

# Probe into the development potentiality of Chinese electric power

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**Abstract:** After 70 years of development, especially the development of the 18th National Congress of the CPC, the development of China's electric power industry has entered a critical stage of transformation, adjustment and transformation. The high quality development of electric power industry is a kind of development that reflects the new development concept, which must be realized through qualitative change, efficiency change and power change. The core of high-quality development in the power industry is to improve efficiency. Reform, opening up and innovation are the core of efficiency. China's power industry high-quality development of opportunities and challenges coexist. People's desire for a better life, continuous improvement of electrification levels, clean use of coal, energy conversion, multi-energy complementarity, coupled market reform of the power system, "Belt and Road Initiative" and electric heating for electric vehicles are among the policies for power and other energy alternatives in China. A great opportunity for industrial development. However, it is also faced with the pressure of large-scale clean transformation, the efficiency of the power system is not high enough, the power cost is not low, and the system mechanism is not perfect. Therefore, we must seize the historical opportunity of energy transformation to establish a high-quality green power system. We will deepen the reform of the electricity market and improve the systems and mechanisms for high-quality development of the power industry. Solve all kinds of contradictions in the development of electric power industry scientifically.

**Keywords:** Power industry; High quality development; Power industry efficiency; Power system reform.

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## 1. Introduction

Since the founding of the People's Republic of China 70 years ago, especially since the 18th National Congress of the Communist Party of China, China's electric power industry has achieved rapid development and continuous breakthroughs, and has made great achievements attracting worldwide attention. These achievements have underpinned China's economic development and the continuous improvement of people's living standards. China's power industry ranks first in the world in terms of its installed capacity, generation capacity, grid scale, voltage grade, clean energy generation capacity and market transaction capacity. In order to realize the Chinese dream of the great rejuvenation of the Chinese nation, to achieve the two commemorative goals, and to promote high-quality economic development, the electric power industry should assume its due responsibility, find the right direction of development, and strive to promote the high-quality development of the electric power industry.<sup>[1]</sup>

## 2. Opportunities and challenges facing the high-quality development of electric power industry

The development of China's electric power industry has entered a key stage of changing the development mode, adjusting the structure and changing the driving force. The features of new forces, green structures and intelligent

systems are becoming more and more prominent, presenting both opportunities and challenges. People yearn for a better life, continuous improvement of the level of electrification, clean utilization of coal, energy conversion, multi-energy complementarity, coupled power system marketization reform, "One Belt And One Road" initiative, electric vehicles and electric heating and other electric energy replacement policies are important opportunities for the development of China's power industry. The development of China's power industry is faced with challenges such as slowing demand growth, excess coal capacity, long-term pressure of clean transformation of the power industry, efficiency improvement of the power system, and energy system and mechanism issues. China's power industry is still unbalanced and underdeveloped in all aspects of power generation, transmission and transformation, and distribution. Weaknesses exist in the construction and management of power grids. The imbalance in the development of main marketing network, distribution network and agricultural network is prominent.



## **1. The high-quality development of the power industry faces the pressure of large-scale clean transformation**

China's power large-scale clean transformation pressure is huge. Under the influence of coal power stock assets, resource conditions and power technology level, coal power will still occupy the dominant position in China's power structure for a long time in the future. China's power structure has long been based on and dominated by coal. Controlling the development of coal power is conducive to the development of renewable energy, nuclear power and natural gas power generation.<sup>[2]</sup>

Compared with most industrialized countries in the world, China's electric power industry is characterized by large scale and high proportion of coal-fired power generation, while small scale and low proportion of gas, electric power and nuclear power, which leads to the difficulty of clean transformation of China's electric power. The power supply structure of a country can reflect the difficulty of clean power transformation to some extent. The proportion of coal-fired units can reflect the difficulty of a country's electric power transformation. The higher the proportion, the greater the transformation pressure. In 2018, China's coal-fired power generation was still as high as 66.5 percent, much higher than the world average (38.0 percent) and much higher than the United States (27.9 percent), the European Union (20.0 percent), Russia (16.0 percent) and other countries.

The proportion of gas-fired power generation can also reflect the difficulty of a country's electric power transformation, that is, the lower the proportion, the greater the pressure of transformation. In 2018, China's natural gas power generation is only 3.2%, lower than the level of gas power generation in the world (23.2%), lower than in the US natural gas (35.4%), Russia (46.9%) and the UK (39.4%), and the European Union (18.9%), Germany (12.8%), Japan (36.8%) and India (4.8%), rely on gas imports.

