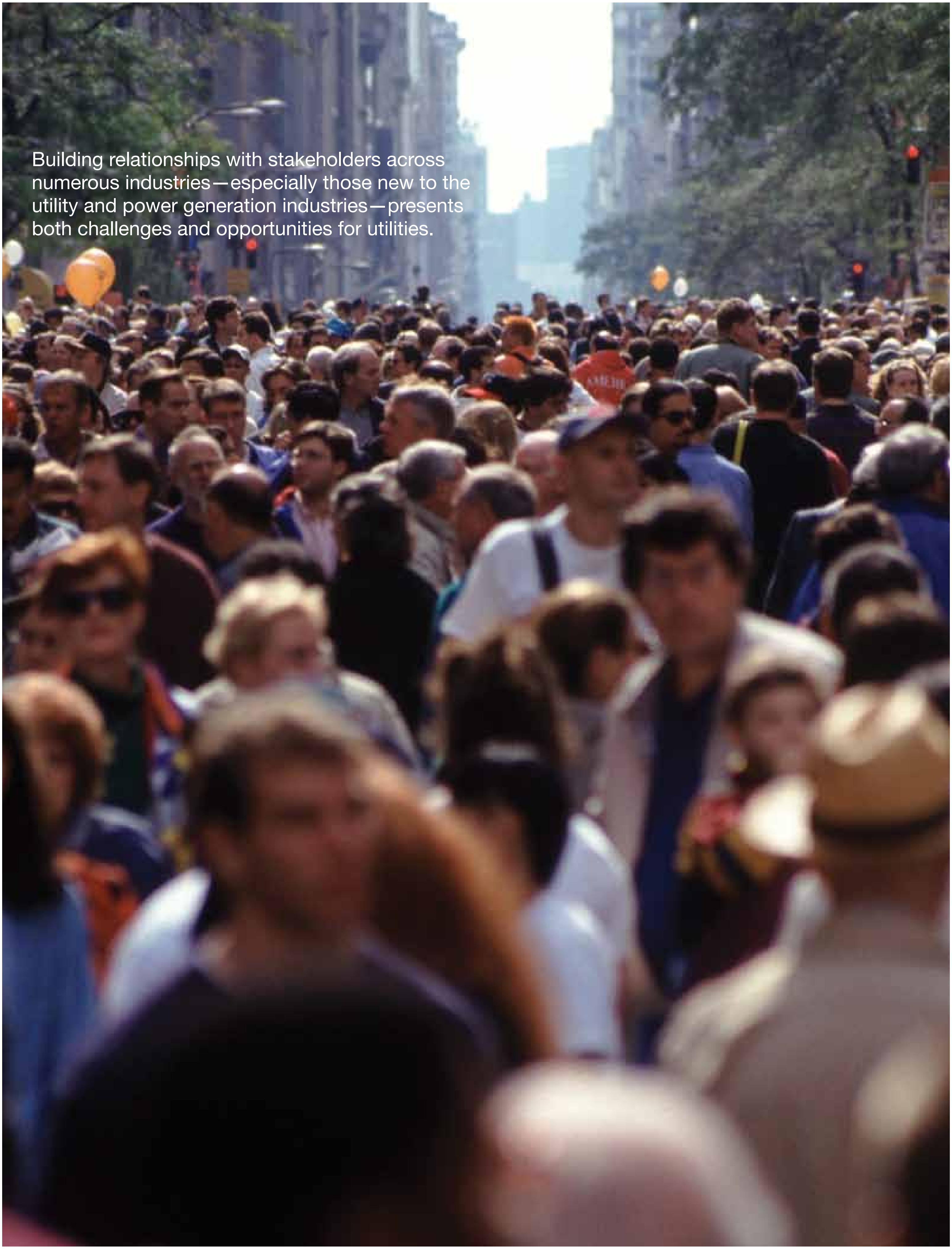
The takeaway

Smart grid data management will increasingly become important to utilities as regulators will likely expect more granular smart grid data (especially relating to costs and benefits) to be included in proposals for smart grid capital expenditures and rate increases to cover them. Utilities will need to demonstrate to PUCs and other stakeholders how the smart grid will realize measurable improvements in service and eventual operating cost savings. Successful data mining and analysis may demonstrate the improvements in customer relationship, billing, customers' cost savings and satisfaction. Information networks that fall short of regulators' and customers' expectations will also fall very short of leveraging and optimizing the smart grid.

