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smart grid expectations

what will make it a reality

THE TERM "SMART GRID" IS ALmost becoming a household name. From the U.S. president talking about the smart grid to television commercials on this topic, we have a plethora of activities around the world where engineers, policy makers, entrepreneurs, and businesses have shown a keen interest in various aspects of this technology. There are smart-grid-related funding opportunities, projects, seminars, conferences, and training programs going on in Europe, the United States, Japan, and China to name a few.

But what really is the smart grid? According to the U.S. Department of Energy's modern grid initiative, a smart grid integrates advanced sensing technologies, control methods, and integrated communications into the current electricity grid. Thus, it is not a grid in the sense of a transmission grid as we know it. At the transmission level, today's grid is efficient, smart, and intelligent. At the distribution and customer levels, there are opportunities for automation, advanced data collection, and intelligent appliance control that provide opportunities for energy efficiency and better integration of distributed generation including renewables to reduce carbon emission.

Generally speaking, the smart grid encompasses the distribution network with an interface to the transmission system. So its components will include distributed energy resources, grid interfaces, distribution circuits, customer loads, and an IP-addressable load control architecture that represents the decision support system of the smart grid. In this grid we will see distributed generation sources like solar photovoltaics, wind turbines, microturbines, fuel cells, and storage technologies (including plug-in electric vehicles) in addition to central station power plants, all interconnected. The smart grid can thus be thought of as a platform where both supply and demand sides meet.

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With all this hope and expectation about the smart grid, the question needs to be asked—what will it take to make it real? For the smart grid to be practical and beneficial to society, the following enabling technologies and supporting standards must be present.

Automated Meter Reading

The ongoing work on automated meter reading (AMR) and automated metering infrastructure (AMI) appears to be the stepping stone for many electric utilities on the path to smart grid implementation. While AMR allows the electric utility to remotely read the customer's meter, the availability of AMI provides them with the basic building blocks for two-way communications with customers. With the proper sensors and software support, this will allow the utility to get appliance end-use data from customer premises and control such loads, if desired. However, these controls need to be judiciously, applied taking into account the customers' priority and privacy concerns.

Security and Privacy Issues

With the thought of the smart grid controlling the end-user's appliances to control load, concerns have been raised: Will the power company be able to control the customer load without the customer's prior permission? Can that permission, once granted, be revoked or suspended if the customer's priorities change? Should the customer have a preprogrammed priority order to shed load when the power company wants to reduce the system load by a given amount? With the availability of home-based renewable energy sources, like solar and wind, and feed-in tariff, does the homeowner have a choice

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between selling the electricity to the grid or storing it on premises to avoid high on-peak charges? What are the costs/benefits of such options? A lot of software and advanced communication infrastructure need be developed to address such questions.

Advanced Communication Infrastructure and Cybersecurity

The success or the failure of the smart grid rests on a communication system that is intelligent, secure, reliable and cost effective. Questions are being asked: Do all the data from the customers need to be transmitted to the utility control center? Or can some data be collected locally and only exceptions be reported to a higher level? The ability to collect and process data locally will not only reduce communication overload and bandwidth requirements, it will also make the network less vulnerable to hacker attacks and alleviate some cybersecurity concerns.

Cybersecurity is of major concern in the electric power system due to increasing interconnection and integration, new two-way systems, new customer touch points into utilities, the proliferation of third-party control systems, and the increasing use of communication software.

Standards

For components, software, and systems from many vendors around the world to work together in an interoperable fashion, and thus to make their integration seamless and identify end-user values, standards need to be developed. We need to know how, in some cases, existing standards have helped deploy smart grid technologies in a timely fashion while, in some other cases, the lack of acceptable standards has delayed or stopped the deployment of these technologies. The smart-grid community needs to be aware of guidelines and best practices that the electric utility industry has been using in the integration of energy technology and information and communications technologies and their limitations of these.

Greening of the Grid

Lately we have been hearing a lot about this topic, which usually implies introducing increasing amounts of solar and wind energy sources into the electric power grid. There is, however, a growing concern about the stability and reliability of the grid due to the intermittent nature of such energy sources. The common response to such concerns is to provide large amounts of storage and back-up generation. But, as the penetration of such intermittent sources into the grid increases, such solutions will not be cost effective because of the infrequent use of such storage devices and their cost. Within the smart grid, the proper application of two-way communication provides an opportunity for large-scale load control, thus minimizing the impact of generation shortfalls. The smart grid makes distributed generation more practical through demand management by controlling a large number of end-use devices.

Business Model for Customer Level Integration

With all this said, the question keeps on popping up: What will the role of the individual homeowner be in the smart-grid environment? Will customers have to worry about when to cook, when to wash and dry their clothes, when to charge their plug-in electric vehicle, or when to use the stored energy in their electric vehicle to minimize the amount of purchased power and therefore avoid high peaking rates? I can envision a scenario where entrepreneurs will come forward and consolidate a number of end users and sell or buy on their behalf to make a business case, thus providing the homeowner with the benefit of the smart grid without the associated headaches. And the electric utility will deal with these consolidators, thus saving them the complexity of dealing with a very large number of customers with different levels of sophistication.

So What Is Next?

I can see many nonutility players entering this smart-grid market and attempt to provide solutions. For example, many computer networking companies have plans to deliver an end-to-end, highly secure network infrastructure that helps utility customers take the most advantage of energy efficiency, demand reduction, and the integration of renewable energy sources in their homes and businesses. The end result may not be cost reduction but more value for the money spent and an environmentally friendly power grid.

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