

The Review of the Electric Power Market Reform on Electricity Sale Side

Jiazhuo Xu

School of Astronautics, Harbin Institute of
Technology
Harbin, China
xyy960318@hotmail.com

Yufeng Guo

School of Electrical Engineering and Automation, Harbin
Institute of Technology
Harbin, China
gyufeng_hit@163.com

Abstract—Based on the power system reform 5 and 9, the China's power system market is in a positive stage of reform. After the 9th, the reform is mainly aimed at the establishment of a fully functional power market system. This reform requires the power generation, transmission, distribution, electricity selling links being vertically separated. China needs to break the monopoly model, and strive to achieve a retail competition model. The market needs to make the plant and the network apart, introduce competition, and strengthen regulation in order to achieve the greatest effect of reform. This paper first summarizes the path and mode of the reform in China suitable for the developing countries. And it compares with the foreign reform process, and analyzes the current situation and existing problems of the reform. At last, this paper prospects the future development.

Keywords—Power market reform; reform on electricity sale side; competition; vertical separation; regulation

I. INTRODUCTION

According to the ninth official document about the reform, China made the goal of this round reform clear. The goal is 'to gradually establish a fully functional power market system with a long-term transaction to avoid risks, a spot market to set the price, and a full range of transactions. Gradually form a fully competitive, open, orderly and healthy developing market system.' China's power system used to be a traditional vertical monopoly power market. However, after the first round of electricity reform (the early 1980s to the early 21st century), China's power system has basically changed into a single buyer model with the combination of the transmission side, distribution side, and the sale side. But the separation is not complete. Combined with the current situation of China's power market development, China's power market is constituted by national power markets and regional power markets and provincial power markets. Although after years of development and reform, China's power market has made great achievements. The basic system has changed, but there are still many problems. These problems still exist and are in urgent need of reform.

Therefore, the second round of reform makes the introduction of competition as the focus, and strives to transit from the wholesale competition model to the retail competition model. With the transmission grid and distribution grid remaining the monopoly nature, reform uses fierce competition of the sale side to make the electricity price reasonably decline and effectively improve the wholesale efficiency and the user's welfare. The transition process of the retail competition model needs to make the power generation, transmission, distribution,

sale side these four aspects vertically separate, vigorously introduce competition, and further improve the separation of plant and grid. Then through the national power regulatory agencies, conduct a fair and reasonable supervision in order to form a reasonable and benign competition power market. Therefore, the reform of the electricity sale side is particularly important in this round of reform. Shown in Fig. 1 and Fig. 2.

II. The Path and the Pattern of the Reform

The new round of power market reform mainly focuses on the sale side. In this round, the electricity grid is no longer the main body of electricity transactions, but plays the role of transmission and distribution service providers, only charging 'net fee'. Electric power business model changes from the planned electricity sales to the government to the direct sales to the users according to the market demand. The sale side reform is mainly introducing competition to the side, giving users the freedom to choose, and using the government's supervision to make electricity prices set into a market control model. Shown in Fig. 3.

A. Establishment of power trading institutions

The establishment of a relatively independent power trading institutions, the formation of fair and standardized market trading platform, is one of the vital changes in this round of reform. The trading institutions set up according to the requirements of the electric reform, are mostly grid-based enterprises with the form of the grid companies holding the shares. At the early stage of the establishment, before the independent operation, the trading staff should be based on the existing personnel of the grid companies. Personnel relations and wage relations remain unchanged and funding is still protected by the power grid enterprises. After the trading organization has the independent operating conditions, the independent operation of the company can be realized under the implementation of the government supervision. Taking the state grid corporation for example, since 2006, the transaction business has been separated from the power dispatch center to achieve a relatively independent transaction business. On November 28, 2015, the National Development and Reform Commission and the National Energy Administration approved the Chongqing City and Guangdong Province to carry out sales

reform test program. According to incomplete statistics, as of May 2016, there are more than 420 electricity sale companies incorporated, including central enterprises, local state-owned enterprises, private enterprises and mixed ownership enterprises. At present, the comprehensive pilot scheme has been introduced in Beijing, Yunnan, Guizhou, Shanxi, Shaanxi, Gansu, Shandong, Xinjiang, Hubei, Hainan, Guangxi, Liaoning, Henan, Hebei and Anhui. Among them, Shaanxi, Gansu, Zhejiang, Jilin, Guangdong, Inner Mongolia, Heilongjiang, Fujian, a total of 10 areas introduced the reform program on electricity sale side.

