Towards to a smart community: the role of smart grids

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In a smart community, customers will be able to interact, in various ways, with power suppliers in such a way that the social welfare of customers and suppliers are maximized. The idea of smart grid, originated in the USA early 2000, further developed in Europe, now widely accepted across the world including China, can help accomplish this goal. The emergence of smart grids is often motivated by the need of reducing emissions, maintaining energy security, preventing large-scale blackout, and providing reliability-differentiated powers.

The fundamental principles of modern electric power grid were invented about half a century ago. Under the classic notion of regulatory economics, power industry had been considered as a natural monopoly, where power suppliers are obliged to supply, at regulated prices, electrical power to demands which are generally inelastic. This "golden rule" was altered with the introduction of electric power market some 20 years ago in many countries. However, this market is not a truly ideal market, not without the introduction of demand participation. A smart grid does just that.

Enabled by the state-of-the-art communication/control technology, a smart grid allows power suppliers to collect the real-time information of electric power customers such that differentiated electric powers are delivered. A smart grid better facilitates the penetration of green power, which is often difficult to accommodate in existing grid. A smart grid may also allow customers to sell a variety of electric power services, such as but not limited to, downward reserves (turn on a washer midnight you may end up with earning credit!), frequency regulation, etc., to the grid. In a nutshell, a smart grid serves as the next-generation infrastructure which permits customers to enjoy in an ideal market.

The notion of smart grid is rapidly gaining publicity in China. In May 2009, State Grid Corporation of China (SGCC) described a vision of smart grid as: A strong power grid that takes advantage of modern information technology, that fully supports a digital economy, that enjoys automation, and that allows interactions between the network and the demand. In the same time SGCC published a staged implementation plan of SGCC smart grid. In 2010, the Chinese government followed an ambitious research plan of smart grid, focusing on the interconnection of renewable energy and electric vehicles. In addition, two demonstration projects are under construction. The first one, Jinghai City Smart Grid Project, was initiated in the fall of 2009. Upon completion, 24.62% of electricity consumptions of this mid-size town in Tianjin (with a population of about 350,000), will be supplied by green power. This grid will also be integrated with cable television, IP telephone, realizing remote control, remote measuring, and remote information collection. Several advanced technologies, including energy storage systems, on-line equipment monitoring, smart building, electrical vehicles, etc., will be tested and exhibited. Jinghai Smart Grid is also expected to realize self-healing power supply to local customers. The second demonstration project is located in Yangzhou, a city nearby Shanghai.

In Zhejiang University, we have been working very hard, with the financial support of several entities including Fuji Electric, on a number of challenging tasks. Our goal is to develop practical solutions to microgrid, virtual power plant, and grid-friendly load. Take the research on grid-friendly load as an example. An interesting observation we found is that: much of the electrical loads can be temporarily reduced without introducing an essential impact on load performance. A classical example is that of residential air conditioning load. This implies that the characteristics of loads can be made grid-friendly. What is missing here is the information exchange between the network and the load. Therefore, in a smart grid regime, the notion of load participation should include frequency control, emergency voltage stability control, etc. This seems to be a potentially powerful and relatively new concept compared with the traditional demand response programs.

In summary, despite of the confusions and controversies, smart grids are gaining acceptance world wide. It is our view that eventually the core functions of smart grids will be identified and implemented, leading to the development of a much more efficient infrastructure, a win-win solution to both power suppliers and customers.

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