

## RESEARCH ON THE REGULATION OF CHINA'S POWER INDUSTRY MARKETIZATION

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### ABSTRACT

*This paper first analyzes the particularity of electricity as a commodity from economic perspective to find out its impact on the design of power industry market-oriented system; and then, determines the selection of the operation mode of China's electric power marketization through the analysis and study of the four operation modes of power market and of China's power industry marketization process, and finally, presents the recommendations and strategies for the regulation of China's power industry marketization on the basis of the analysis of existing regulation in China.*

### 1. INTRODUCTION

Since 1980s, the reform bandwagon has swept across the world's electric power industry. The main subject of this reform is to ease the restrictions on power enterprises, and carries out industry restructuring, that is, disintegrate the traditional power industry under vertically integrated management into three links, i.e. power generation, transmission and distribution, and introduce market mechanism into the links with competition potential to achieve resource optimal allocation through market competition, and to promote the long-term, sustained and stable development of power industry [1-3].

The production and transmission of electric power has its unique characteristics that are clearly distinguished from other industries. Electric energy cannot be stored in bulk. Power production, supply, marketing and consumption have to be achieved at the same time. As an inseparable system, power network is required to remain stable, secure and reliable in the whole process of production and operation. Therefore, how the market-oriented reform of power industry is carried out and how to construct the framework of power market are significantly different from other industries. It is a very unique and complex process with many outstanding problems that are still under study in many countries. The study of power market is still at an exploration and development stage. The essence of power market is competition. Competition can achieve the resource optimal allocation of overall power industry. In the competitive atmosphere of power market, generation enterprises, power grid companies and users will all be the members of a fair trading market. Power and power service are commercialized. This forms a sharp contrast with some traditional ideas. For example,

power industry has to be under monopolistic operation. Competition cannot be introduced because power generation, transmission, distribution and consumption have to be achieved simultaneously; Power industry is a public utility, whose products aren't commercially characterized. Therefore, the new ideology brings a huge impact and challenge to existing power industry system [4].

In China, the study of power marketization has been focusing attention on the separation of power plants from power grid in equity relationship, reorganization of power enterprises, competitive connection to power grid and the like issues, and relatively, less attention on the impact of the particularity of commodity electricity upon design of power market system, development alternatives for the marketization of China's power industry, and the regulation of power market. Therefore, this paper is aimed to carry out a further analysis of these issues. Section 2 makes a study of the particularity of commodity electricity and its impact upon power market system; Through the analysis of power market models, the selection of the operation mode for the marketization of China's power industry is determined in light of the present condition of China's power industry marketization in section 3; Section 4 proposes the policy advices to the regulation of China's power industry marketization on the basis of the analysis of the existing regulation of China's power industry; Section 5 concludes the whole paper.

### 2. CHARACTERISTICS OF COMMODITY ELECTRICITY AND POWER MARKET SYSTEM

Power system consists of such links as power generation, transformation, transmission, distribution and consumption, which convert natural resources into electric energy, and supply it to users. Based on the principles of fair competition, voluntary and mutual benefit, the members of power system, i.e. generation, transformation, transmission and distribution enterprises and consumers, shall be reorganized, coordinated and managed by legal and economic means to form a series of mechanisms and executing systems. From technical perspective, power market is an industrial complex of power production, transmission, distribution, conversion, communication and computer systems. From pure economics and the producers and consumers' perspective,

power market first is a trade mechanism, which is fundamentally differently from traditional power industry under vertically integrated monopolistic operation, say, the participants begin to have and exercise the right of free selection, thus creating a competitive atmosphere. However, compared with common commodities, more emphasis should be placed on planning and cooperatives for power market due to the particularities of power production process in many aspects.