A central question remains: Who, exactly, will own energy consumption data? And it is uncertain how energy use data will be accessed—or even owned—by customers, with data accessibility standards still being hammered out on the state and federal level.[44] In fact, a federal mandate that would require states to allow customers to gain ownership of personal energy use data is currently being considered.[45] It is not too soon, however, for utilities to sort out this question.

44 FERC, FCC Developing Smart-Grid Consumer Access Guidance for States, *Energy Washington Week*, March 10, 2010.
45 "White House Will Weigh State Mandate to Spur Smart Grid Data Access", *Energy Washington Week*, March 3, 2010.

Building relationships with stakeholders across numerous industries—especially those new to the utility and power generation industries—presents both challenges and opportunities for utilities.



Managing new partners in the smart infrastructure space

Utilities will be thrust increasingly into the role as “clean energy systems integrator,” charged with integrating legacy and emerging operations that have traditionally been siloed. In many cases, utility companies are learning how to work with new partners and are adjusting vendor-management behavior. Consider technology vendors, many of whose roles have changed. Five years ago, some technology vendors in this space were willing to develop solutions at low cost or no cost to utilities on a proof-of-concept basis. Today, some of these same vendors, having crossed the threshold from proof-of-concept to viable solutions, are expecting full compensation. Also, whereas some vendors once tested their solutions at utilities’ sites, these vendors instead invite utilities to visit a pilot site of their own.

It is unlikely that utilities companies will be able to own all parts of the smart infrastructure components. They will partner with, outsource to or enlist other companies to assume wholesale or partial control and oversight. Indeed, utilities are already bringing other industries—especially telecommunications, computer networking and software—increasingly into the fold through a cross-industry mash-up of partnerships and outsourcing of wide swaths of the smart infrastructure ecosystem architectures.

Partnering with companies that have already assisted similar build-outs in other industries, such as financial services, also provides utilities with the experience to prepare for critical infrastructure compliance requirements as well as data privacy and security issues.

Eric Ackerman, Edison Electric Institute analyst, put it this way: “We see the smart grid as a transformative technology, a ‘game changer’ as they say in Washington. It will bring a complex new infrastructure, portions of which are regulated, and portions of which are market-based. And it will lead to a new kind of electric utility, one which uses information—‘smart’ technologies—to reduce carbon emissions and realize new operating and energy efficiencies, while improving power quality and reliability. This new utility will no longer enjoy the degree of planning and operating control its predecessors did. We see the smart grid as enabling the integration of an expanding portfolio of distributed resources—for example, roof top photovoltaic systems, other kinds of distributed generators, storage systems, demand responsive loads, and electric vehicles—whose deployment and operation will be controlled by customers and third parties, not utilities. Regulatory policy will need to recognize both aspects of this transformation—that is, the convergence of information technology with electricity delivery, and the devolution of utility control—and adjust to them. New policies will be needed to ensure that the smart grid is built and maintained, that market-based suppliers can use the smart grid to deliver new products and services, and to define where and how regulated utilities can compete with market-based suppliers. It’s a brave new world that will be wrought by the fully smart-grid-enabled utility.”

From “self-build” to “partner-build” As the various components of the smart infrastructure mature, each component will, in effect, become its own system (home area networks, billing systems, customer data management, distributed generation and microgrids, for example) which will increasingly need to be managed by a wider system. Forging partnerships also spreads the financial risk in capital projects. New partners cover a very wide gamut indeed —network computing, communications, renewable energy developers, home energy management hardware and software developers, even automakers and electric vehicle charging concerns. “Utilities are becoming really good at managing skill sets within their core functions, but they are deciding quickly that if they do not have the skill sets in other areas such as telecom and networking experience, then they will either have to recruit from the outside or outsource those skill sets altogether,” said Sandy Simon, vice president of global technology and systems deployment at EnergyGrid Networks, a smart grid services company.

