Smart Grid Opens New Doors but Needs Correct Environment

Paul Fenn

Smart Grid technologies enable not just new technologies to be sold, but also for new kinds of energy transactions to occur.

For example, one major opportunity is *islanding*—allowing adjacent buildings to share on-site solar photovoltaic capacity, share storage, tailor demand response to this capacity to reduce costs, and maintain power during grid failures. Smart Grid technology exists that could offer shared blackout protection between customers who need it for critical equipment, such as refrigeration systems at grocery stores—or heating, ventilation, air conditioning, and lighting in high-rises—and customers able to host onsite capacity and power storage.

That is, the technology exists, but utilities do not support its implementation: it is a "guerrilla" phenomenon. Typically, islanding is not so much "allowed" or "not allowed," so much as it "occurs." Standards and equipment for "intentional islanding" are barely emerging, although they should be widely available in the next few years. Islanding usually occurs on an unplanned basis now, when normally occurring distribution-line-segment protective devices (fuses, switches, circuit breakers, reclosers, and similar hardware) operate and leave a section of radial distribution line disconnected from utility power, and some distributed generation (DG) is present that keeps the circuit hot. Utilities universally consider this a bad thing, as it leaves workers exposed to potential danger of electrocution when working on restoring power to lines that are believed to be dead, but are not.

Paul Fenn is founder and CEO of Local Power, Inc., in San Francisco.

As an island is, by definition, a piece of the utility distribution line (the "area electric power system," a public resource) that is separated from the rest of the utility grid but energized by the DG, the utility usually takes the lead in prohibiting such use of their facilities in a manner that they do not control. This will change, in some presently unpredictable way, once a national standard is available. Likewise, the wiring of any single premises (the "local electric power system," a private resource), regardless of the number of structures located upon it, can simply separate from the public grid, and that is all it is, a "separation" or a "disconnection," and is not, properly speaking, an island.

Islanding of individual premises is not only feasible but also simple when there is only one connection between that premises and the distribution system. Islanding in special downtown areas with adjacent high-rises may be more complex, but may be cost-effective in some large applications.

In a network, there are multiple connections; thus, if one transformer fails, there are other transformers to pick up the load. A special kind of circuit protective device (like a circuit breaker), called a network protector, is used to protect the transformers serving a network. These are optimized to reduce complexity, maintenance, and cost, in a manner that does not allow for reverse power flow from the low-voltage net back on to the high-voltage net. Power export is not allowed on any networks, and net energy metering (NEM) and the various generating installations that depend on NEM for their effective operation, may not be appropriate.

Systems are already developed to manage the separation of a single premises from the grid, so long as it has but one connection to the grid. These systems are not fundamentally different from the systems and equipment used to allow the operation of diesel generators to power a facility when the grid goes down. Very complex and expensive equipment is required to manage an island across the multiple connections. When you have an island you must manage the connection to the rest of the grid, the so-called macrogrid from the premises wiring (the *microgrid*). When, as is normal, there is only one connection, it is relatively easy to manage, but the complexity increases in a more-or-less geometric fashion with the number of interconnections to the same premises.

Considering microgrid transactions that may be facilitated with Smart Grid technology, one may describe the overall trend as replacing a transcendent, centralized, and symmetrical system of firm capacity in a data-poor environment with a decentralized asymmetrical system of intermittent capacity and time-sensitive load automation in an increasingly data-rich environment.

Because secondary networks involve multiple connections, you cannot have an arbitrarily chosen geographic area—it would be too complicated to separate from the surrounding network. However, any single building can be an island, even in those downtown areas where geographic islanding is not currently possible. Not only that, but any number of buildings can be an island in these downtown areas, so long as all of these buildings are connected on a single radial line that has a single connection to the low-voltage side of the distribution network.

DEMAND AUTOMATION AND STORAGE

The Smart Grid is arguably ultimately about managing load in a real-time environment in relation to intermittent renewable capacity and limited but economical on-site storage.

San Francisco's Community Choice Aggregation program includes potential development of a microgrid for a building cluster in the downtown financial district. The governing criterion for islanding today is that there be a single power connection from the island to the macrogrid. The present state of the art is at the point of developing an effective and economical multipoint control system.

Most renewable distributed-generation technologies only produce energy when the wind blows or the sun shines, which is not necessarily correlated to demand for electricity. One way to enhance the value of wind power is by storing the energy until the time when it is most needed. For example, in California the wind typically picks up at night, when demand and energy prices are low.

