Nextbigfuture interview with IEEE Fellow Massoud Amin on Smart cities and smart grids

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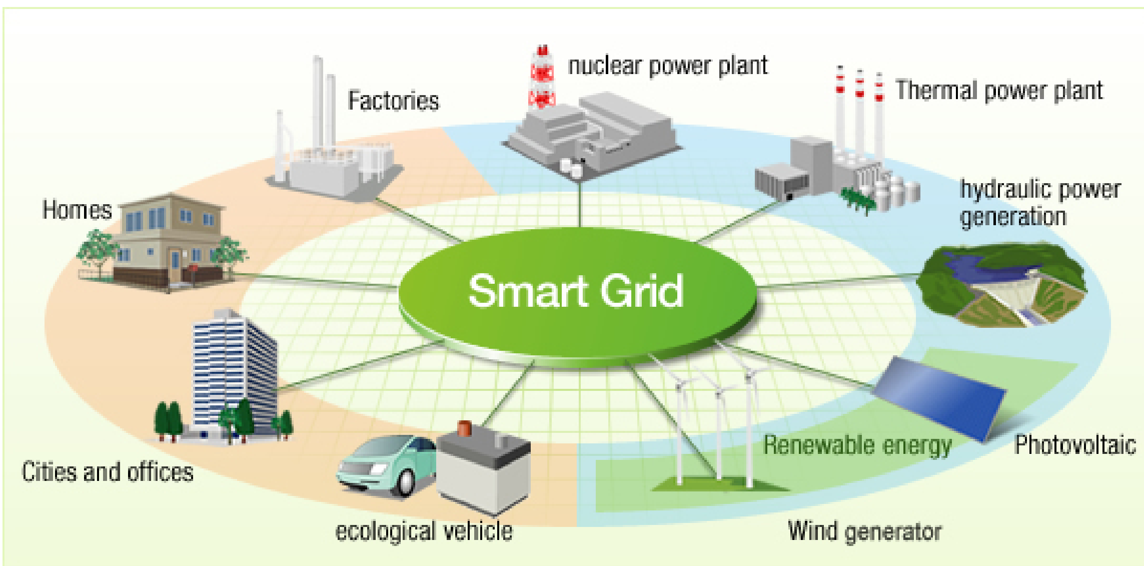
Dr. Amin is known as the “father of the smart grid” because of his teachings and work on power grid theory and research throughout the past three decades. A long list of his accomplishments includes high-ranking involvement with the IEEE, Electric Power Research Institute (EPRI), Texas Reliability Entity, and Midwest Reliability Organization. Most notably, Dr. Amin’s expert knowledge on grid security has led to a recent interview on NPR and many other notable media outlets. He has also advised the White House, governors and other agencies on matters related to cyber security. University of Minnesota Professor and IEEE Smart Grid Chair Dr. Massoud Amin received the “Thought Leader of the Year” award.



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.

2. 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.

3. 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.

4. 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.

5. What's involved in creating a smart self-healing grid?

To transform our current infrastructure into a self-healing smart grid, several technologies must be deployed and integrated. The ideal smart grid system consists of micro grids, which are small, mostly self-sufficient power systems, and a stronger, smarter high-voltage power grid, which serves as the backbone to the overall system. Upgrading the grid infrastructure for self-healing capabilities requires replacing traditional analog technologies with digital components, software processors and power electronics technologies. These must be installed throughout a system so that it can be digitally controlled, which is the key ingredient to a grid that is self-monitoring and self-healing. Much of the technology and systems thinking behind self-healing power grids comes from the military aviation sector, where I worked for 14 years on damage-adaptive flight systems for F-15 aircraft, optimizing logistics and studying the survival of squadrons and mission effectiveness.

6. 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 micro grids because these facilities can meet community energy demands

7. Framing pressing issues, key drivers, and potential pathways forward — The top 10 drivers for change in the electric power sector, not priority ordered, include:

- Acceleration of efficiency (energy intensity dropping 2%/yr.)
- Consumer demand for more "Distributed Energy Resources" including Energy
- More cities interested in charting their energy future
- District energy systems
- Smart Grid
- Electrification of Transportation
- New EPA regulations, including on GHGs under Section 111d of Clean Air Act
- Demand Response and 3rd-party aggregation of same
- Combined heat and power / waste heat recovery
- Increasingly inter-state (and even trans-national) nature of utilities (and Storage and Microgrids contractors, which also has security dimensions).

8. In the United States, what role does renewable energy play in the smart grid? What needs to be done to access sustainable energy resources?

Much of the renewable energy and natural gas potential in the United States is located in areas that are remote from population centers, lack high demand for energy, and are not well connected to our national infrastructure for transmission of bulk electrical power.

The recent expansion of natural gas production in the U.S. has also affected development of the grid. To achieve public policy objectives, sufficient transmission capacity must link new natural gas generating plants, on-shore or off-shore wind farms, solar plants and other renewables to customers if those resources are to serve the energy needs of homes and businesses, and have the potential to replace significant portions of the oil used today in vehicle transportation.

New transmission will play a critical role in the transformation of the electric grid to enable public policy objectives, accommodate the retirement of older generation resources, increase transfer capability to obtain greater market efficiency for the benefit of consumers, and continue to meet evolving national, regional and local reliability standards. With a stronger and smart grid, 40% of our electricity in the U.S. can come from wind by 2030.

9. How is IEEE addressing the smart grid transition?

The 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.