

Power reform

ABB technology is helping to liberalize China's power market.

Marina Öhrn, Peter Maltbaek

China has gone through a remarkable transformation in the last decade or so and the stress that this has created on the power sector is considerable. Power consumption in China is increasing at rates completely unheard of at any other time in any other part of the world.

In recognition of this, as well as for economic necessity, the Chinese cabinet officially approved the "Power Industry Reform Program" in March 2002 with the aim of fundamentally restructuring China's power sector and dismantling the vertically integrated monopolistic structure of the industry. The principle measures of the reform promote the separation of administration from operations, the separation of power generation from power transmission and fair and healthy competition among power producers.

As a consequence, the former State Power Corporation of China was split up in December 2002 to form two grid companies (China Southern Power Grid Company and the State Grid Corporation of China), five power generation groups and four other affiliated companies. The State Grid Corporation of China is itself made up of five super-regional sub-grids and three provincial grids. One of the primary objectives of this break-up is the creation of an industry that is more responsive to the booming demand for power.

De-aggregation of the power industry is not an entirely new or unproven concept. It has been adopted extensively in the west and is commencing in other Asian countries. The objectives are to introduce competition into wholesale power generation and retail supply, and to increase the efficiency of production and optimize resource allocation to reduce the overall cost of power to the consumer. These benefits have already been realized, to various degrees, in parts of Europe and the US as well as Australia and Singapore.

China is also rationalizing a power tariff system to stimulate the independent development of the power industry and to promote nationwide grid interconnection. Initially, the aim is to open part of the generation market and implement a transparent cost structure in transmission and distribution businesses. As the reform process continues, a consolidated power market will be created in which transmission and distribution access will become available to independent pro-



ducers. The creation of entities to control the dispatching of power and operate a trading floor type of power exchange is visualized for a second phase. The new tariff will also allow for the direct sale of electricity to large end-users, something which was not previously possible.

A clear legal structure is being established which will define the relationship between parent and subsidiary companies and between regional network and provincial operators. The ultimate goal is the realization of full competition among all market participants, and the establishment of power related financial markets such as power futures and power options.

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Regional power trading in China

Before the benefits of effective power deregulation can be seen, however, the necessary physical infrastructure has to be in place. Obviously power cannot be traded between places that have no physical interconnection. Each of the eight regions of China currently within the State Grid Corporation has a closely meshed internal high-voltage transmission grid, but the electrical interconnection capacity between these regions is, in many cases, quite limited. Boosting the power transfer capability between these regions is now a priority and several major projects are already under construction or in the final stages of planning.

Even though the eight regions within the State Grid are not necessarily aligned directly with the political boundaries of China's Provinces, they are candidates for "regional power markets" in much the same way as Regional Transmission Organizations may cover several states within the US. One such region is in East China.

The East China Grid Company Limited (ECGC) is one of five state-owned groups that oversee provincial power companies. The utilities under the jurisdiction of ECGC serve nearly 200 million people in the city of Shanghai and the provinces of Anhui, Jiangsu, Fujian and Zhejiang – the eastern region of the country that has enjoyed steady economic growth over the past decade. That growth, however, has brought with it severe electricity shortages as the region's generation and transmission capacity struggles to keep pace with the booming economic development.

To meet the increasing demand, ECGC has invested in new generating assets, such as nuclear projects and coal-fired plants, to take advantage of China's extensive reserves. In addition, East China has recently started receiving power from a 500kV DC transmission line that connects the region to hydro-power facilities 800km to the west, including the Three Gorges project. This has provided some temporary relief from the generation shortage, but the challenge of keeping up with demand remains.

Since East China is one of the country's most economically dynamic areas and one of the areas most in need of a major shift in policy, the region was chosen to introduce the restructuring process under a pilot program. This program is intended to ensure that information systems, market mechanisms and regulatory policies are tested and proven before the "experiment" is extended to the rest of the country.

It is expected that the pilot program will do much more than simply boost generation and transmission capacity to support future growth. The program is intended to create and test the future of China's electric power industry.