Smart Grid technology includes use of a power storage system to allow the energy to be deployed during the peak hours of demand during the day, when the need for energy and prices are high. Though many ingenious ways have been devised to store energy for electric power, there are not many ways to store large amounts of power economically.

POWER STORAGE ON THE SMART GRID

The best-known system of storage is a battery. Batteries are very efficient and highly portable compared to a natural gas, coal, or nuclear power plant. They usually do not emit air pollution or greenhouse gases (though lead-acid batteries can emit hydrogen sulfide), and most batteries can be placed near or at the site where the energy is needed.

Battery systems have been used reliably for at least 200 years, but most batteries suffer from numerous problems. Among these are short useful life, inability to be charged and discharged to their full storage capacity, high expense when compared to the energy supplied, performance loss over time, and large volume and weight required to store significant amounts of energy.

New battery technologies, and improvements to old battery technologies, have reduced the drawbacks greatly. Prices for energy storage are cheaper, product life is longer, and performance has improved. One of the most remarkable new battery systems is the sodium sulfur battery. This battery system is the first that can efficiently store megawatt levels of power and that is useful at a utility company level. Industrial strength, these batteries can last for 15 years or longer, can take very deep charge cycles, and come in power packs up to 9 megawatts. These batteries can be charged at night using inexpensive wind, hydroelectric, geothermal, or other grid power. The energy can then be released during the peak hours of demand in the day for six or more hours. These batteries are expected to come down in price, though they are currently only slightly more expensive than a new natural gas peaking plant, especially once future life-cycle fuel prices are taken into consideration.

LOWEST COMMON DENOMINATOR OR DAMAGE CONTROL?

Those utilities who do promote the Smart Grid concept seem to have a proclivity for installing the

DOI 10.1002/gas / © 2008 Wiley Periodicals, Inc.

© 2008 Wiley Periodicals, Inc. / DOI 10.1002/gas

dumbest possible technology. In August, San Francisco considered banning PG&E's smart meters because of their limited and limiting functionality. Specifically, PG&E's meters did not include automatic "always-on" gateway control to allow customers to install systems to sequentially power down (or shuts off) in-building appliances in response to dynamic electric-rate structure. As a gas company in a city that heats on gas, PG&E's smart meters would not allow automatic room temperature control capability, and it is uncertain whether they even could be upgraded to do so or what the cost would be to ratepayers to have access to off-the-shelf Smart Grid technologies through PG&E's new meters.

Smart metering under grid owner control is not necessarily a good idea, as it puts the grid operator in a position to look smart at the customer's expense but strategically able to install inferior and obsolete technologies in order to limit what kinds of Smart Grid technology can be allowed under the meter—effectively blocking Smart Grid technology. For example, Pacific Gas & Electric is now implementing a plan to install smart meters within San Francisco city limits. Key questions raised are: Will the smart meters include automatic room temperature control capability? Will smart meters include automatic "always-on" gateway control capability that sequentially powers down (or shuts off) in-building appliances in response to dynamic electric-rate structure?

Once rate-based by state regulators at the California Public Utilities Commission, San Francisco ratepayers would have their on-site demand management and on-site renewable generation options limited by PG&E's meters. A recent study has shown that smart meters show only modest benefits unless they put in temperature control, which provides a 27 percent reduction in peak usage, and unless the meters have a gateway, where they get an average 40 percent peak load reduction. PG&E's smart meters would have neither: air conditioner, lighting, washer-dryer, and half a dozen other electric loads would not be allowed to be automated.

Thus, the notion of the Smart Grid being a "utility business" is essentially as mistaken as the notion of energy efficiency as a utility business. In fact, Smart Grid technology is better implemented by an entity other than the grid owner as well as the grid operator, even if it is a public entity, because improvements of grid efficiency normally cause reduced grid revenues from reduced demand for and consumption of electrical capacity. It is a classic conflict to ask the person who owns a problem to solve that problem. The Smart Grid is naturally a third-party, or demand-side, business. Like demand-side technology in general (which is the heart of the Smart Grid concept), it has languished under monopoly "management" for 30 years.

When PG&E said it would install the meters anyway, the city fathers ordered a study to slow down PG&E's program. Meanwhile, the California Public Utilities Commission (CPUC) is deciding whether to spend more than the $1.7 billion already approved for PG&E's customer base—$340 per customer—with $800 million coming from San Francisco for these particular meters. July 29 legislation ordered a study of the technology and potential alternatives after supervisors accused the utility of "trying to pick the pockets of its customers." Former CPUC President Loretta Lynch told the supervisors, "I don't need no stinkin' meter to tell me to wash my dishes at night. And we don't need to pay $800 million to tell San Franciscans to do that either."[1] On the other side of the aisle, former FERC Commissioner Nora Brownell said that PG&E had adopted "ridiculously old" technology for its "smart" meters.

