



# Evolution of the smart grid in China

**Development of this enormous market could shape the future of the smart grid globally.**

**David Xu,  
Michael Wang,  
Claudia Wu, and  
Kevin Chan**

China has become the world's largest market for power transmission and distribution (T&D) and is poised to become a major consumer of smart grid technology. Commitments by China's political leaders to reduce the carbon intensity of its GDP by 40 to 45 percent by 2020 relative to 2005 and to increase the use of renewable power promise a massive transformation of the nation's energy landscape. The ambitious plans have attracted top equipment makers, communication device players, and integrated solutions providers from around the world.

China's smart grid market will be large and influential for two reasons. First, China's increasing commitment to green development will

lead to a tremendous need for smart grid technologies. Second, China has a unique structural context that could enable it to leap ahead in the development of the smart grid: government ownership of the T&D sector, the market's ability to drive down equipment costs, and the central role that government can play in the economy make this possible.

China may not, however, fully exploit this opportunity. Government regulators will have to create a suitable vision for the nation's smart grid and provide appropriately supportive policies and incentives. State Grid and Southern Grid, which own 80 and 20 percent of the grid system respectively, will need to establish



effective standards and build systems and capabilities that focus on demand and supply in a balanced way.

Equipment makers can facilitate the process and profit from development of this market: global players will need to bring their best technologies and solutions to bear in order to earn a share in what will be one of the most important and competitive smart grid markets. Local players will need to upgrade their technologies and help China move down the cost curve. The next 12 to 24 months will reveal just how fast China's smart grid will actually develop.

### **China's tremendous need for the smart grid**

As China increasingly embraces energy efficiency and clean energy, it will need smart grid capabilities to transform the demand and supply sides of the nation's power industry.

On the supply side, a massive build-out of renewable energy sources will increase the need for grid connections and management systems to handle the intermittency of these sources. As of 2009, less than one-third of wind power plants were connected to the grid, due to limitations in the transmission network and the difficulty of dispatching intermittent power, among other reasons. By 2020, China is forecast to have more than 100 gigawatts (GW) of installed wind capacity. Solar power presents similar challenges, though China is targeting an installed capacity of only 20 GW by 2020.

China is furthermore expecting a significant increase in combined heat and power (CHP) capacity, while building-integrated photovoltaics (BIPV) and rooftop solar PV are also receiving

greater attention. In particular, CHP could grow from less than 100 GW in 2009 to 400 GW by 2020, if it proceeds on an aggressive development path.

On the demand side, the continuing urbanization of China's population and the potential for distributed power together create tremendous opportunities for the smart grid. McKinsey estimates that China's urban population will grow from 640 million in 2010 to 840 million in 2020. The increasing share of residential demand within total power consumption could accentuate peaks and troughs in the load profile.

Urbanization is also speeding introduction of electric vehicle (EVs), which China is aggressively promoting; projections indicate that 5 million EVs could be on Chinese roads by 2020. These vehicles will add significant load to the electricity grid, which will need to be managed carefully.

As is true with many demand-side energy efficiency measures, the net present value of many smart grid opportunities is positive. Our experience suggests that a pilot focusing on smart meters and home-area networks in a Chinese city could pay for itself in 6 to 7 years, and create significant environmental benefits through energy savings and emissions reductions.

Working from China's definition of a "strong and robust"<sup>1</sup> smart grid, we estimate that China's smart grid market could total \$20 billion annually by 2015. While more than 60 percent of that investment is expected to be associated with the rollout of the UHV transmission system, by 2015 the markets for smart meters and wind power connectivity, for example, could reach \$2 billion and \$800 million respectively on an annual basis.

<sup>1</sup> China's own definition of smart grid as characterized by State Grid's "Strong smart grid" includes a broader range of applications than the definitions used in accompanying articles; the market estimate here includes some components of grid transmission excluded elsewhere, especially ultra-high voltage (UHV) transmission.

## If the smart grid grows in line with its potential, the government could accomplish two goals at the same time—driving economic development and increasing environmental protection

### China's unique structural context

Beyond the sheer scale of demand that this market will generate for smart grid technologies over the next 5 years, a number of other factors present in China will contribute to its global smart grid impact.