Through the establishment of a relatively independent power trading institutions can effectively separate the electricity selling link from the four classic links. Due to the status quo of the country, transmission and distribution is still in a state of monopoly, and is difficult to have a large-scale change in a short term. The independence of electricity sale link, to a large extent, helps to realize the vertical separation, in order to make a foundation of further realization of the marketization of power transactions.

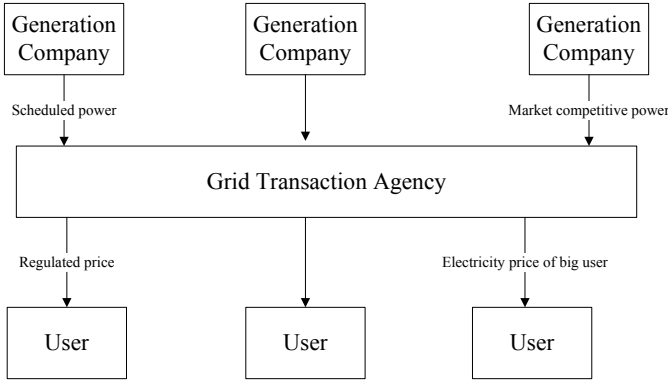


Fig.4 Single buyer model in China

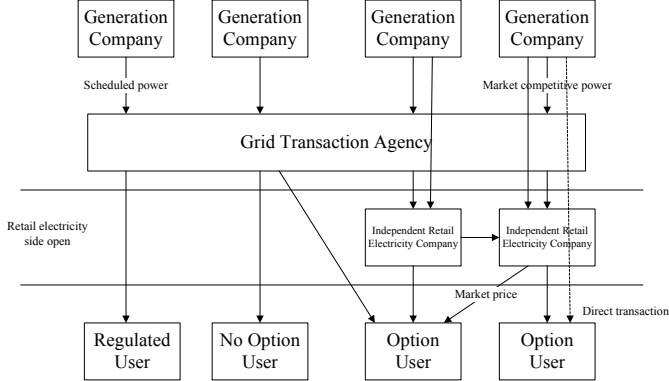


Fig.5 Market Model after Retail Electricity Side Open

B. Introducing competition to set the electricity price

The establishment of relatively independent power transactions institutions will inevitably bring some competition to the market. Reform promotes the power enterprises' consideration of the nature of electricity, which is corresponded price setting. Establish flexible pricing mechanism, abandon the original administrative pricing mechanism, authorize power supply company's provincial and municipal three independent sales companies to take a fully market-oriented price competition strategy, take a different price competition strategy

for different levels of users. The introduction of benign competition on sale side can break the power grid enterprises' single purchase model and promote the establishment of power market system.

The role of the market has become particularly important in the implementation of the "three liberalization, one independent, and three strong" requirements. China has to achieve the sale price set by the market model step by step. The government will change the price control model from controlling the two sides to controlling the middle. Through the check of natural monopoly charging electricity prices, China improves the competition mechanism in the power generation and sales link, which is conducive to give full play to the role of price signal transmission. The market plays a decisive role in the power resources allocation. At present, Jiangsu, Guangdong, Guangxi and other provinces have launched a power market bidding transactions, through the online or offline way of the actual auction.

