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Considerations for Chinese power industry to participate in carbon market

Su Yang¹, Tian Zhao, Zechen Wu, Xiaoxuan Zhang and Li Ma

State Grid Energy Research Institute, Beijing, China

¹ Email: yangsu@sgeri.sgcc.com.cn

Abstract. In 2017, China started its national emission trading system. Power industry has been covered as a critical member. During the carbon market construction, the new power market reform has started in 2015 in China. It is crucial for power industry to simultaneously meet the requirements from both power market reform and emissions reduction. This paper puts forward four key considerations for power industry to participate the emission trading system in China, including cap setting approach, the quota allocation approach, coordination mechanism for carbon trading and power trading, and the carbon cost transmission mechanism.

1. Introduction

The global climate change problem is increasingly serious. It is an international consensus to reduce carbon dioxide emissions. Countries around the world are reforming the energy sketch in the context of limiting the use of coal [1]. China is also actively promoting carbon emission reduction work. The carbon dioxide emissions of the power industry account for more than half of the total emissions in China [2]. It is a key industry for carbon reduction. On December 19, 2017, the national emission trading system (ETS) of China officially started (Figure 1). The carbon trading system will surely have a profound impact on the power industry. In addition, China's new round of power market reforms has started in 2015[3]. How to make the development of power industry meet the dual requirements of power market reforms and emission reduction is an urgent issue. Therefore, it is necessary to discuss carbon trading in China's power industry and explore ways to coordinate carbon trading with electricity trading.

2. Development history of China's carbon market

The Chinese government has been working on the carbon market for a long time. In 2011, the National Development and Reform Commission approved Shenzhen, Beijing, Tianjin, Shanghai, Guangdong, Hubei and Chongqing to launch carbon emissions trading pilot projects. Each pilot market officially started in 2013-2014, and covered electricity, steel, chemical engineering and nearly 3,000 key emission units [4]. As of November 2017, the cumulative volume of quotas for the seven pilots exceeded 200 million tons of carbon dioxide equivalent, and the turnover exceeded 4.6 billion CNY. From the pilot results, the total amount and intensity of carbon emissions have descended [5].



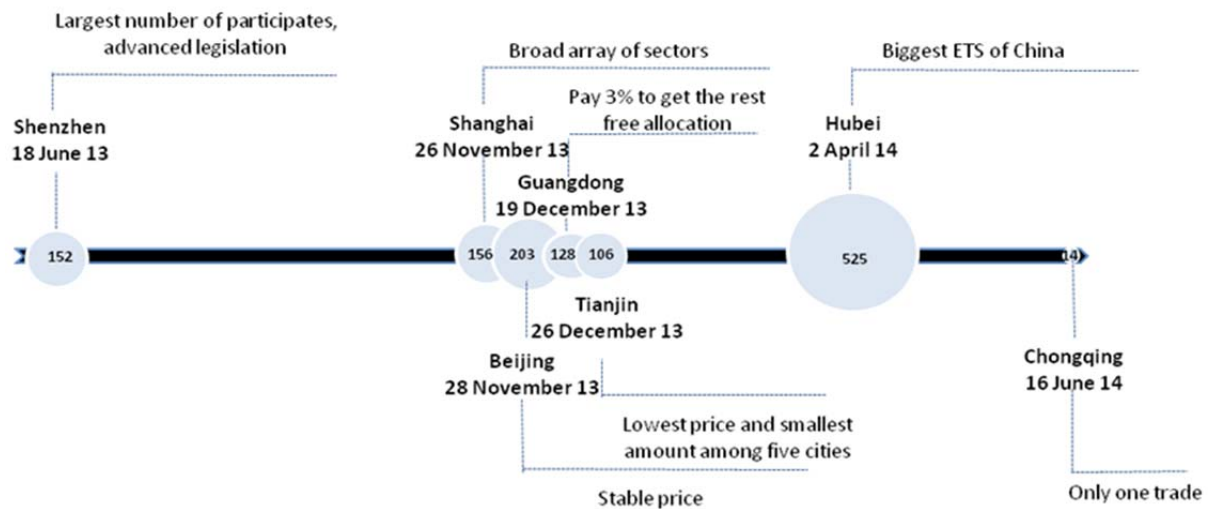


Figure 1. Timeline and characteristic of Chinese ETS (emission trading system) pilots.

In September 2015, when President Xi Jinping visited the United States, he proposed to start a national carbon emissions trading system in 2017[6]. In November 2015, President Xi Jinping also proposed to establish a national carbon emissions trading market at the Paris Climate Conference [7]. On December 19, 2017, the National Development and Reform Commission organized a conference for the opening of the National Carbon Emissions Trading System work, and announced the “National Carbon Emissions Trading Market Construction Plan (Power Generation Industry)”[8], which was marking the official launch of the national carbon market.

3. Participation and challenges for power industry in carbon market

In China's seven carbon trading pilots, the power industry has been included as the focus member. A total of 155 power generation companies and three power grid companies were covered. The total amount of emission allowances included in the power companies accounts for 30-40% of the total carbon emissions quotas. According to the performance of power companies in the pilot market in China, the trading activity of power generation companies is very high, with a compliance rate of 100%, and they are actively involved in the development and trading of CCER (Chinese Certified Emission Reduction) projects [9,10].

