10 Big Questions About the Smart Grid

BY: Karen Stewartson | September 14, 2012

At a very young age, Massoud Amin, director of the Technological Leadership Institute, realized that electricity was vital to modern society. Growing up and traveling in Iran in the 1960s, he saw how access to electricity transformed society — from farming, schools, businesses and medical facilities. As a teen visiting New York City, lightning caused a 24-hour blackout, during which Amin observed that the world depends on reliable electricity to support economies and quality of life. The experience reinforced his passion for electrical infrastructure, and he's been committed since then to helping improve the grid.

Amin, *pictured at left*, is a senior member of IEEE, Institute of Electrical and Electronics Engineers, a professional organization dedicated to technology innovation, and chairman of the IEEE Smart Grid Newsletter.

In a recent interview with *Government Technology*, Amin talks about IEEE (pronounced I-triple-E) and the smart grid — its complexities, governance and broadband implications.

1. What is IEEE, in a nutshell?

IEEE refers to itself as "the world's largest professional association dedicated to advancing technological innovation and excellence for the benefit of humanity." The organization has about 400,000 members in fields as diverse as aerospace, biomedical engineering, computing, consumer electronics, electric power, and telecommunications. It is well known for its professional and educational activities, its peer-reviewed and general-interest technology publications, the conferences it hosts around the world, and its standards development organization.

2. How do you define the smart grid?

The smart grid is a next-generation electrical power system that uses digital technologies — such as computers, secure communications networks, sensors and controls, in parallel with electric power grid operations — to enhance the grid's reliability and overall capabilities. The smart grid extends to fuel sources for electric power production and the many devices that use electricity, such as household refrigerators, manufacturing equipment or a city park's lighting fixtures.

In particular, the secure digital technologies added to the grid and the architecture used to integrate these technologies into the infrastructure make it possible for the system to be electronically controlled and dynamically configured. This gives the grid unprecedented flexibility and functionality and self-healing capability. It can react to and minimize the impact of unforeseen events, such as power outages, so that services are more robust and always available.

The smart grid also has very important features that help the planet deal with energy and environmental challenges and reduce carbon emissions. To give a few examples, a stronger and smarter grid, combined with massive storage devices, can substantially increase the integration of wind and solar energy resources into the [power] generation mix. It can support a wide-scale system for charging electric vehicles. Utilities can use its technologies to charge variable rates based on real-time fluctuations in supply and demand, and consumers can directly configure their services to minimize electricity costs.

3. What's the IEEE's role in smart grid?

IEEE is involved in virtually every aspect of smart grid. Its engineers in academia, government and private industry are helping guide its evolution and standardize its technologies and they are deeply engaged in designing, testing and deploying smart grid projects around the world.

IEEE members have published around 2,500 papers on smart grid topics in more than 40 IEEE journals. I'd like to mention, in particular, the IEEE Smart Grid Newsletter, a monthly newsletter, which provides up-to-date news about the smart grid, results of field tests, as well as forward-looking commentary on important issues. It is published on the IEEE Smart Grid Web Portal, which the IEEE hosts as a comprehensive information gateway to smart grid resources and expertise.

4. Why is it important to have national smart grid standards and is an international body needed to govern standards?

Technology standards are needed so that products can interoperate and businesses can distribute their products to multiple countries or regions. The economies of scale that standardization creates can drive down costs, which benefits everyone. And because more vendors might participate in a market, customers have more product choices. Also, when a technology is standardized, customers can have more confidence that their products will function as expected.

The IEEE Standards Association has more than 100 smart grid standards developed or in development, and these will support a wide range of technologies and services that will be used throughout a smart grid system. Many other regional and international standards development organizations are also creating smart grid standards. IEEE and other leading groups are working together on smart grid standards because they recognize that collaboration is necessary to make sure smart grid succeeds.

This type of collaboration represents a new paradigm in standards development today. Collaboration is seen as a practical means of solving problems that are common to all participating groups and stakeholders, regardless of the formal status of a particular standard within an industry or country.

5. How is the smart grid community addressing interoperability and security as it pertains to the smart grid? What role, if any, is IEEE playing there?

The IEEE Standards Association (IEEE-SA) has published an architectural framework for the smart grid, called IEEE 2030, which defines the interconnection and interoperability standards for the power, IT and communications technologies that will be used in smart grids.

IEEE-SA is working actively on standardization with the NIST Smart Grid Interoperability Panel, which includes IEEE-SA standards in its catalog of smart grid standards. IEEE-SA also collaborates with many standards organizations that represent specific industries, countries or regions to help make sure that products that operate on smart grids are complementary and compatible with one another.