The development of non-water renewable energy generation is the trend of the world's power transformation. The proportion of non-water renewables in electricity generation can also reflect the difficulty of a country's electricity transformation. The lower the ratio, the greater the conversion pressure. At 9.1 percent, China is close to the world average (9.3), slightly below the United States (10.3 percent) and far below the United Kingdom (31.6 percent). China's nuclear power for 4.1%, lower than the world average level (10.2%), is far lower than the United States (19.0%), the European Union (25.2%), UK (19.5%) and Russia (18.4%). It is also lower than Germany, which plans to abandon nuclear power (11.7%).<sup>[3]</sup>



The coal rich power generation structure in China is directly related to the long-term growth pattern of power supply. China's capacity expansion, with coal-fired power plants accounting for most of the growth (72%) between 1949 and 2012; Even though clean energy accounts for the majority (57%) of new energy generation from 2013 to 2018, the growth of coal-fired generating units has been substantial. This is different from the United States, which between 1949 and 1983 relied on coal-fired power plants for most of its economic growth; Over the next four years, nuclear power will be a major contributor to the growth of U.S. generating capacity; Since then, natural gas power generation has dominated, with nearly all new generating capacity in the United States coming from natural gas plants from 1990 to 2005. Wind power has been a major contributor to the growth of power generation capacity in the United States in recent years. According to 2018 data, the US generates 7.1 times as much electricity from natural gas and 3.0 times as much from nuclear power. The reasons lie not only in the objective reality of energy resources endowment, but also in the subjective factors such as the emphasis of China's energy development strategy and energy transformation policy. In addition, there is a large amount of waste water and landscape problems. In 2018, China will abandon about 69.1 billion kWh of water, or 5% of water. Wind abandonment was about 27.7 billion kWh, with a wind abandonment rate of 7%; The light abandonment is about 5.49 billion kWh, and the light abandonment rate is 3%.

## 2. The efficiency of the power system is still low

The high quality development of the power industry is first reflected in the high efficiency of the power system. The efficiency of power system can be measured by the load rate and other indicators.

China's power grid load rate is not high. Grid load rate and power line ratio are important indicators of power

supply side efficiency. At present, the light load problem of transmission lines in China is quite serious, most of the lines are in the state of light load for a long time. (1) The average load rate of transmission lines in China is only 8%, while the reasonable average load rate of transmission lines in the conservative case should be about 40%. (2) China's power line ratio of 9.72 million kWh/km is significantly lower than that of the US (14.86 million kWh/km) and Japan (3.08 million kWh/km).<sup>[4]</sup>

The load rate of power grid decreases year by year, and the peak-valley difference becomes larger and larger. Load rate is an important index to measure the efficiency of demand side management. The load rate is the ratio of the average annual load to the maximum annual load. The smaller the load rate, the bigger the difference between the average load and the maximum load, the bigger the difference between the peak and the valley, the worse the operating efficiency and economy of the power system will be. In China, the difference between peaks and valleys is still huge. Except for North China Power Grid (32.5%) and Northwest Power Grid (29.4%), the peak-valley difference of other power grids is above 35%.

At present, China's transmission efficiency still has room to improve. The network loss rate is an important index to measure the transmission efficiency. In 2018, China's transmission line loss rate was 6.21%, ranking at the world's advanced level of the same power load density. However, there is still a gap when compared with the countries with the lowest net loss rates.

### **3. The system and mechanism for high-quality development of the electric power industry are not yet perfect**

The current transmission and distribution price mechanism has the risk of inducing the increase of power grid investment and resulting in excessive investment. China's electricity transmission and distribution price reform is still in the initial stage, there are many problems in the cost supervision and assessment of electricity transmission and distribution, and the separation of transmission and distribution has not been touched.