- *World's Largest T&D market.* In 2008, capital expenditures by State Grid and Southern Grid combined reached \$43 billion, a figure expected to grow at an annual rate of 15 to 20 percent over the next 10 years. This scale of spending will permit China rapidly to incorporate the latest technology into its system, set its own standards, and even lead standard-setting efforts globally.
- *Potential to drive down costs and grow equipment supply.* Due to cost advantages across the value chain, power generation equipment from China can be 30 to 50 percent cheaper than comparable products manufactured in developed markets. China has already become the original equipment manufacturer for smart meters offered by leading global utilities. The net effect of this ultra-competitive equipment sector is that China has ready access to cost-competitive equipment, and its utilities will be able to build out their infrastructure faster than anywhere else.
- *Ability to standardize and replicate.* Integrated ownership of utilities and the T&D system will enable China to drive unparalleled consistency of standards across the nation at lightning speed. State Grid is drafting standards for smart meters and renewable energy connectivity with the expectation that these standards will be piloted in 2010. Replication of these standards will allow China to leverage its massive production capacity fully and utilize intense internal competition further to reduce costs of the smart grid rollout.
- *Local governments' focus on economic development.* Many local governments are restructuring their economies through investments in the smart grid. Yangzhou, for example, plans to develop a smart grid-technology cluster together with photovoltaic and new materials industries. Wuhan is seeking to distinguish itself as the EV city with a strong interest in developing a smart grid cluster.
- *Centralization of political leadership.* China's central government can expedite policy setting and coordination across multiple departments and jurisdictions, and with key industry players. In its drive for greater energy efficiency, the central government has adopted key performance indicators that have been rapidly cascaded to provinces, cities and towns.

### Crucial role of key stakeholders

China's success in becoming a global leader in the development of the smart grid depends, however, on all stakeholders playing their parts, including leading grid companies and domestic and global equipment and service providers, with the government taking a critical leadership role.

**Government: Provide critical enabling leadership**

If the smart grid grows in line with its potential, the government could accomplish two goals at the same time—driving economic development and increasing environmental protection. The State of California offers a useful illustration of how regulators can provide the support needed for smart grid efforts to thrive. To clear away some of the disincentives preventing utilities from pursuing demand-side management benefits through demand response or energy conservation programs, California has sought to decouple utility revenues from the number of kWh sold. As a result of these efforts, California's leading utility, PG&E, was able to begin deploying advanced smart meters in 2006. By the end of 2009, the company had installed almost 3 million meters, creating the largest installed base in North America.

To realize the full potential of the smart grid opportunity, China's government will need to play a vital and visionary role. This role could involve four market-shaping actions.

1. *Creating a vision for the smart energy system.* China's emphasis on a supply dispatch paradigm reflected an urgent need to expand generation capacity in the early 2000s, but rapid urbanization combined with increases in distributed power will necessitate shifting to an emphasis on demand-supply balancing. Such a smart energy system will require the government to create incentives to support demand-side applications for the smart grid, in parallel with supply-side developments.
2. *Driving pilots and implementation with supportive policies.* Cities could actively participate by piloting special financing,

tariffs, and collaboration models to facilitate the testing and implementation of smart grid technologies.

3. *Supporting the development of industrial clusters.* A leading metropolitan area is considering creating a special industry fund and 20 city-level incubation platforms to transform itself into a "smart grid valley." Funding and assistance with talent development will be central to this effort.
4. *Push for holistic city-level solutions by integrating energy services.* Energy management services that help building owners and occupants reduce their energy consumption can generate sufficient energy savings to reduce energy bills and pay back investments made by the energy management provider. Although these services represent a somewhat unconventional business model, they are financially viable, and pilots are being set up in several cities.

**Power grid companies: Set standards and adapt operating systems**

Development of the smart grid offers China's power grid companies a remarkable opportunity to transform their performance and develop new businesses. They could significantly reduce capital expenditures associated with smart grid deployment through economies of scale, in much the same manner that China completed the world's largest build-out of power generation and grid infrastructure cheaper and faster than would have been possible anywhere else in the world.

The smart grid could also enable grid companies to handle the intermittency of renewable energy sources more effectively, as well as facilitate peak-shifting, reducing the need for additional

generation capacity by as much as 25 percent. Finally, the smart grid could enable China's grid companies to build a new platform for globalization in the same manner as Korea Electric Power Company (KEPCO) did, which used its experience in smart grid technologies to create advantageous international partnerships.

To realize the full potential of this opportunity, grid companies would need to address three core areas.

1. *Standards.* Grid companies could help prioritize and establish standards by systematically leveraging pilots to test the latest technology and verify the business case for deployment. State Grid, for example, is beginning to set standards for grid connection of renewable energy sources and information transmission. Local utilities can play a similar role by running pilots of smart meters and home-area networks.
2. *Systems.* Given the transformative potential of the smart grid, utilities will be expected to go beyond making incremental improvements to establish a vision of service for the future, and then work backward to develop a transition plan to that future state.
3. *Capabilities.* The smart grid will create demand for new or highly enhanced capabilities in such areas as data management, charging infrastructure for EVs, and customer service that can support new smart grid applications.