## **2.1 Characteristics of Commodity Electricity**

Compared with other commodities, commodity electricity has following characteristics:

### **2.1.1 Electricity cannot be stored**

Electricity cannot be stored. Power production, supply and consumption are carried out simultaneously. Power demand fluctuates greatly with time, season, and accidental causes. For electricity product, no effective storage medium is available currently. "Zero inventory" is only a physical law rather than the target of management. To ensure the security of system power supply, adequate reserve capacity should be made available for the system most of the time.

### **2.1.2 Electricity is transmitted at the speed of light in electric power network, and is subject to physical effect**

In electric power network, electricity runs along the route with maximum diameter and minimum resistance, and cannot be forced to run along a specified route. Where electricity will flow is completely subject to Ohm's law. Power flow is determined by a set of nonlinear equations. The variation of network structure and operation mode will greatly change the distribution of power flow in the system. Generally, it is necessary for the dispatching agency to change the operation mode of power grid to meet the load demand. Electricity is transmitted at the speed of light in electric power network. Power supply and demand must be balanced simultaneously. Otherwise, power frequency will fluctuate, which may lead to the failure of some precision equipment, even cause lots of load accident to trigger chain reaction, resulting in power outage. The dispatching and operating agencies should adjust the output and load of the generators promptly to keep output and load balance so as to maintain the stability of the system. At the same time, it is necessary to change the operation mode of power grid in due time to prevent system overload.

### **2.1.3 Power grid decides the quality of commodity electricity**

The quality of common commodities is decided by producers. However, as for as most of the electricity consumers are concerned, the commodity on the same power market is exclusively provided without different brands available. Its quality often depends on intermediate link, i.e. power grid. The intermediate link of power market performs secondary processing function in addition to general commodity circulation function,

which places a much greater influence on the reliability and quality of the commodity than other commodities.

### **2.1.4 Power market has a unique supporting service market**

Supporting service refers to the necessary measures that are taken by the power plants to ensure the safe and reliable operation of power system, including: (1) automatic power generation control; (2) spinning reserve; (3) non-spinning reserve; (4) substitutional reserve; (5) No-load and voltage support; (6) recovery control and black-start. Supporting service plays a very important role in maintaining the stability of power market and power system (especially for long-term stability). The power grid companies are also the "producers" of such supporting service themselves, particularly in the respect of no-load and voltage support as well as accident disposal.

### **2.1.5 The stability of power market and the stability of power system have a reciprocal impact**

Power system is the physical foundation of power market. Power market is the operation mode of power system. Therefore, the economic stability of power market is restricted by, and meanwhile has an impact on the physical stability of power system. The two stabilities are closely correlated, forming a closed loop. The problem of either stability will act on the other, which may further lead to serious social problem, even endanger the safety of the country [5].

### **2.1.6 Investment in power industry is characterized by lumpiness**

So-called "lumpiness" means the indivisibility of production factors resulting in a difficulty in achieving the correspondence between supply and demand. For example, power grid is only provided with limited voltage levels. When voltage is stepped up, its capacity varies leapingly rather than continuously. It is the same for generators, that is, generator capacity is increased step by step. This performance leads to the difficulty for investment in power industry to achieve the exact correspondence between supply and demand. Either more, or less. Especially for power transmission, its lumpiness has the greatest influence. To minimize the loss, this factor should be optimally controlled at the time of investment in power industry.

### **2.1.7 Other characteristics of commodity electricity**

Commodity electricity is also characterized by externality, precipitability, monopoly, distance and commonality.

## **2.2 Characteristics of Commodity Electricity and Power Market System**

### **2.2.1 Power market system**

System plays a very important role in economic activities. It not only specifies the rules for the competition of market members, but has an impact on final market efficiency [6]. To this end, it is essential to establish a series of rules and regulations in the course of power industry marketization to normalize market behavior and

increase the efficiency of market competition. For example, property system will be established to specify market members' return and compensation in their economic activities. Various provisions will be formulated to mitigate market risks and reduce transaction cost. Centralized transaction method will be established for the fields where scattered transaction is improper. If there are no reasonable rules and regulations, market competition cannot be carried out, or else evolves into blind competition.