According to the electricity price formation structure, we can calculate the profits of different links in the power market. And then set an expected price of electricity. Let Q_c , Q_r and Q_g be the generation for contract market, the generation for short-term market and the distributed generation. Let

P_c and P_r be the purchasing price in contract market and short-term market. Let a , b , and c be coefficients of cost function. The profit of the generation side is:

$$Profit_G = Q_c \cdot P_c + P_r \cdot [Q_r - Q_g]^+ |_{P_r - c_m}^+ - a[(Q_c + Q_r - Q_g)^2 + b(Q_c + Q_r - Q_g) + c]$$

Let P_s and r_g be the retail price and the cost of purchasing distributed generation. The profit of the retail side is:

$$Profit_R = (Q_c + Q_r - Q_g) \cdot P_s - Q_c \cdot P_c - (Q_r - Q_g)^+ \cdot P_r - (Q_r - Q_g)^+ \cdot r_g$$

Let P_c and P_T be the purchasing price in contract market and the transmission and distribution price. Let Q_{c1} and Q_{r1} be the power from contract market and short-term market. The cost of consumers is formulated as follow.

$$Cost_c = Q_{c1} \cdot (P_{c1} + P_T) + [Q_{r1} - Q_g]^+ \cdot (P_s + P_T) - [Q_g - Q_{r1}]^+ \cdot r_g$$

To set a proper price for electricity, it needs to consider the HHI index. The HHI index is the sum of square of all power generation enterprises' market share.

$$HHI = \sum_{i=1}^n S_i^2$$

Where, n is the number of power generation enterprises, which are involved in competition; S_i is market share of the enterprise numbered i , generally refers to the installed capacity of the power generation enterprise accounted for the proportion of the total installed capacity of competition.

According to the formula above, the expected price can be set in advance. By comparing with the expected price, the price determined by the competition can be controlled.

C. Enforcing government management and supervision

Electricity is a commodity and its particularity. In the

construction of a competitive market, China has to ensure the power grid, electricity using security, which needs the government's regulatory authorities to play an important role. To ensure fairness, we must give full play to the enthusiasm of various types of market players. The government grasp the following key links. Set up a market management committee. Improve the trading institutions management mechanism. Extensively solicit opinions from all parties. Improve the regulations of market transactions. Strengthen external supervision. Form a government supervision force. As the price of electricity is gradually becoming determined by the market, the role of government regulation is very important. China needs timely monitoring of market operations to prevent the emergence of adverse competition, and strive to ensure fair and reasonable price.

At present, under the correct leadership of the National Energy Administration and the provincial government, the South China Energy Regulatory Bureau has continuously strengthened the supervision of the matter before and after, strengthened the supervision of the power safety, strengthened the key links and important areas, and actively promoted the construction of the electricity market. China's various provinces carrying out electricity market bidding transactions are also actively play the role of government monitoring and supervision. For example, in August 2016, Shanxi Energy Regulatory Office (in the whole country) first opened additional power distribution business to the market main part that meets all the conditions. It is also the first to issue five power sales enterprises a power business license (power supply category), which marks the five enterprises with distribution grid operation right having rights to sell electricity. The companies were allowed to sell electricity in the power supply business area with the same rights with the grid business.

III. Comparison with the Foreign Developed Countries

A. Reform in England

Britain's electricity market reform began in the Thatcher era. Margaret Thatcher firmly believed that "market omnipotent" and carried out a series of state-owned industry privatization reform. In February 1988, the White Paper on "Privatization of Power Market" was published. The way to reform is to set up a power control office to turn power generation, transmission, distribution and sales into independent operations.

In the field of power generation, all the non-nuclear power plants of the State Central Electric Power Company were reorganized into British Electricity Company and British Power Company, and the two companies were privatized. Large users are free to choose power suppliers. British power market price is divided into electricity generation price, sales price and power supply price, three parts. The specific price is mainly set by the competition. The electricity generation price is the marginal price of the market after the competition, which is the highest offer the system load can accept after ranking the quotation of power producers' price, from low to high. On October 27, 2002, "China Power News" reported that the United Kingdom in recent years, due to excess capacity of power generation,

electricity prices fell by 40% compared with 1998, leading to the British power generation company operating difficulties.