Table 1. Power companies in pilot carbon market and their compliance rate [11]

	Power companies in the carbon trading pilots				compliance rate			
	2013	2014	2015	2016	2013	2014	2015	2016
Beijing	8	11	12	12	100	100	100	100
Shanghai	14	14	14	24	100	100	100	100
Guangdong	62	63	64	84	100	100	100	100
Shenzhen	8	8	8	8	100	100	100	100
Hubei	/	27	27	34	100	100	100	100
Chongqing	/	14	14	14	100	100	100	100
Tianjin	13	13	13	13	100	100	100	100

※ Carbon trading pilots of Hubei and Chongqing started in 2014.

The main reason is that due to their own pressure of power generation companies to control emission, they pay more attention to carbon market transactions. On the one hand, there are many

large-scale groups of power generation companies, and they are more mature and with market awareness. In the future, they will continue to play a demonstration and benchmark role in the national carbon market.

According to the pilot experience, the advantages of carbon trading in the power industry are summarized in the following three aspects: the first is the good metering system for the electric power industry and the better market base. Second, the effective connection of electricity trading mechanism, emission reduction mechanism and carbon market mechanism in the power industry can improve the efficiency of carbon trading in the future. Third, carbon trading helps to reduce the overall costs for carbon emission reduction in the power industry.

The difficulties are as follows: first, at present, some of the electricity prices in China are still strictly regulated by the government. Mandatory application of carbon constraints may increase costs of power companies and they cannot promote their emission reductions. Second, China's power market reform is underway. There will be major changes in the internal and external environment of the power industry. It is difficult for the power industry to achieve effective convergence between the carbon trading and power system reform. Third, the technical level of China's power industry has reached or approached the international advanced level, and it is difficult to exploit potentialities of emission reduction.

The continued research on key technologies are needed to meet the requirements of the national carbon market and further promotion of carbon emission reduction in the power industry

4. Key methods for developing carbon trading in the power industry

4.1. Scientific and rational cap setting approach

At present, China's carbon emissions have not yet reached its peak value, and it is in the emission intensity reduction process before 2030. The total power industry emission cap setting should be combined with China's 2030 carbon emission peak. The progress plan of carbon emission reduction in the power industry can be made using the target deduction method and the ultimate tolerance method

Target deduction method is based on carbon intensity target. The Chinese government has clearly stated that by 2020, China's carbon dioxide emissions per unit of GDP, so called carbon intensity, will be reduced by 40%-45%. According to the carbon intensity target and combined with the economic forecast, we can calculate the demand for carbon emissions each year for China's future economic growth. This is used as the cap of China's carbon emissions. In addition, this cap can be divided in to each industry, including the power industry.

The ultimate tolerance method calculate the emission cap using generation hours of generators. According to the economic forecast and power industry operation research, we can calculate the tolerable limit of generation hours for generators, which makes the economy grow well and power industry can still develop. Considering the different fuels of generators, we can get the carbon emission cap of power industry using the generation hour limit.

The reduction process calculated by the ultimate tolerance method is much faster than the target reduction method, but both have application scope. Among them, the target reduction method is relatively reasonable. However, due to different emission reduction potentials in different industries, the progress of emission reductions obtained by this method may not be suitable for the power industry. The ultimate tolerance method has resulted in large reductions in emissions, but it may easily damage the interest of power generation companies because of restrictions on the number of generation hours. It is not conducive to the sustainable development of the power industry. It is only applicable to the emission reduction policies in emergencies and is not suitable for long-term use.

4.2. The quota allocation approach

Carbon emission allowances allocation mode include the free mode and the non-gratuitous mode. Free mode include the grandfather method and the benchmark method. The grandfather method is based on

historic emissions, and historic data for the reference period are required. The benchmark method is to give quotas based on the set of emission baseline values [12].

After calculating the basic quantity of free quotas through the grandfather method or the benchmark method, a certain percentage of reductions may be needed for the differences between industries and years.

Non-gratuitous mode is divided into auction and fixed price sales. The former determines the quota price by the buyer's bid, and the latter determines the quota price by the seller. At present, the carbon trading design programs in various countries all reflect the trend or intention of free allocation to non-gratuitous [13,14]. The allocation of quotas for China's carbon trading pilots is mainly free allocation. At the same time, the pilots have also proposed to introduce quota auctions and other paid allocation methods at an appropriate time.

The pros and cons of grandfather method, the benchmark method, and auction method can be compared in terms of fairness, environmental effects, institutional costs, and political feasibility. The fixed price allocation method is similar to the auction in all four aspects and is used less in the regular initial allocation.

The grandfather method is less fair since the more the company emits, the more quotas they can get, and there is the problem of over-allocation and excessive profits. Due to the need for early data, the cost mainly comes from the previous monitoring, verification, and reporting. Since companies only bear the corresponding carbon emission costs, they are politically easier to implement.