For power market, different systems may bring out different economic efficiencies, and produce different transaction costs. System can directly stipulate the people's return and expenditure in their economic activities, affecting market members' transaction cost. Therefore, final market efficiency will surely be affected if the system of power market is not well selected.

### **2.2.2 The impact of the characteristics of commodity electricity on power market system**

The characteristics of commodity electricity, i.e. externality, commonality, lumpiness, precipitability and monopoly, may make power market out of order. On the other hand, electric power plays an extremely important role in the development of national economic. On this account, the market-oriented reform of power industry must be carried out with prudence to avoid or reduce the occurrence of market breakdown and ensure the sustained development of power industry.

The characteristics of commodity electricity, e.g. non-storability, transmission at the speed of light, subjection to physical laws, rigidity between supply and demand, and supporting service market, require that such problems should be well solved in the design of the transaction system of power market as "unbalance of electric energy, management of transmission obstruction, supporting service, planning and coordination" and so on.

Commodity electricity is distinguished by considerable investment, sunk capital and long construction period as well as the interaction of power system stability and power market stability, etc, so that long-term equilibrium cannot be assured completely by market mechanism, and must be regulated and controlled by a sound system design [7].

For power market where policy decisions are made dispersedly, such issues as spot market, transaction of power transmission right, power planning, power transmission superintendence and market force should be centrally coordinated and optimized to reduce market breakdown.

## **3. RESEARCH ON THE SELECTION OF POWER INDUSTRY MARKETIZATION MODES**

Depending on the level of competition and selection, power market has four operation modes, i.e. monopoly, power purchase by one buyer, wholesale competition, and

retail competition.

### **3.1 Comparative Analysis of Four Operation Modes**

#### **3.1.1 Main characteristics of the four operation modes**

For monopolistic mode, there is no option at any links. For one-buyer power purchase mode, power purchaser possesses an option. He can buy power from different power generation companies selectively. Power purchaser becomes a wholesaler. When a new power plant is put into operation, power purchaser will sign a long-term contract with the generation company to have the option. Of course, power purchaser also can buy power in spot market or from other power grids.

For wholesale competition mode, power distribution company possesses the option. It can buy power selectively from independent generation companies, generation consortiums (consisting of several generation companies), power companies or power purchasers in other areas. To this effect, power distribution company needs to sign an agreement with power transmission company. At the same time, selected power supply partner must be connected to power transmission network. This agreement is generally called "power transmission service agreement".

For retail competition mode, the option is given to end users. Eng users can buy power directly from generation company, or selectively from independent power retailer or other power companies. To this effect, a "distribution network use agreement" shall be signed.

#### **3.1.2 Operation mode transition mechanism**

When monopolistic mode is transformed into one-buyer power purchase mode, it is required to sign a power purchase contract (agreement) with independent generation company. At the same time, a regulatory agency shall be established to institute a market dealing system, and provide power transmission service. When one-buyer power purchase mode is transformed into wholesale competition mode or retail competition mode, it is essential to fix a price for power distribution service, and to sign a market trade contract. In addition, the charges for the use of transmission network and of distribution network must be taken into account with corresponding agreement signed. For wholesale competition mode and retail competition mode, a special system should be furnished to measure the quantity of power load that flows into and out of power grid, so as to make clear whose electricity is supplied to whom.

For transition from monopolistic mode to one-buyer power purchase mode, generation enterprises need to be separated from power grid in business connection; For transition from one-buyer power purchase mode to wholesale competition mode, power transmission and distribution link needs to be separated; For transition from wholesale competition mode to retail competition mode, power distribution need to be separated from sales of power. In vertically integrated monopolistic mode,

interest internalization can be achieved as the enterprise takes the responsibility for the consequences of their actions. However, when power generation, transmission and distribution are respectively under the control of different enterprises, the increased number of the enterprises with system component and the pursuit of profit maximization will lead to the inconsistency of interest. In this case, much more transaction cost will be needed to maintain the reliability of power grid.