British lessons have shown that electricity prices are not as low as possible. Too low electricity prices, may blow the enthusiasm of the power industry investors and operators, so that the power industry sluggish. Ultimately in turn negative for consumers.

B. Reform in America

The US electricity industry is basically a pattern with a number of power plants and the exclusive power grid. The market reform is in accordance with the unified federal regulations. The Energy Commission only proposed "the separation of plant and grid" and introduction of competition in the field of power generation requirements. The specific reform model and timetable is determined according to states' actual situation.

Over the past couple of years, there have been some problems with power reform in the United States. The most prominent is the California power crisis. California power crisis appears in the lack of electricity supply, a serious shortage of power resources, and a sharp increase in electricity prices, which is the market mechanism working. Electricity prices will certainly attract new investors, but to build a new power plant needs a year or two. The situation of power shortage can not be resolved immediately. California power crisis gives us the revelation: power supply business, regardless of the interests of power producers with "bid online" excuse, deliberately depress the interests of power producers to expand their own interests and space; large generators or generators and power supply business together make new monopoly; power supply business in order to maintain market monopoly, will easily create a variety of reasons and means to curb others to build (own) power, but when the power supply can not be guaranteed, they do not assume responsibility.

C. Reform in other countries

France did not like other Western countries makes the power system for major reforms. The state is still relatively high power monopoly, but the French electricity unit price in Europe is the lowest.

Australia, New Zealand, Japan and other countries have begun brewing power system reform. The main idea is to implement privatization and build a competitive power market. In 2002, 20% of the Japanese electricity stepped into the power market.

D. Enlightenment

The experience of the United Kingdom and the United States proves that electricity price and antitrust are the core and most sensitive part of power reform. That the price is lower or higher does not mean better. Too low electricity prices, may be against the enthusiasm of the power industry investors and operators so that the power industry sluggish; the end is in turn negative for consumers. Monopoly is not easy to break overnight, but not breaking the monopoly means no change to the power market.

It is not difficult to see that the most direct cause of the California electricity crisis is that the government controls the retail price. China is in the transition from a monopoly to a market-oriented form. The reform of the electricity sale side is the center of gravity of this round of reform. China needs the separation of the plant and grid, the vertical separation, the establishment of an independent trading institutions, and the set of a reasonable price through the competition. These changes require the government to control the direction of the power market promptly to make the appropriate rectification, to avoid the occurrence of excess electricity or lack of electricity situation.

IV. The Current Situation and Existing Problems of Reform

From the various news summary on the National Energy Administration website, a new round of power reform is accelerating. Since September 2016, in just two months, the National Development and Reform Commission approved the intensive development of Beijing and other 14 provinces or municipalities to carry out integrated pilots for reform of the power system. Fujian and other 5 provinces or regions to carry out sales side reform pilot, which means power reform pilot and sales side of the reform pilot has expanded to 26 provinces and municipalities, the basic coverage of the national economy and electricity consumption province.

Set up power trading centers at multiple levels. These centers are independent, including the national level, the regional level and the provincial level, at the same time to give the transaction center autonomy, free to cultivate a variety of trading varieties, to achieve the diversification of interactive transactions forms. For the power trading institutions, in accordance with the reform requirements, Beijing, Guangzhou Electric Power Trading Center and more than 30 provincial power trading centers have been established one by one in 2016. According to the public information, the vast majority of power trading centers have taken the form of a wholly-owned subsidiary of the grid companies, and a very small number of trading centers take the grid company absolute or relative holding company form. In general, power trading institutions are relatively independent from the power grid enterprises. The

V. The Development in the Future

According to the experience among the world, the symbol of mature power market is: the price level generally reflects the cost of return on investment; users have a strong capacity to bear electricity price, that is, strong purchasing ability; limited, steady growth on demand for electricity; the needs and abilities of raising funding. The symbol of developing power market is: electricity prices can not truly reflect the cost of return on investment, and distortion and confusion is more common; users have limited capacity of the price fluctuations, that is, purchasing power is weak; having a great demand on the construction and expansion of power facilities required funds. According to the above, China's current power market is undoubtedly the developing power market.

focus of this approach lies in the independent institutions, legal supervision, and to ensure fairness. In the sale link, the establishment of an independent power sales company, the formation of a controllable market competition to the county-level independent sales of electricity as the main body.

