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by Don Dawson, Earl Simpkins, and Josh Stillman

There have probably been a few times when you've opened your electric bill and been shocked at the amount you owe. But in the future, widespread implementation of the digital electric grid may help you avoid such moments. Your smart meter would tell you how much electricity you're using and when. It could also help you offset costs by running your dishwasher during off-peak electricity hours or turning off your living room lights if you forget to. If you have a solar panel or wind turbine on the digital grid, you might even find yourself selling electricity back to the power company.

Smart meters are among the more visible signs of the digitized grid. Utilities have begun installing them at customers' homes, and power companies are already sending consumers monthly notices comparing their electricity consumption to that of their neighbors. In fact, about 33.5 million smart meters have been installed in the United States, representing 25 to 30 percent of residential utility customers. Installation rates approach 75 percent in some

areas, and full penetration across the country could happen by 2020.

But smart meters are only a starting point. A fully realized digital grid requires a panoply of new hardware and software throughout the power distribution network, and infrastructure that can support and maintain it. Utilities have just begun to install these network components. And the technology needed to update the electric infrastructure has yet to be fully developed. Completed rollouts of digital grid technology will take several years, and the pace will vary among both states and utilities. Although digital grid technology should be a win-win advancement in utilities management—generating cost savings and efficiency gains for both customers and their utilities—thus far it has failed to live up to its full potential.

We're Not There Yet

Despite the promise of the digital grid to help with problems like power outages and high electric bills, most utility companies and their customers have yet to see the concrete benefits. In fact, few companies are offering any of those innovative services—like home automation—that the digital grid is supposed to spawn.

What happened? Many in the utility industry wonder if the hype around digital grid technology outpaced individual utilities' ability to deliver or got ahead of regulatory willpower to support the needed investments through rate hikes. The first wave of smart-meter installations fueled expectations that falling rates and amazing new services would soon follow for businesses and consumers alike.

But when those expectations

weren't met, the door was opened to a range of concerns, mostly unfounded, about the costs and privacy implications of automated metering. Smart meters have also been blamed for making people sick—with ailments as varied as headaches, arthritis, and high blood pressure. Even recurrences of cancer are being pinned on the technology. Consumer backlash ensued, slowing smart-meter deployment in some states and undermining utilities' messages about the grid's benefits.

To recover the momentum, much depends on each utility's inclination and ability to make necessary investments. Industry studies suggest that full digitization of the U.S. electric grid could cost between US\$338 billion and \$476 billion, many times the estimated \$8 billion invested in digital technologies so far. Utility investment decisions will depend to a large degree on the willingness of regulators to add digital infrastructure costs to customers' bills. Regulatory attitudes will mirror public perceptions.

Moreover, many of the early investments have been in front-end communications and data-gathering technologies. But to move the grid forward, utilities need to focus on the capabilities that create benefits for their customers by investing in back-end analytics that make sense of front-end data—translating that data into meaningful customer insights. These insights, in turn, will help utilities tailor products and services to better meet customers' demonstrated and potential electricity usage.

A survey of U.S. consumers in 2012 by the Edison Electric Institute found that only 45 percent of respondents knew the term *smart grid*, and barely half of those famil-

iliar with the term felt they understood how digital grid technology worked and what it could accomplish. Consumers often take a skeptical view of new technologies they don't fully understand. Utilities can counter this skepticism by educating customers on the benefits and risks of the digital grid (including the operational benefits it provides), setting realistic expectations, and addressing consumers' concerns.

Smarter Is Better

The obstacles are numerous, but given the possibilities this technology offers, the widespread implementation of the digital grid should be an imperative for utilities in the United States and around the world. Here's a look at what *could* happen.

Reliability. With a digital grid in place, power companies would no longer have to wait for customers to call in and report a loss of service. The utility could immediately dispatch service crews to restore power whenever and wherever the network infrastructure detected an outage. This would also avoid the costly and time-consuming process of sending restoration crews into the field to patrol power lines in search of trouble spots. At the same time, notifications would automatically go out to customers through the Web and social media, followed by progress reports with time estimates for power restoration. This is one of the first digital grid technologies being deployed today, though it is still limited in scope.

Digital technologies also hold the promise of preventing outages. Over time, utilities will implement self-healing capabilities that reduce the frequency, scope, and duration of power loss. Sensing mechanisms in the network will sniff out trouble

before it can cause an outage, enabling the power company to act.

Pricing. Digitized electric networks will give customers the information they need to manage their power consumption and cut their electric bills. The system tells customers how much power they're using at various times of the day, and how much electricity costs at each time interval. This information reveals opportunities to save money by shifting more power usage to the hours when rates are lower. Although few consumers relish the prospect of turning on the dishwasher at 3:00 a.m., home automation technology eventually will take over the chore of managing power consumption for optimal pricing. And as more people spread out their consumption, price spikes at times of peak demand could stabilize.

Supply-demand integration. Digitization turns traditional one-way power distribution channels into two-way streets. Today, most electricity is generated at a utility's power plant and sent over the grid to customers. That will change as new

technologies enable power to flow back into the grid from alternative energy sources.

Customers who install solar panels on their roof or erect a windmill on their property can offset electricity costs by selling some power back to the utility. At times of heavy demand, customers with on-site power-generating capabilities can also save by switching to their own power source, in response to a warning signal from the utility that rates are peaking.

Product and service innovation. The interactive capabilities of intelligent electric networks open the door to a wide range of new products and services that will help customers use electricity in new ways. The relationship that now ties customers to utility companies will become more open, encompassing a range of vendors that will provide hardware, software, and services for the digital grid. These offerings will help consumers understand their electricity use and capitalize on digitization to squeeze more value from the wattage they consume.



Network automation and utility efficiency. Grid digitization improves operating efficiency at utilities. Smart meters are already reducing the need to send technicians out for routine matters such as service activations and shutoffs, and, of course, meter reading. As utilities become more efficient, they can respond faster to customer needs. Greater efficiency can also slow the rise of electricity costs over the long term. As electric grids become smarter and more efficient, utilities won't need to spend as much money on improvements to infrastructure and other projects that require significant capital investment. Cost reductions for the power companies mean customers won't see rate increases in their bills that are meant to recoup expenditures for the utilities.

There are many *shoulds* and *coulds* when it comes to the digital grid. But in the end, it will take commitment and investment by the utilities to turn this vision of a more energy-efficient and cost-effective future into reality. +

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