**Global equipment and service providers: Compete for a place in the largest market by bringing the best solutions**

For a global equipment maker, success in China means capturing a share of the largest T&D market of the world, testing technology not yet

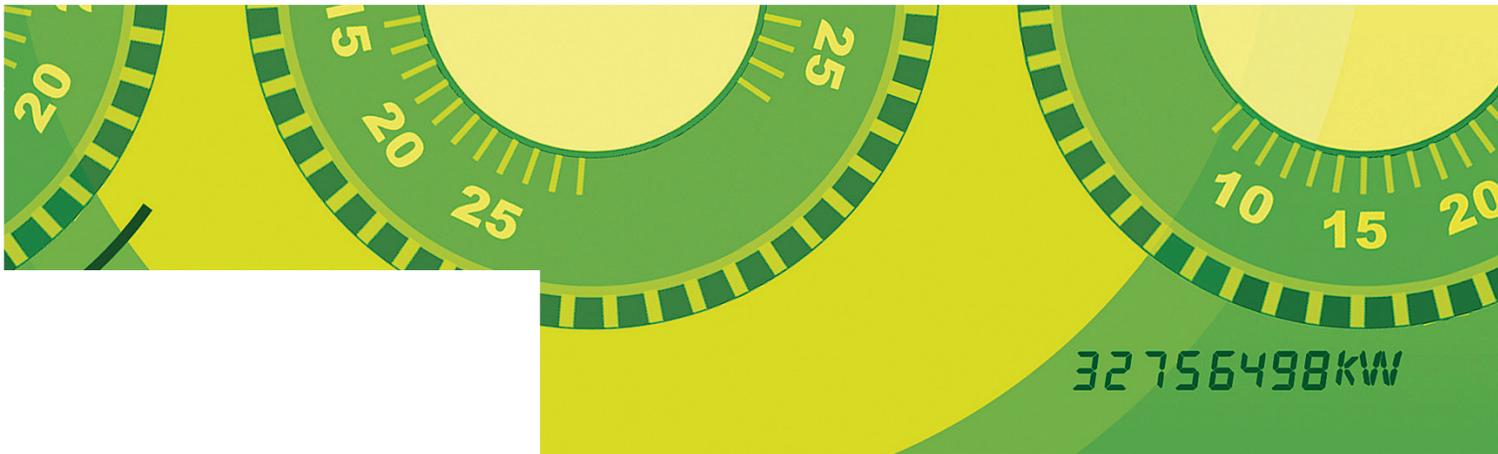
used elsewhere, and establishing an advantageous cost position to compete globally. China's power equipment sector is, however, already one of the most competitive in the world. The challenge will be to maintain a distinctive offering and position at a time when active local competition on similar technology is driving the market toward commoditization.

Global players will have to be aggressive but smart about how they compete. Success will likely require tailoring product offerings, introducing first-class technology that can be localized for China's needs and expectations about the total cost of ownership. In the smart meter space, for example, China is looking at a cost of \$100 or less per smart meter versus an expected \$200 to \$400 in the United States, based on lower expected functionality and shorter expected lifespan (7 to 10 years versus 10 to 25 years or more).

**Local equipment and service providers: Upgrade technology and drive down the cost curve**

For Chinese firms, the smart grid is a major opportunity that could provide a platform for global leadership. In the T&D sector, local players have been increasing their market share in recent years, though they are not yet seen as technology leaders. For them, missing this wave of smart grid development would mean the loss of an important opportunity to break through the existing structure of the T&D industry and seize a true leadership position.

The crucial breakthrough for local players will be to upgrade and build core technological capabilities through a skillful combination of in-house development and global partnerships. In step with these technology upgrades, local players should leverage local relationships to scale up production and help China move down the cost curve.



China could soon become the most significant market in the smart grid arena, in the same way that it has emerged as the world's most important T&D market. Despite China's advantages, however, nothing guarantees that it will achieve that level of global impact. Much will depend on the degree to which the key stakeholders—the government, China's two giant grid companies, as well as local and global equipment makers—seize this momentous opportunity.

One indicator of China's resolve could be the speed with which it starts piloting customer applications (especially HAN applications), in parallel with the testing of more flexible time-of-use electricity tariff schemes. Another possible indicator would be the testing of advanced smart meters capable of supporting two-way electricity flows, a necessary first step for integration of distributed power sources, including many renewables.

Proactive equipment and service providers will take this period of uncertainty as an opportunity to shape the landscape, working with government and key utilities to co-develop standards and support pilots. Given the significance of the potential prize, there is tremendous value at stake for all players in this market. ○