At present, the domestic power market structure is single. Social power is bought by the State Grid Corporation, China Southern Power Grid Corporation and other regional companies and then sold to the power users, with regional monopoly properties. The sale of electricity has almost no competition. While the power market alternative energy accounted for a very small scale, the entire electricity sales market presents a "supplier - power supply company - the users" monopoly. With the gradual development of the sale side of the reform, social capital have set up independent electricity sale companies, making the potential competitors in the power market become a direct competitor of power supply companies.

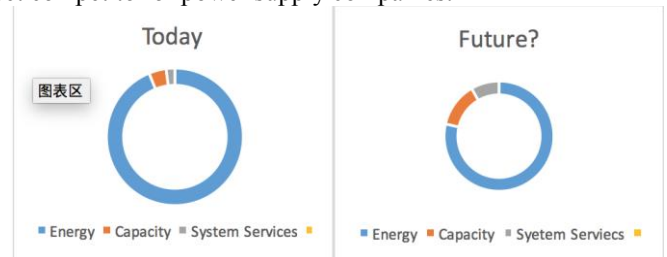


Fig.6 An Expected Possible Shift from Energy to System Services

Since 2014, after Shenzhen experimental pilot reform, the transmission and distribution price reform is carried out in China gradually. At present, seventeen power system reform pilot cities in Anhui, Hubei, Ningxia, Yunnan, Guizhou, Beijing, Tianjin, Hebei, Hebei, Shaanxi, Jiangxi, Hunan, Sichuan, Chongqing, Guangdong and Guangxi have implemented the power transmission and distribution reform. The initial construction of the grid built independent transmission and distribution price mechanism based on the market allowed cost and reasonable income. In addition, Yunnan, Guizhou, Shanxi, Guangxi four provinces in China have launched integrated experimental pilots of power reform, and Guangdong, Chongqing have carried out the pilots on sale side.

In the development in the future, we need to continue to establish a reasonable price set mechanism. Electricity prices play a decisive role in regulating power production, development and consumption. At present, China's electricity price is too messy. According to statistics, only the Beijing area has more than 200 kinds of electricity prices. China has to ensure the reasonable price stability in the premise of free competition. Establish the state electricity regulatory commission and other power supervision departments of the national power market to implement centralized and unified supervision. The reform process of the power market is full of changes. China has to adjust the program at any time according to the actual situation, in order to achieve the most suitable power market for China's national conditions.

References

[1] KONG Xiangrui, HAN Dong, YAN Zheng, SONG Yiqun. "A Stress Testing Analysis on China's Power Market in the Future Under the New Power Reform Policy". 2015 IEEE PES Asia-Pacific Power and Energy Engineering Conference (APPEEC).

[2] Wang Liwen, Shi Xinhong, Yang Zhenglin, SHI Fei, Wang Xiaoli. "The Impact of Electric Power System Reform on Power Dispatching Institution". 2016 China International Conference on Electricity Distribution (CICED 2016).

[3] Hongxun Hui, Xing Jiang, Yi Ding, Yonghua Song. "Demonstration of Friendly Interactive Grid Under the Background of Electricity Market Reform in China". 2017 IEEE.

[4] Z.J. Feng, W.Yang, X.M. Bai, L.S. Mu, Y.Y.Liu. "A New Paradigm for the Relationship Between Power Suppliers and Users through EE Services".

[5] Mark Ahlstrom, Erik Ela, Jenny Riesz, Jonathan O'Sullivan, Benjamin F. Hobbs, Mark O'Malley, Michael Milligan, Paul Sotkiewicz, Jim Caldwell. "The Evolution of the Market". IEEE power and energy magazine, November/December 2015.