For different modes, industry restructuring needs to be conducted to different extents to establish a new mechanism. Therefore, the selection of the operation mode mainly depends on the purpose of restructuring, the necessity of establishing new mechanism and the complexity of reforming existing system.

### **3.2 Current Status of Power Industry Marketization in China**

In 2002, the State Council issued the file, "Reform Program of the System for Power Industry" of No. [2002]5. Under its guide, current pattern of power industry marketization is formed in our country.

(1) The assets under the management of the State Power Corporation was reshuffled to set up two Power Grid Corporations, five Power Generation Group Companies and four group companies to deal with non-core assets. In this way, power plants were separated from power grid in relation between ownership and management of enterprises; and the status of regional Power Grid Companies was clearly established, and primary business activities were separated from secondary ones at central level.

(2) Power regulatory agencies are established at national and provincial levels.

In November 2002, the State Electricity Regulatory Commission was officially founded, marking a substantive step to establishing an independent and unified regulatory department in our country.

(3) Governmental regulatory system is innovated. Simulated operation of regional power market was carried out in some regions, promoting interprovincial and nation-wide networking; The Power Regulatory Rules as well as the Interim Regulations on power rate for connection to power grid, for transmission & distribution and for sale to users were instituted, promoting the establishment and formation of governmental regulatory system, power market operation rules and new electricity price mechanism; A test that large users buy power directly from generation enterprises was conducted first in our country, taking the first step in breaking the tradition that only power grid enterprises can buy power from generation enterprises; Renewable Energy Law was enacted by NPC, producing a significant effect in promoting the exploitation and utilization of renewable energy and the construction of energy. Market-oriented power system reform has taken firm steps.

### **3.3 Selection of Operation Mode of China's Power**

### **Industry Market**

The market-oriented reform of China's power industry has created such a situation that more than one operators participate in the operation of power business under a competitive atmosphere instead of original one operator's monopolistic operation; diversified economic sectors have been introduced in the course of transition from planning mechanism to market mechanism; new electricity price policies have been implemented with the participation of more than one operators; power supply has developed from disperse supply to nation-wide networking; government functions have been relatively separated from enterprise management instead of previous indistinction between them; power industry system has been transformed from vertical integration to the separation of power plants from power grid; original one giant monopolistic operator has been disintegrated horizontally and vertically; and power regulatory mechanism has been preliminarily established. At present, power transmission network with the nature of natural monopoly participates in market competition, becoming the single buyer in wholesale market and the single seller in retail market, which limits effective competition. To this end, the reform must be further deepened to achieve fair competition. China's power industry market should apply wholesale competition mode, that is:

(1) Power transmission and distribution link shall be separated. Power grid company shall not participate in business activities any longer, and shall become an independent agency together with power dispatching and trading center, providing just and equitable power transmission and dispatching service, and earning income by collecting "network fee". At the same time, power grid company shall receive the supervision of Power Regulatory Commission.

(2) Local power companies shall be split. Large users are encouraged to sign power purchase and sale contracts directly with power plants, so as to set up a multi-buyer struggling pattern in wholesale market. Meanwhile, the restrictions on generation-side power market can be eased accordingly. For medium and small users selecting power distributor, transaction cost is higher. So power distribution and sales should remain under monopolistic operation, and receive the supervision of Power Regulatory Commission.

### **4.Regulation of China's Power Industry Marketization and Policy Suggestions**

#### **4.1 Regulation of China's Power Industry Marketization**

##### **4.1.1 The functions of regulation are decentralized**

At present, the functions of power regulation are decentralized in our country. For example, power construction projects are reviewed and approved by National Development and Reform Commission; power technical innovation projects are reviewed and approved

by National Economic and Trade Commission; electricity prices are under the management of National Development and Reform Commission and various provincial Price Bureaus; business licenses for power supply service are issued by National Economic and Trade Commission; cost determination and financial supervision are under the responsibility of Financial Department; and the business scopes of the enterprises are approved by Industrial and Commercial Bureaus, forming a situation of multi-departmental management. Excessive decentralization of regulation functions leads to difficult coordination, high cost of coordination, bad timeliness in decision making and low efficiency of regulation.