For those spaces where utilities will be unable to go it alone, new partners will likely continue to fill them via joint ventures, public-private partnerships (PPPs) and relationships with venture capital and private equity groups. Myriad examples of new partners are entering the smart grid space—at the fringes and at the heart—and doing so at a rapid clip. IT and communications and networking companies are quickly becoming central partners in smart grid projects. Electric vehicle charging infrastructure, for example, is already being driven by nonutility companies. Take General Motors, which is partnering with 30 utilities in 40 states to ensure that electric vehicle infrastructure is in place to support its Chevrolet Volt. Ford Motor Company has been working with a dozen utilities, including Progress Energy in Florida and Southern California Edison, in testing its Ford Escape plug-in hybrid electric vehicle (PHEV) vehicle-to-grid technology.

As these partnerships expand, utilities will co-opt business practices from other industries. One utility, for example, believes it may be able to offer fixed contracts to owners of electric vehicles that would pay for a fixed number of miles, in the same way telephone carriers offer fixed-minute contracts for mobile phones.[46]

Fitting renewable energy into the mix At the outer edges of the smart grid, developers of renewable energy persist as key players that continue to gather investor interest. Utilities will continue to weigh the advantages of either purchasing electricity from renewable energy developers—or expanding their roles as owners–operators of such facilities—especially the fast-rising crop of wind farms (see sidebar). The business case prospects of owning and operating solar energy generation, too, will continue to weigh heavily on utilities. PG&E, for example, announced in February 2010 a

Wind surge

According to PwC's study of global renewable mergers and acquisition activity, "Renewable Deals: 2009 Annual Review", 55% of total renewable deal value in 2009 was made by power utilities, up from 47.6% in 2008. Wind generation continues to become the most prominent renewable energy among investors, with North American wind power deals, for example, accounting for 34% in deal value in 2009, up from 17% in deal value in 2008, the report found.[47]

This deal activity parallels a surge in renewable energy investments and installed capacity on the heels of the ARRA, and to a large degree spurred by investment tax credits or the Department of Treasury's "cash in lieu of investment tax credit" incentives. In 2009, new US wind power capacity installations crested at a record 9,922 MW, according to the American Wind Energy Association, up from 8,425 MW in 2008, a 17.7% increase and creating total US wind power capacity of 35,159 MW.

46 Larson, Kathy, "Now comes David Crane, with a cool idea", Platts.com, February 2, 2010.
47 PricewaterhouseCoopers, Renewable Deals 2009 Annual Review, 2010.

five-year plan to develop up to 500 MW of solar photovoltaic systems.[48] Still, utilities will increasingly encounter the challenges inherent in integrating renewable energy. Take the issue of transmission projects—and exactly who will pay for them. Nevada's NV Energy, in a plan submitted to regulators in February 2010, requested the approval of a joint ownership between NV Energy and Great Basin Transmission LLC to build a transmission line linking two service areas to transmit renewable-generated electricity.[49]

Utilities, then, will need to work with each other and with investors and regulators to resolve issues such as transmission, utility-scale battery storage and integration of distributed renewable energy (such as home solar systems) to keep pace with the development of renewable energy projects.

The takeaway

The redefining role of utilities as a "system of systems" will necessarily open opportunities for more types of companies to partner with utilities, especially new nonenergy entrants. Utilities will ultimately serve as a sort of traffic cop for all systems that need to be folded into smart infrastructures—from nonenergy companies building or acquiring distributed renewable energy, to new relationships with independent power producers and nonutility electricity generators, to computer networking firms.

Building relationships with stakeholders across numerous industries—especially those new to the utility and power generation industries—presents both challenges and opportunities for utilities. These new alliances and partnerships, and the new emerging smart grid subsectors these alliances will spawn, will have long-standing implications on which parts of the smart grid ecosystem utilities will control, and which ones utilities will cede to other industries.

As the ramp-up of smart grid projects continues through 2010 and beyond, it is important for utilities to count other utilities as part of their expanding network of collaborators. Many utilities have reached out both formally and informally to their peer companies to share smart grid successes and failures—swapping experiences that range from unexpected cost overruns to technology adoption. Although utilities typically carve out short-term pilots and plan full deployment of smart grid strategies tailored to their needs, utilities that capture lessons learned from their peers through a network will be able to apply those lessons, instead of operating in an informational vacuum.