[6] GUO LEI, XUE SONG. "Provincial electricity market orderly operating evaluation model adapting to the new round of electricity reform requirements". 2016 China International Conference on Electricity Distribution (CICED 2016)

[7] L.Javier Barrionuevo, Ricardo G. Rubio-Barros. "The Regulatory Reforms in the Argentine Wholesale Electricity Market" 2016 IEEE PES Transmission and Distribution Conference and Exposition-Latin America.

[8] Wan Yuting, Che Chang, Zhao Honghai. "The Research on the Use of Electricity Price on the Power Demand Management Side. China 's high - tech enterprises , 2017-10

[9] Niu Dongxiao, Chen Zhiqiang. A Summary of Reform and Development of Electricity Market. East China Electric Power , 2008-11

[10] Liang Guoyong. Analysis on the Strategy of Electricity Marketing after Sale Side Reform. Mechanical and Electrical Engineering Technology, 2017-46

[11] Gao Ciwei, Dong Li, Sun Lingling, Su Weihua. Demand Response Under the Electricity Sale Side. Electricity Offer and Use, 2017.03

[12] Wu Qiming. Reflections on the Market of Competitive Electricity Sale in the Situation of Electric Power System Reform. Research on Modern State -owned Enterprises, 2016.4 (Volumes 2)

[13] Si Heqiu. Electricity Trading Institutions: Separated From the Inside to Relatively Independence. China's power enterprise management, 2016.11

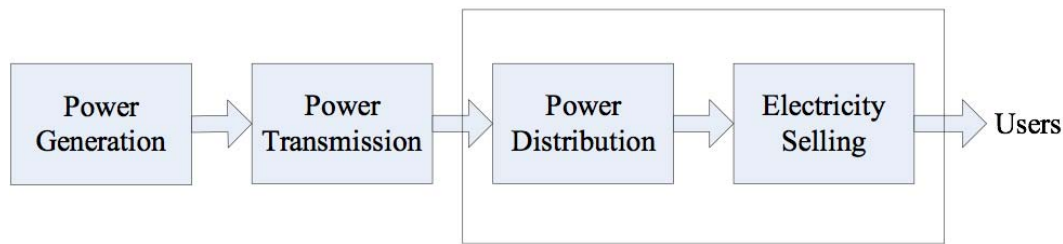


Fig. 1 Wholesale Competition Model

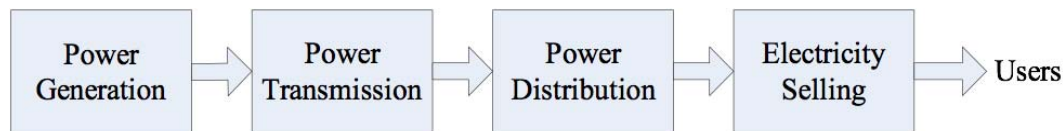


Fig. 2 Retail Competition Model

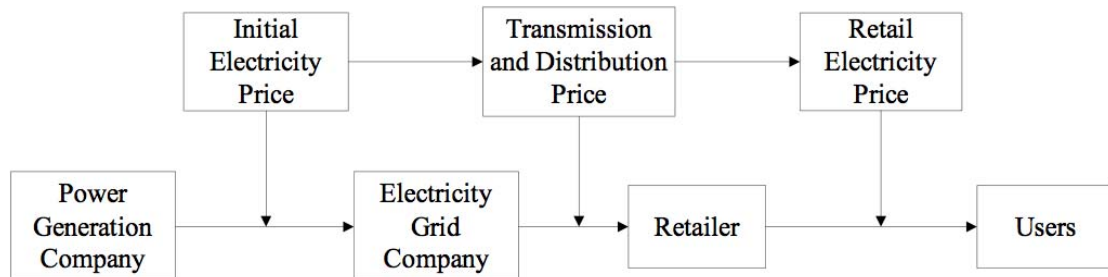


Fig. 3 Electricity Price Formation