#### **4.1.2 Rules are not clear**

First, legal framework isn't sound. No rules are available in many areas of regulation. Nearly ten years have past since the implementation of Power Law on April 1, 1996. But many of supporting ordinances haven't been enacted yet. Particularly, there still is a gap in the legislation of the laws and regulations concerning economic regulation, still less practical rules. For example, for the hydropower projects with the functions of flood control, navigation and etc, obviously, non-power investment and operation cost shouldn't be borne by the hydropower enterprise. But if the hydropower enterprise doesn't bear, how should the cost be apportioned, and who should compensate the Investment on flood control and operation cost?

#### **4.1.3 Regulatory department is not independently enough**

Power regulation aims at specific industries or enterprises to increase their efficiency and safeguard concerned parties' legal rights and interests by determining price structure, auditing financial revenue and expenditure, approving access to market, and punishing illegal actions. The confusion of the functions of regulation with those of macro-control will surely result in power regulation at a loss. Power regulation has long been taken as one of the government's macro-control means in our country. For example, at the time of inflation, suppression of terminal electricity price, especially the price of electricity consumed by residents, is often applied to keep the prices of commodities under control. This way makes distorted terminal electricity price system more distorted and more unreasonable. Moreover, independent regulatory rights that regulatory agency should have are often interfered. For example, associated policies and decisions of the central government are often changed in executing process due to local leaders' intervention. In addition, in the review of power projects, some local leaders may directly pledge price or investment return to the investors. All these set up insurmountable barriers for the normalization of electricity price management and the economic dispatching of power grid.

### **4.2 Suggestions to Regulation of China's Power Industry Marketization**

#### **4.2.1 Perfect laws and regulations to advance the process of institutionalization.**

"Legislation Precedes Reform" is an important means and successful experience that was widely applied and drawn by developed countries in promoting their reform of power industry. Power industry a basic industry and a public utility vital to the nation's economy and the people's livelihood with both industrial and commercial characteristics. To ensure the authority and continuity of reform policies and measures, it is indispensable to determine the right-obligation relation and the conduct rules of government, enterprises and market subjects in reforming process by national legislation, and to assure the implementation thereof by applying the coercive force of the state. It is of special importance to define the responsibility and obligation of the Power Regulatory Agency. It is very important for the reform of the regulatory system of power industry.

#### **4.2.2 Apply different forms of supervision for competitive and monopolistic links**

Power regulation should differentiate between competitive link (power generation and sales) and monopolistic link (power transmission and distribution), ease the economic restrictions on competitive link, and strengthen supervision over network access and price as well as non-economic supervision (social supervision) over safety, environmental protection and general service at natural monopoly link, so as to bring market functions into full play at competitive link and concentrate regulation mainly on monopolistic link, so that the objects and extent of supervision are centralized to improve the effectiveness and efficiency of supervision. For economic supervision over competitive link, severe access and price supervision shall not be imposed any longer like before. The objective of supervision is to encourage fair competition, prevent market monopoly, and safeguard a just and effectively competitive market order. The scope of supervision includes industry access (such access management is to check the qualification of enterprises, whether environmental and technical requirement are satisfied and so like rather than limit access), shareholding structure, environmental protection, service quality and etc. For economic supervision over competitive link (power transmission and distribution), the scope of supervision includes network openness, power rates for transmission and distribution, service quality and etc, of which, power rates for transmission and distribution and just access to network are the core of supervision. Social surveillance mainly includes technology (system planning and operation), safety, consumers' interest, development of clean energy, pollutant discharge, environmental protection, general service, etc.