48 Lum, Rosy, "Utility ownership of solar stimulates demand, helps drive solar's 'crazy' growth", SNL, March 12, 2010.
49 "NV Energy and Great Basin Transmission to Pursue Jointly-owned Transmission Line", Business Wire, January 11, 2010.

What this means for your business

Valuable smart grid deployment lessons are filtering out, and developers need to take heed

As all stakeholders grapple with the challenges—and welcome the potential benefits—that come with modernizing the nation's power grid, it is important to be mindful that these projects, by and large, are being carried out at an accelerated pace in compressed time schedules. Growing pains will inevitably arrive sooner than later, and likewise, benefits may well be captured at an earlier time than estimated. And some anticipated benefits may arrive later—not in months, but rather in years or decades.

In addition, mature smart infrastructures are being established in pockets of the country—or regional smart infrastructure ecosystems—where economic, demographic and political conditions present fertile ground for their proliferation. That all utilities will and should run on the same parallel tracks, and that these infrastructures will be built in the same manner, pace and degree is unrealistic and unnecessary. The development of smart infrastructure is in a growth mode during which many lessons will be learned that can be applied to future infrastructure projects.

The following lessons are already apparent, and they can be received not so much as warnings or red flags, but more as signposts for further smart infrastructure development.

- Utilities will increasingly be scrutinized by customers and regulators for smart grid cost overruns and will need to devote resources to project governance and cost-benefit analyses of greater accuracy. Early signs indicate that smart grid capital expenditures are accounting for a growing percentage of total spending, and that will likely continue unabated for the next several years. Keeping AMI and smart grid projects on budget and on time is a project governance issue, one exacerbated by having numerous vendors, many of whom are partnering with power companies for the first time, and with new, relatively untested technology.

- Each utility needs to thoroughly assess whether or not a fast-tracked, widespread deployment of smart grid technology is, in fact, best for its region and customers, and to model its plans after experiences of its early-adopting peers. An all-or-nothing approach simply is not necessary, with future regional smart grids likely to vary as needed from region to region.

- In order to best redefine smart grid deployments—and, looking forward, the development of the electric vehicle infrastructure—utilities will need to fundamentally redefine their relationships with their customers. More vigorous customer relationships and transparency on smart grid programs will also lower inhibitions among some customers. To this end, utilities will likely benefit by taking cues from other industries and developing robust customer education and relationship campaigns to explain what the smart grid is, how it can be leveraged to cut electricity bills and why it has potentially long-term benefits for utilities and those it serves. Likewise, utilities are entering a new era of relations with regulators, and will need to revisit new types of negotiations and deliberations on smart grid cost recovery and to reduce the "regulatory lag."

- Smart grid data management will rise quickly as the driving factor to truly optimize smart grid infrastructures. This will be key not only to provide customers with real-time billing and net metering of distributed energy, but also to demonstrate to regulators granular data from the smart grid on pricing, cost savings and the like. How well utilities manage, mine and analyze customer feedback and smart grid data will determine the ultimate success of these programs. Optimizing the data will also be crucial for future rate cases that include rate hikes earmarked for smart grid capital expenditures and to demonstrate to PUCs and other stakeholders how the smart grid will realize measurable improvements in service and eventual cost savings. Information networks that fall short of regulators' and customers' expectations will also fall very short of leveraging and optimizing the smart grid.

- Utilities must clarify which party (or parties) will own and have access to energy consumption data. This is potentially a highly contentious issue, and must be decided upon and clearly communicated to customers.

- Securing the physical and cyber assets from tampering or attack could potentially become a large and costly endeavor, and the security controls put in place at the beginning of the smart grid life cycle is likely to prevent significant costs and other potentially crippling issues later. Utilities will likely be held to higher standards in their security efforts as new cyber security standards emerge. Regulators and customers alike will be focused on any security breaches, especially if they result from weak protection. Security will loom as an ever-growing concern as the smart grid extends beyond smart meters and into customers' home area networks, distributed energy generation and electric vehicles and charging infrastructures.

- The redefining role of utilities as a "hub-of-hubs" will necessarily open opportunities for companies to partner with utilities, especially new nonenergy entrants. Utilities will ultimately serve as a sort of traffic cop for all systems folded into smart infrastructures—from nonenergy companies building or acquiring distributed renewable energy, to new relationships with independent power producers and nonutility electricity generators, to computer networking firms.

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