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Over time, China's "Internet+" initiative will transform electric power generation, distribution, and consumption. >>

China's Internet+ Route to Energy Intelligence

By Yin Cao, Energy Internet Lead Researcher of Cinda Securities

Long associated with inefficiency and pollution, China's energy industry has received a push in a positive direction in the past year by the country's Internet+ initiative. In the 2015 Internet+ action plan, Premier Li Keqiang refers to "Internet+ intelligent energy" as the national strategy for the Chinese energy industry. The plan outlines a direction for electrical power systems reform and the development of the Energy Internet in China.

Though most Chinese power generation enterprises are holding onto a wait-and-see attitude, there are a few Chinese entrepreneurs who have begun the development of intelligent power equipment, including remotely controlled platforms and energy crowdsourcing infrastructures. Comparatively, innovators lack the close, historical ties to the two largest electricity distributors with the business leverage to drive change: the State Grid Corporation of China (SGCC) and China Southern Power Grid (CSG).

The electric power industry is not alone in China for delaying the transition from basic Information Technology (IT) to the advantages of "knowledge-based" Big Data analytics. Many other traditional power companies are operating with a bare minimum of IT facilities and are yet further behind the business value generated by Big Data technologies.

The demands of our ongoing technical evolution require power companies to adopt a step-by-step approach for transitioning to Internet+ intelligent energy solutions.

The goal is to enable power companies to evolve to "smart power" platforms through equipment digitization — i.e. the addition of sensors and connectivity to their infrastructures — and follow-through to adopt comprehensive levels of intelligence through real-time analytics in preparation for the eventual realization of complete Internet+ systems.

Digital Energy

The first step in the evolution plan is to add an end-to-end layer of digital sensors to existing energy networks. The data captured from this sensing layer enables power companies to see the operating status and ambient conditions of devices and systems at all times in real time. For example, sensors on primary equipment such as transformers can collect voltage, current, frequency, load, temperature, and physical integrity details.

Unfortunately, this first-level digitization is uneven across the grid in China. There is a higher proportion of networked sensors in the power generation and transmission equipment of larger cities — where the installation of secondary sensors has begun — but often quite little in smaller cities and rural areas.

Generally, the ability to utilize the sensor data for continuous monitoring of the power distribution network is weak throughout China and nonexistent in small cities and rural areas. Even where sensors are deployed, data collection granularity is not ideal. The low-density data is not able to report the actual operating status of the power system. Further, power producers are unprepared to collect, process, or analyze the massive amounts of unstructured data, such as web logs, video, and audio recordings that pass through their IT systems.

Smart Energy

For the purposes of this article, "smart energy" refers to system upgrades from first-level digitization platforms that have yet to reach a high level of intelligence. Based upon the potential for comprehensive sensor networks, a smart energy system will implement full-domain control through the interactions between different sub-systems of the power generation and distribution plant. In addition, smart energy systems will provide users and system administrators with multiple optimization schemes tailored to match working conditions and environmental factors in ways that enable the system to work most efficiently.

Coordinated smart energy systems will reduce power consumption, improve equipment reliability, and enable power companies to achieve optimal operating results.

Although the smart energy system will implement remote control of substations at some core sites, the system will be far from achieving full-domain remote control. Most field operations will continue to be performed by on-site engineers making on-the-spot decisions — an approach that guarantees slower response times for crew positioning and the risk of introducing errors that may affect system reliability.

Intelligent Energy

Automated smart energy systems based on computer-aided decision-support are enabled by modern data analysis techniques. For power utilities, state-of-the-art information processing technologies are critical to maintaining the levels of reliability that are vital to the good health and profitability of each business and the industry as a whole.

Due to the real-time nature of electricity production and consumption, the primary challenge is maintaining the balance between supply and demand. The ongoing installation of huge numbers of renewable energy generation sites and growing diversification of consumer demand promise to bring greater fluctuations on both the supply and demand

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sides. Advanced ICT solutions that include Big Data analytics are the most effective way to manage modern electric power systems.

Advanced power utilities will integrate data from a wide variety of sensor modules deployed throughout the power production, distribution, consumption, and storage systems. The implementation of system-lifecycle modeling will enable intelligent energy systems to learn, adapt, and evolve by themselves.

The power utilities that achieve these objectives will be those best positioned to provide clean and economical electricity by managing the balance between supply and demand.

The adoption of ICT-based intelligent energy solutions will drive two major trends over the coming decades. First, on the supply-side, the production, distribution, and consumption of electricity will be integrated to an unprecedented degree. And second, the application of Big Data to business management will enable the correlation of historical analysis, current status, and predictive modeling of the energy value chain.

Internet+ Intelligent Energy

The addition of Internet+ technologies is the final phase of the energy industry evolution as is currently understood. The goal is to actively employ Internet business models to transform the energy industry according to the following steps:

- Development and deployment of intelligent hardware.
- Systemic software design.
- Release of open platform interfaces.

Intelligent hardware will enable the active control of power system consumption, utilization, and infrastructure resources, including nuclear, gas turbine, wind and photovoltaic generation, power distribution automation; demand-side response based on inputs from intelligent building; and policy-managed energy storage utilization.

Sensor data from every part of the energy system will feed Big Data platforms. Energy management software suites are being developed to provide real-time asset management and operation optimization services. Software applications include routines for environmental health, safety, and predictive maintenance.

Energy Internet

Enterprise Energy Internet cloud platforms will connect operators with each and every piece of equipment involved in power generation, transmission, distribution, sales, and consumption.

Ultimately, Energy Internet application ecosystems will form around enterprise Energy Internet cloud platforms. Energy Internet App factories will employ social forces to generate the data used to create real-time supply and demand models on Big Data platforms. Enterprise electricity sales service platforms operated by grid utilities will provide reference application modules for deployment on their Energy Internet cloud platforms. In this way, operators become application developers able to provide targeted services for diverse populations of energy users.

The core task of Energy Internet construction is the building of open platforms for implementing end-to-end interactions across the entire value chain. Internet business models and Software-Defined Networking (SDN) are expected to be used to link energy producers and consumers in ways that encourage end-user participation in building the Energy Internet ecosystem. So, while it may not be possible for every utility to implement a user-friendly Energy Internet strategy, it is entirely realistic that Energy Internet-enabled enterprises on the demand-side coordinate the balance of local, renewable electrical generation sources with large-scale, centralized facilities. ▲