Early in 2003, ECGC signed a contract with ABB to provide the critical IT systems that will control the physical grid and the electricity markets it will support. ABB will provide a two tiered solution: its Network Manager SCADA/EMS will deliver the SCADA and EMS capabilities and Network Manager BMS – SABLE will provide the framework for the region's wholesale power market. The Network Manager SCADA/EMS system provides a complete set of

advanced power system application functions. Network Manager BMS comprises ABB software solutions for independent system operators, regional transmission organizations, power exchanges and other entities charged with managing competitive wholesale markets for electricity [1]. The integrated IT systems are scheduled for operation in mid-2005.

Market participants can enter bids/schedules for the real-time and forward markets via a portal that offers both Web-based and programmatic interfaces.

Network Manager SCADA/EMS system

ABB will install Network Manager at ECGC's power network dispatch center. This system will supervise and control the power transmission network and optimize its operations. When complete, the East China Electric Power Group Corporation (ECEPGC) facility will act as a nerve center for 64 Remote Terminal Unit (RTU) links, hundreds of substations and Inter-Control Center Communications Protocol (ICCP) connections to the EMS systems of four adjacent regions [2]. The system will be accessed via fifteen operator consoles (the information will be displayed in Chinese) and will be run on redundant servers to ensure reliability. The

applications can be tuned for real-time control and analysis as well as for optimization and planning purposes.

The Network Manager platform uses a web-based full-graphics interface, a real-time relational database and a modern process communication system to provide uninterrupted real-time communications with field equipment and neighboring control centers. Although it is an open and versatile platform, it allows for easy integration of utility information systems while maintaining IT security levels.

The Network Manager SCADA/EMS is equipped with a full complement of planning, scheduling, and predictive and control software applications required to ensure system reliability while minimizing long-term capital expenditure (see text box).

Network Manager BMS: wholesale electricity market administration

ABB's Network Manager BMS is an open, multi-tiered, web-enabled system that includes a range of applications to manage electricity market operations and related communications. Market participants can enter bids/schedules for the real-time and forward markets via a portal that offers both Web-based and programmatic interfaces. They in turn they will receive awards, market data and other communications from the market operator. The software includes:

- Bid validation and verification applications.

- Security-constrained economic dispatch application to perform congestion analysis and compute market clearing prices.
- Components to provide interfaces for settlement and accounting applications.

The system also includes market participant registration, authentication and related transaction security features.

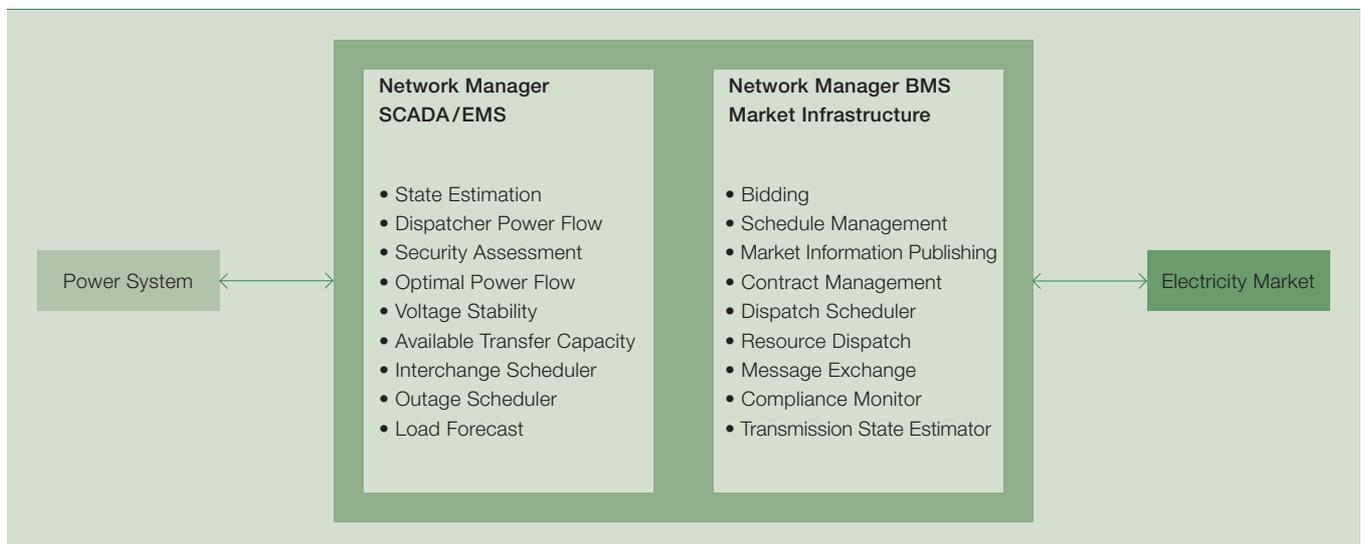
The system is configured to flexibly accommodate changes in market rules as they evolve.