The benchmark method is fairer than the grandfather method. The quota allocation is based on the emission level of whole industry. Each company receives the same emission quotas, which is the benchmark. Companies that perform worse than benchmark do not have sufficient quotas and need to purchase additional quotas. Companies that perform better than benchmarks receive more quotas than needed and excess quotas can be sold. However, large amount of historical and technical data is required to calculate the benchmark, its institutional cost is higher than the grandfather method.

The auction method is superior to the other two methods in terms of fairness, environmental performance, and institutional cost. Since the auction process is open and transparent, fairness is guaranteed. Auction revenue can be used for emission reduction investments, while auctions with reserve prices can effectively reduce excess quota supply. No previous data is required. The cost comes only from the auction organization and is less expensive than the other two methods. However, because enterprises need to bear all the emission reduction costs and weaken their external competitiveness. It is politically less viable than the other two methods.

Taken together, the grandfather method was most popular in the early days of the trading system. The areas with well database preferred the benchmark method in the middle and early stages, and auctions were the best choice for advancing the long-term health of the emission reduction market. In terms of industry dimensions, industries that face external competition and less likely to transmit costs should adopt the free allocation method, such as power industry.

4.3. Design of coordination mechanism for carbon trading and power trading

4.3.1. Medium and long-term electricity contract market with low-carbon constraints

(1) Market access mechanism based on energy consumption and emissions

The market access mechanism based on energy consumption and emissions stipulates the energy consumption and emission standards for generator participating in the medium and long-term power contract market. It ensures that the market mechanism promotes energy conservation and emission reduction from the source in the power trading.

(2) Establish market mechanism to promote the use of green energy, which fit with the medium and long-term electricity contract transactions

As market support measures continue to mature, it is necessary to gradually establish a market mechanism for the use of green energy that is compatible with medium and long-term power contract

transactions. The government can further implement the renewable energy quota policy and gradually establish a green electricity certificate market.

4.3.2. *Centralized auction market considering the external cost*

In the traditional quotation-based centralized power bidding market, it is not taken into account that the negative external costs incurred by the power generation enterprises on the environment. The differences in negative external costs caused by generating units with different coal consumption, transmission losses, health costs, ecosystem damage costs and pollutant emissions are not reflected. Therefore, to achieve the goal of energy conservation and emission reduction in the centralized bidding market, we must consider the externalities of the generating units in the market mechanism.

In the market conditions where a large number of small generating units exist, carbon emission markets have not yet been established, and resource tax rates have not been adjusted, the centralized bidding power market should use market mechanisms based on energy consumption corrections and environmental protection discounts. The power exchange should consider the external cost of the generator set when ranking the auction [15].

In the market conditions where the basic shutdown of small generating units exist, carbon emission markets are relatively mature, and resource tax adjustments are in place, a centralized bidding market for the internalization of external costs should be established. So that the quotation of the power generation enterprises includes the cost caused by the tax and environmental equity market, which can fully realize the internal market mechanism of external costs to promote energy conservation and emission reduction.

4.4. *Carbon price and electricity price*

The rising electricity costs caused by carbon prices can be reasonably shared by linking carbon prices and electricity prices. If carbon prices and electricity prices are not linked, the carbon market cannot help the power companies to reduce emission. On the contrary, it may lead to bankruptcy. Research shows that 50%-70% of the EU ETS (European Union Greenhouse Gas Emission Trading Scheme) carbon price is passed to the downstream consumer end, and the power generation companies bear 30%-50% [16].

Under the scenario of insufficient electricity marketization, it is a feasible method to include carbon price in the regulated price system. The rules set by the competent authorities refer to the carbon price changes on a regular basis and convert them into integrated power generation costs. The regulated price should be adjusted appropriately.

After the power market reform, marketization of power trading is realized. The way in which carbon prices are linked to electricity prices will be affected by the various energy policies and factors such as economic trends.

5. Conclusions

(1) During the design of the national carbon trading mechanism, special issues in the power industry must be considered and resolved.

In 2017, the national emission trading system of China started. The electric power industry is the main market player in China's carbon trading market. Meanwhile, as a strategic industry that supports the economic development, power industry plays a very important role in the development of nation's economy. During the design of mechanisms and rules, scientific and reasonable total carbon emission control targets should be set, and related policies and measures should be formulated to encourage power enterprises to reduce emissions. It should accelerate the development of the power industry while achieving planned emission reduction targets. Therefore, the design of the national carbon trading mechanism should fully consider the special nature of the power industry, and focus on the issue of carbon trading in the power industry, including the setting of total emissions, standards and methods of quota allocation, and the impact of carbon trading on electricity development.

(2)The development of the national electricity market and the national carbon market should be Coordinated.

China's electricity market reform is gradually advancing, and the national unified electricity market is under construction. We should consider the establishment of two markets as a whole, and policy formulation should help the two markets to coordinate development and promote each other. Since both market construction is unfinished, each market design should take the construction stage of the other market into account. For example, the medium and long-term electricity contract market with low-carbon constraints and centralized auction market considering the external cost can be used to reduce emissions where carbon market does/cannot cover.

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