The reform of electricity transmission and distribution price is the core content of the high quality development of power industry and an important means to improve the efficiency of power system. By improving the pricing efficiency of electricity transmission and distribution, it can guide the development of power investment to a reasonable and efficient direction. At present, China's power transmission and distribution price is based on the pricing method of "allowed income = allowed cost + income", which, to some extent, leads to the transformation investment of power grid enterprises, effective investment, but also causes power grid enterprises to increase investment, expand the scale of assets, resulting in excessive investment. Data show that since the new round of power market reform, the investment in power grid continues to be at a historical high. Since 2014, investment in power grids has begun to exceed investment in power supply, with the proportion increasing year by year. The proportion of power grid investment in power industry was 52.77%, 52.94%, 61.44%, 64.8% and 66.4%, respectively. Investment in the power grid has increased year by year. In 2018, China's investment in power grid projects reached a record high of 537.3 billion yuan. This phenomenon of high investment growth rate reflects that the problem of distorted resource allocation in the current power construction has not been solved, and even has a worsening trend. This also reveals the inherent contradictions in the current electricity price formation mechanism, indicating that the government's supervision capacity is insufficient and the level of monopoly enterprises is low.<sup>[5]</sup>

Progressive distribution network reform progress is slow, the reform of the existing distribution network has not been included in the reform agenda.

Incremental distribution network reform is the key to solve the unbalanced development of transmission and distribution network. Incremental distribution network reform, social capital into the incremental distribution network business is faced with many obstacles and difficulties, inventory distribution business reform urgently needs to study.

The fundamental purpose of incremental reform of distribution network is to introduce competitive distribution network, establish diversified investment mechanism and change the status quo. The distribution network can only be



invested and operated by power grid enterprises, so as to solve the problem of backward construction of distribution network. Transmission network construction and investment imbalance transmission and distribution network. It is necessary to adjust the investment focus of power network through reform in the new stage of power industry development. But the gradual reform has made slow progress, both from the difficulty of coordinating power grid companies and from the phenomenon of some local governments charging exorbitant prices and competing with the people for profits. Although successively introduced the increment distribution network reform measures, such as the increment distribution business unit distribution measures (trial) ", "notice to further push forward the reform of the distribution of the incremental business ([2019] 27) sent to the body, but because of the distribution network business hit a grid enterprise core interests, cause the power supply department, stock assets disposal, distribution network engineering access barriers, influence the distribution of incremental reform. The incremental distribution network pilot projects that have been completed are almost all owned or participated by the power grid enterprises to prevent the "cake" of the new distribution network from falling into the hands of others.

China's existing distribution network is in urgent need of reform. There are illegal "users investing in the existing distribution network" and a large number of "compound users". In the past, because of insufficient investment in distribution network, the illegal phenomenon of users' investment in distribution network was formed objectively. The problems of "User Investment Stock Distribution Network" are mainly reflected in two aspects: one is lack of unified planning, inconsistent construction standards and operating safety standards, there are security risks; The second is the lack of regulation. No power business license to engage in power business, in the government supervision of the vacuum state.

The construction experience of power spot market is insufficient, and the standardization of power trading institutions has yet to be solved. Market reform of electricity sale is the full play of market mechanism and effective electricity market, and it is also the core content of high-quality development of electricity. The lack of experience in the construction of electricity wholesale market, the implementation of equity transformation of power trading center, the marketization reform of power retail business has not entered the agenda.<sup>[6]</sup>

The purpose of establishing electric power spot market is to optimize resource allocation through scientific and reasonable price guiding mechanism, which is an important part of high quality development of electric power industry. However, due to this round of reform, there are phenomena, such as power grid enterprises seize the establishment of power trading institutions and prevent the establishment of regional power grid companies, as well as delay the trial operation of the pilot provinces of the power spot market and power trading institutions of the unfavorable situation of the reform of non-tradable shares. All these show that the promotion of power spot market is very difficult. In addition to technology and experience in power design and construction, obstacles created by industry monopolies are also an important reason for the slow progress of reform. For example, the Opinions of the CPC Central Committee and the State Council on Establishing a More Effective New Mechanism for Coordinated Regional Development (November 2018) clearly states that "the selection of regions with better conditions... To promote the... Electricity market trading, further improve the trading mechanism." However, the "unified market, secondary operation" mechanism of the power grid enterprise block transfer from a provincial dispatching center regional dispatching center power system design, so it is impossible to promote the marketization of power transactions from the perspective of the mechanism, it is difficult to achieve "large-scale and high-quality optimal resource allocation". This is also one of the reasons for the low efficiency of resource allocation in China's power industry.

### **3. The realization path of high quality development of electric power industry**

#### **1. Drive the development of electric power industry through technological innovation and institutional innovation.**

Strengthen the electric power industry base technology and key technology research and development investment, energy storage technology, uhv technology, nuclear equipment, gas power generation equipment technology, renewable energy power generation technology, electric cars and electric power core technologies such as application technology of highland, make technical innovation become the core power in the development of power industry in China in the future.