#### **4.2.3 Pay attention to social regulation to promote sustainable development**

After the United State, China is the second largest environmental spender in the world. Most part of installed

capacities is from fossil-fuel power plants, which have low energy efficiency and cause environmental pollution, directly affecting the sustainable development of China's economy. Therefore, social surveillance should be strengthened, e.g. improving energy efficiency, developing renewable energy and protecting environment. These are also an important part for reforming the regulation of power industry.

## 5. Conclusion

(1) Taking electric power as a commodity, this paper makes an analysis from economic perspective, presents the characteristics of commodity electricity, i.e. non-storability, subjection to physical effect, rigidity between supply and demand, differentiation of commodity, dependence of power quality on power grid, lumpiness of power investment, etc, and states that Pareto optimal allocation and long-term equilibrium of resources cannot be completely achieved for power market only through market mechanism due to these characteristics. Therefore, importance should be attached to the design of power market system for the market-oriented reform of power industry, that is, try to allow the power market where policy decisions are made dispersedly to obtain the support from central coordination and optimization by solving such problems as "unbalance of electric energy, transmission obstruction, supporting service, planning and coordination".

(2) This paper conducts an integrated comparative analysis for the four operation modes of power market, i.e. monopoly, one-buyer power purchase, whole competition and retail competition, states that mode selection depends on the purpose of restructuring, and point out the necessity of establishing new mechanism and the complexity of reforming existing mechanism. The final operation mode for the development of China's power industry marketization should be wholesale competition mode. Power transmission and distribution link shall be separated. Power grid company shall not participate in business activities any longer, and shall become an independent agency together with power dispatching and trading center, providing just and equitable power transmission and dispatching service, and earning income by collecting "network fee". At the same time, power grid company shall receive the supervision of Power Regulatory Commission. On the other hand, local power companies shall be split. Large users are encouraged to sign power purchase and sale contracts directly with power plants, so as to set up a multi-buyer struggling pattern in wholesale market. Meanwhile, the restrictions on generation-side power market can be eased accordingly. Power distribution and sales link should remain under monopolistic operation, and receive the supervision of Power Regulatory Commission.

(3) For the regulation of China's power industry marketization, associated laws and regulations should be made perfect to advance the process of institutionalization.

Attention should also be paid to social regulation to promote sustainable development. Power market can be divided into two parts, i.e. generation-side power market and power transmission & distribution market. Suggestions are proposed respectively to the two markets. For the regulation of generation-side power market, emphasis should be placed on reducing market force and increasing competitiveness. For power transmission and distribution link, it is essential to establish supervisory system and strengthen regulation. Motivation mechanism should be adopted to improve the efficiency of the regulation of power transmission and distribution. In addition, it is necessary to promote the separation of power transmission from power distribution to improve the efficiency of power market competition.

## References

- [1] Sally Hunt, 2002, *Making Competition Work in Electricity*, John Wiley & Sons, Washington, DC, USA.
- [2] David M. Newbery, 1999, *Privatization, Restructuring and Regulation of Network Utilities*, Massachusetts Institute of Technology Publishers, Cambridge, UAS.
- [3] State Electricity Regulatory Commission, 2005, *European and Australian Power Markets*, China Electric Power Press (CEPP), Beijing, China.
- [4] State Electricity Regulatory Commission, 2005, *American Power Market*, China Electric Power Press (CEPP), Beijing, China.
- [5] Xue Yusheng, 2002, "Interaction of Power System Stability and Power Market Stability", *Power System Automation*, Vol.26, No.21, pp. 1-6.
- [6] Tian Guoqiang, 2003, "Economic Mechanism Theory: Information Efficiency and Motivation Mechanism Design", *Economics*, Vol.2, No.2, pp.271-308.
- [7] Lai Fei & Xia Qing, 2005, "Power Characteristics and Power Market", *Power System Automation*, Vol.29, No.22, pp.1-5.