No incentive has yet been invented to persuade huge corporations to allow threats to their core business revenue— transmission of power, transportation of fuels, and power plant debt repayment.

According to Brownell, PG&E has recently "changed its position and is trying to do the right thing" with its replacement meters. Nevertheless, the fundamental question remains as to the wisdom of enabling a throughput-based business (a gas and electric company, a grid owner) to choose the technology that will decide which Smart Grid technologies will be made economically feasible—technologies that would allow the customers to use less of what the electric company puts out. And while ratepayer incentives can mitigate utilities' conflicts of interest against a truly Smart Grid that allows customers to take control of their energy use, no incentive has yet been invented to persuade huge corporations to allow threats to their core business revenue— transmission of power, transportation of fuels, and power plant debt repayment.

DOI 10.1002/gas / © 2008 Wiley Periodicals, Inc.

Part of the Smart Grid problem is a lack of accountability by grid monopolies and regulatory lurch. By the time San Francisco threatened to ban PG&E's meters, the CPUC already approved $1.7 billion for PG&E to spend on smart meters. San Francisco had only spoken up when PG&E asked the state regulatory agency for an additional $677 million after revealing similar difficulties in its smart meter program in a rural California community, saying the utility will disconnect and replace the "smart" 200,000 meters it deployed two years ago in Kern Country, California. After installing them (presumably also at $344 per customer), PG&E later decided the meters were out of date and are now seeking to remove and replace them with a new round of smart meters, and expect their ratepayers to pay for these also. Sound smart to you?

Another major problem with utility-based Smart Grid deployments is that customers do not like the salesman. Acorn's Moore refers to California's recent law requiring building codes statewide also to require demand response to be built into every home that was constructed. Because consumers did not trust the utility, it was reversed. Retail virtual capacity desperately awaits a nonutility channel for DR provider services to perform the rollout. Utilities cannot sell—there is a distrust of the utilities by the customers, and utilities are catchers not pitchers, so to speak. They do not know how to convince people that something is good for them even if it is—there is no culture of selling at utilities.

A brief look reveals [Smart Grid technologies] to have been kept on the shelf for as many years as the electric cars or solar power.

SKYPERGY?

While some observers assume the Smart Grid to be essentially a utility infrastructure, a brief look reveals it to have been kept on the shelf for as many years as the electric cars or solar power, suggesting the need to bring in new market participants to implement outside the grid. "Virtual Demand Response is a 30-year-old technology," says Acorn's John Moore, referring to a paper published by Scientific Atlanta in which PSE&G had studied time-of-use pricing and reported a 47 percent reduction in its demand during peak periods. "Imagine the implications for this (well-intentioned) grid owner, for which a 47 percent drop in demand could mean catastrophic revenue losses." That was all PSE&G wanted to do: "asking utilities to use demand response and smart meters in order to reduce electricity demand is kind of like asking AT&T to adopt Skype"—the free Internet telephone Web site that revolutionized the fiber business by automating bandwidth capacity use and offering free international long-distance calling.

Is Skype part of the fiber system? Hardly—it is outside the system and competes with its owners directly by offering a nominally "free" product: a better product. Moore said:

> Meanwhile, utilities that reduce demand lose three ways—on generation, transmission, and distribution charges on their ratepayers, making them the wrong agents for change. Until something like Community Choice Aggregation gets adopted—where incentives are truly aligned—energy demand response will always be at the periphery of the portfolio, not the center where it belongs.

FROM AACHEN TO SAN FRANCISCO

Thus far, local government is the world leader in renewable energy development and climate protection, and in light of this new ability, electric utilities grow pale, still wanting to treat power as their private monopoly in some states, deregulated and underperforming in other states—and climate change as a theory. The Smart Grid has a great future at City Hall.

The United States has lost its leadership position on renewable energy development to Germany and Japan over the past ten years. In the past decade, complex financial structures called "feed-in tariffs" have been established in European countries to finance rapid and extensive development of solar photovoltaics as well as wind power and other renewable energy technologies. Critical to this success story is that a single city government initiated the program, and it was copied to Schleswig Holstein state government and only years later the Deutsche Bundestag, with financing secured by the federal finanzminister.

NOTE

1. (2008, July 14). Smart meters under fire in San Francisco. *KCBS News*.

© 2008 Wiley Periodicals, Inc. / DOI 10.1002/gas