Security, which includes privacy and cybersecurity, is fundamentally necessary for reliable grid operations and for customer acceptance of smart grids, and many in IEEE and the smart grid community are developing technologies and standards addressing this issue. What's most important, however, is that security is incorporated into the architectures and designs at the outset, not as an afterthought. For the microgrids [distributed resource island system] I'm involved with, we employ security technologies for each equipment component we use and for each customer application we develop — and we do this in a way that cannot be reverse engineered. We use an architecture that cannot be taken down. If any part of the system is compromised, the system reconfigures to protect itself, localize and fend off the attacks.

6. What implications does broadband have on the grid?

Utilities will use a variety of wired and wireless, broadband and narrowband communications technologies for their smart grids. Communications networks will carry information to and from the many sensors, control technologies, and metering devices that will be used in a smart grid, including devices used in homes and businesses.

A utility will use broadband connections to engage with customers for smart grid services. Customers will use network-connected applications on in-home energy monitors, home computers and smartphones to interact with demand-response or energy management programs.

Utilities will likely use a combination of broadband communications technologies, including their own infrastructure for broadband over-the-power-line communications. They will also use a variety of fiber-optic, wireline and wireless technologies for broadband communications.

7. What's the simplest thing about the smart grid and what's the most complex thing about it?

The simplest thing about smart grid is consumers' general expectations for their electric services. Basically consumers expect that when they turn on an appliance or product that uses electricity, it will work without any disruptions of service, it will be safe and secure and affordable.

What's complicated is achieving the infrastructure needed to deliver on those expectations. We have established the general architecture needed for smart grids and have begun putting the initial technologies, like smart meters, in place. But it will take five to 10, possibly 20 years, depending on the level of effort, to deploy the technologies to create complete, end-to-end smart grids. And we need to come up with some truly breakthrough engineering achievements to solve some of our toughest smart grid challenges. This all ties back to the need for public and private partnerships and financing to support smart grid research and deployments and training.

8. In that vein, there are always pros and cons of a solution. What are those as related to the smart grid?

The smart grid will create a more stable and efficient electric power system. It will significantly reduce the number of power outages experienced in the United States and, if an outage does occur, the smart grid will minimize its impact to such a degree that most consumers will not know that it happened. Outages, such as the one affecting New York City in 1997, would be avoided.

I've mentioned that smart grids will introduce energy efficiencies to better support the increasing demands for electricity while reducing environmental impacts. And consumers will have opportunities to use in-home energy-management tools, programmable appliances and other applications that improve their quality of life.

Unfortunately around 68 percent of consumers have no idea what a smart grid is and their understanding is needed to help gain acceptance for the technology. We need leadership in the private and public sectors to educate consumers, as well as incentives and other mechanisms to bring smart grid into reality.

9. It's not just important to have a smart grid. What other factors will contribute to truly having a smart grid?

Smart grids provide energy security because they help a country reduce its dependence on foreign energy supplies. They also protect a country's economic interests and the environment. To build a truly smart grid, we need a better backbone for the grid and we must also build intelligence into the system end-to-end.

The desired system will require a high-voltage power grid that can serve as its backbone and also efficiently integrate renewable resources into the grid. It will likely cost about $82 billion, or $8 billion per year for 10 years, to achieve the upgrades needed for the high-voltage system serving the U.S.

Making the grid smarter — which will be achieved by replacing traditional analog components with digital ones and incorporating the computing, IT, sensors and other equipment — will have a separate price tag. This will cost about $338 billion to $476 billion over the next 20 years, or about $17 billion to $24 billion annually.

It seems exorbitant, but the investment will pay for itself. These technologies are expected to reduce outage costs by about $49 billion per year and save about $20.4 billion per year from improved energy efficiencies. These technologies will also produce the intangible benefits of increased security, reductions in carbon dioxide emissions, and related environmental improvements.

10. Why is it important for states and localities to build a smart grid infrastructure?

I've mentioned the overloaded grid conditions we have today. Yet the situation is certain to get much worse, especially with the increasingly digital society. Twitter alone puts a demand of 2,500 megawatt hours per week on the grid that didn't exist before. Because of increasing demand, experts believe that the world's electricity supply will need to triple by 2050.

Localities should build microgrids because these facilities can meet community energy demands in an eco-friendly way that also provides cost advantages to consumers and families. I also believe that local commitments to microgrids will help the country overall by showcasing their capabilities and just proving that it can be done. Cities, communities, and universities are great candidates for microgrids because their microgrid projects can be manageable in size and the local participants are passionate about the opportunity and want their programs to succeed.

Local entities also can use their microgrids to develop and test innovations for consumers, such as smart homes, and the results of these programs can be used in developing other smart grid projects around the country.