Systems implementation

The Network Manager BMS supports energy, ancillary services and congestion management markets in both real-time and forward modes. As an "early delivery" system, ABB provided a day-ahead market system in January 2004 giving ECGC the necessary components to run the day-ahead market. This enabled the organization to begin preliminary market tests, evaluate proposed market rules, and train its staff and market participants in the process and methods of managing the electricity market.

The system is configured to flexibly accommodate changes in market rules as they evolve with the policies instituted by the Chinese government in accordance with its industry restructuring plan. ECGC's goal is to achieve

2 Solution components.



a fully operational market within 12 to 18 months.

Integration testing between the new EMS systems and the day-ahead market systems is currently being conducted in Santa Clara, together with on-going market testing of the market systems. The complete market-ready system is slated to go live in mid-2005. The purpose of getting this system ready for market trials goes well beyond working out processes and identifying potential bugs. Indeed, the extent to which both the market operators and market participants are comfortable using these new tools will have a tremendous impact on how smooth a transition the East China market will make when it eventually opens its doors for business.

Ensuring the user's confidence with the new system

Another user of ABB's market operation systems, the Ontario IMO, undertook comprehensive market trials, even extending them beyond the originally scheduled period. Because the IMO had not operated a deregulated power market before, one of the highest priorities in the project was to ensure that the people running the market and those participating in it had as much confidence as possible in the system before using it as a real application.

By design, ECEPGC has separated the implementation of the commercial systems – billing, metering and settlements – necessary to support the wholesale market from the SCADA/EMS and market management systems now being developed.

The result was a decidedly uneventful – and therefore highly successful – market opening. The lesson here appears to be that complex market systems must work as well with their human counterparts as they do with

3 Typical control room.



their electronic ones if the market is to function properly.

Flexibility is key

Another benefit of a substantial market trial is the opportunity it affords policymakers to evaluate various market rule adjustments. By design, ECEPGC has separated the implementation of the commercial systems – billing, metering and settlements – necessary to support the wholesale market from the SCADA/EMS and market management systems now

Network Manager EMS

In addition to the standard SCADA functions (eg, data acquisition, data historian, fault localization, etc.), these applications include:

- Outage scheduling
- Interchange scheduling
- Load forecasting
- Unit commitment
- Automatic generation control
- Economic dispatch
- Reserve monitoring
- Production costing
- Network analysis
- State estimation
- Security analysis
- Dispatcher and optimal power flows
- Operator training simulator

being developed. The early delivery of Network Manager BMS will provide the organization with a sort of economic laboratory in which to try out various market rules and evaluate their impact in a controlled environment, before the other software required for the auxiliary functions of “live” operation (real money changing hands) is configured to the final market rules and subsequently purchased and installed.

Obviously, it is necessary for the market administration software to be able to accommodate a steady flow of changes in order to support this process. However, this level of flexibility is also important after the market opens. Unforeseen events

and changes in policy direction are inevitable, and the systems that enable wholesale energy markets must be able to respond to the vagaries inherent to them.

This means changes must be implemented quickly and without significant reworking. To make this possible, market systems in turn must be flexible and able to accommodate market rule changes through reconfiguration rather than redefinition.

Industry pundits may be willing to commit themselves to a particular tack when it comes to the path restructuring will take. However, when it comes to the IT systems that enable this restructuring, pragmatism is the order of the day. By bringing a flexible, integrated solution to bear, ECGC is well positioned as China journeys towards a competitive wholesale energy market.

Marina Öhrn

ABB Utilities GmbH
Mannheim, Germany
marina.ohrn@de.abb.com

Peter Maltbaek

ABB Inc.
USA
peter.maltbaek@us.abb.com