Break monopoly and relax supervision of the power industry. We should standardize the power grid through the price reform of transmission and distribution, and improve the efficiency of power grid investment. Establish and improve the electricity market, establish the market mechanism of electricity price formation, and establish the electricity market system including wholesale electricity market, capacity electricity market and cross-regional electricity trading market.

We will strengthen environmental oversight. In the short term, the weaker the environmental regulation, the higher the pollutant emission and the higher the efficiency of the power generation industry. In the long run, the stronger the degree of environmental regulation, the lower the emission of pollutants in power generation, and the higher the efficiency of the power generation industry.

## **2. Continuously improve the efficiency of the power industry.**

Through technological innovation and opening up, the technical efficiency, resource allocation efficiency and total factor productivity of power generation, transmission and distribution and electricity consumption have been continuously improved. Electric power industry efficiency is one of the important indicators to measure the growth quality of a country or region's electric power industry. On the one hand, compared with developed countries, the technical efficiency, total factor productivity and resource allocation efficiency of China's power industry are not high. A large number of studies have shown that ownership structure, electricity price, coal price and environmental regulation have significant effects on the technical efficiency of China's power industry. The proportion of state-owned capital in the power industry and the price of thermal coal are negatively correlated with technical efficiency, while the price of electricity is positively correlated with technical efficiency, and the environmental regulation is inverted U-shaped. Technological progress, technical efficiency change, scale economy and allocative efficiency are the important factors affecting the total factor productivity of China's power industry. On the other hand, due to the influence of investment intensity, economic development level and location conditions, the technical efficiency of China's electric power industry shows obvious regional development imbalance. Therefore, we should promote the power system reform, technological innovation and opening to the outside world, and constantly improve the efficiency of the power industry.

## **3. Establish a power pattern of coordinated development of different power sources, coordinated development of urban and rural areas, balanced development of regions, and balanced development of transmission and distribution networks.**

At present, efforts should be made to solve the structural problems of unbalanced development in all aspects of "distribution, transportation, transformation and distribution". In the power generation link, the installed capacity of coal power should be controlled reasonably, and the power supply structure should be optimized and adjusted. In the aspect of power grid, we should optimize the structure of power grid, improve the intelligence level and efficiency of power grid, and solve the problem of "unbearable" of UHV transmission lines. We will strengthen planning and reasonable assessment of construction needs, and coordinate the development of major power grids, distribution networks, and rural power grids. The link of power consumption, we should reform the electricity price policy, formulate the power transmission and distribution price science, establish a reasonable and scientific power market pricing mechanism, give full play to the thermal power supply price lever, gold silver copper, promote the load aggregation mechanism and other aspects of response measures.

#### **4. Build a green power industrial system.**

We will continue to raise the level of final energy and electricity consumption by promoting the development of new-energy vehicles and the conversion of coal to electricity. We will vigorously develop clean power generation such as wind power, photovoltaic power, hydropower, nuclear power, and gas, and constantly increase the proportion of green and low-carbon power generation. We will promote the development of the global energy Internet, establish a market mechanism to promote clean electricity export, and raise the level of trans-regional and transnational electricity trade.

#### **4. Summary**

To achieve high-quality development of China's power industry is not only a development issue of the power industry itself, but also a major issue of China's economic transformation and upgrading and high-quality development. High-quality development of power industry is intensive and efficient development, innovation-driven development, balanced development, green and ecological development. The overall goal of the high-quality development of the power industry is to realize the transformation from the scale expansion to the quality improvement of the power system characterized by the establishment of clean, low carbon and high efficiency. First, it is necessary to achieve high-quality and efficient development of the power industry, and constantly improve the technical efficiency, resource allocation efficiency and total factor productivity of the power industry. Continue to invest in electricity, and continue to reduce the cost of electricity. Electric power enterprises should have sustainable profitability. Second, we will shift from a factor-driven approach to an innovation-driven approach, increase input in power technology, expand reform and opening up, and improve the output efficiency, allocation efficiency and total factor productivity of power technology. Third, we need to achieve balanced and full development, forming a good pattern of coordinated development between urban and rural areas, coordinated development of transmission and distribution networks, and coordinated development of various types of power sources. Fourth, we need to pursue green and low-carbon development. We will improve the electricity supply structure and increase the proportion of clean and green electricity.

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