An Introduction to China's Power Industry Participating in ETS

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The Sino-German project is jointly implemented by GIZ and the National Development Reform Commission (NDRC) on behalf of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). The aim of the project is to strengthen the capacities of China's key institutions and stakeholders for the establishment and implementation of effective emissions trading systems (ETS) on regional and national levels in China.

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On behalf of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety of the Federal Republic of Germany.

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Introduction

With the profound adjustment of the world energy landscape and the continuously intensified environment and resource constraints, the power industry in China is facing new challenges, including carbon emission control and the marketization of institutional mechanisms. As the situation of climate change is getting increasingly severe, air pollution control in China has been significantly strengthened, and the ecological and environmental restraints have been further tightened. This also implies that China's power industry, as one of the major GHG emitters, is the first industry to be covered by the national ETS. In addition, the power industry is undergoing a new round of electricity market reform due to the fact that the market-based pricing mechanism has not yet been completely formed in the electricity market and various planning and coordination mechanisms are far from perfect. During this new round of reform, market competition is introduced to both power generation and electricity retail, in order to form a trading system with diverse entities and an orderly competition mechanism.

The relevance of both the carbon market and the new electricity market reform are closely connected despite operating independently on the institutional level. On one hand, both reforms are conducive to optimizing the energy structure and promoting green and low-carbon development of the power industry. The carbon market directly controls the emissions of the power industry, forcing the whole industry to adjust its previously coal-based energy structure, while a market-oriented electricity trading mechanism will provide more space for green and efficient generator units, ensuring the advantages of large-capacity units with high efficiency as well as units using non-fossil power sources. On the other hand, there is a price transmission effect between the two mechanisms. The carbon market will, to a certain extent, impose an additional emission reduction cost on some key emitters in the power industry, while the power industry can transmit this cost to the consumer through the market-oriented electricity trading mechanism, which will be reflected in the retail price.

How can the carbon market and the electricity market reform therefore exert a synergetic effect under the new circumstances? How will power companies deal with the new policy restraints and use the two policies to boost their own development? One of the sub-forums of the "Forum 2017: GHG Emissions and Emissions Trading in Power Sector", the "Emissions Trading and Power Sector Regulation Workshop" aims to hold in-depth discussions on relevant issues and provide practical suggestions for the power industry to better participate in the development of China's carbon market and the new round of electricity market reform. This report is prepared mainly for participating experts in order to help them understand the current situation of China's power industry and its participation in the carbon market better, as well as to ensure the pertinence of the discussions. This report is divided into three parts: Part 1 provides an overall introduction to China's power industry, which covers the total power generation capacity and its geographical distribution, and introduces the core content and the main impact of the new round of electricity market reform. Part 2 mainly explains the participation of China's power industry in regional ETS, among other things the inclusion boundary and allowance allocation methods for the power industry, the impact of regional ETS on the power industry and the response of the power industry to regional ETS. Part 3 introduces the prospect of China's power industry participating in the national ETS, including the allowance allocation method of the national ETS, the impact of the national ETS on the power industry, and the coping measures of the power industry towards the national ETS.

1. An Overall Introduction to China's Power Industry

As one of the pillar industries in the country, the power industry is now facing new circumstances in terms of power supply structure optimization, balance between market supply and demand, and marketization of institutional mechanisms. Although the development in non-fossil power sources such as hydropower, wind energy, solar energy and nuclear energy has significantly accelerated in China, thermal power is still overwhelmingly dominant in China's power industry and the energy structure needs to be further optimized. As for market supply and demand, as China's economy develops into the new normal, the demand growth in the power market slows down and in the country as a whole remains a surplus of power supply capacity. The relationship between supply and demand needs to be balanced and adjusted. With regards to institutional mechanisms, the acceleration of the new round of electricity market reform will break the monopoly of power grid enterprises and change the profit model of power generation and power supply enterpriseS.

1.1 Latest Landscape of China's Power Industry

By the end of 2016, China`s installed capacity reached 1.65 million megawatts, with a year-on-year growth of 8.2%. The installed capacity consists of 1,053,880 megawatts of thermal power, 332,110 megawatts of hydropower, 148,640 megawatts of wind power, 77,420 megawatts of solar power, and 33,640 megawatts of nuclear power. The top ten provinces in terms of installed capacity are Inner Mongolia, Shandong, Guangdong, Jiangsu, Sichuan, Yunnan, Zhejiang, Xinjiang, Shanxi and Henan.

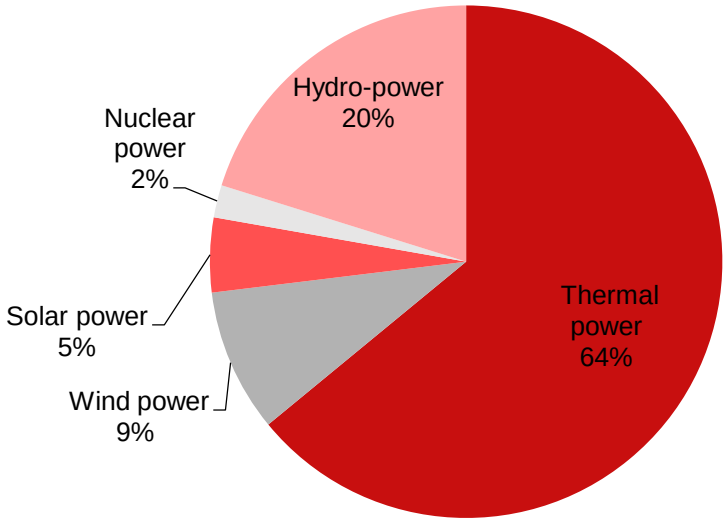

Figure 1: Energy Structure of Installed Capacity in China by 2016

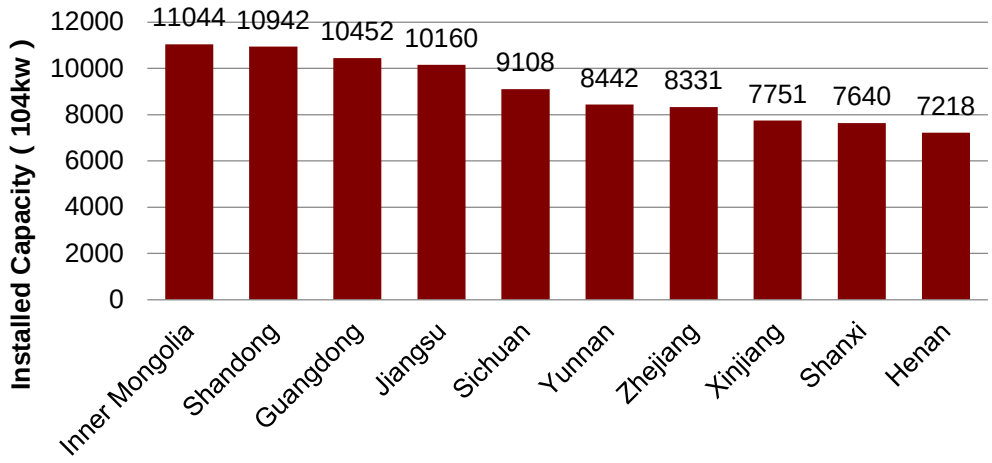

Figure 2: Top 10 Provinces in terms of Installed Capacity by 2016

The 13th Five-Year Plan for Electric Power Development expects that by 2020, China's installed capacity should reach 2 million megawatts with an average annual increase rate of 5.5%. Non-fossil energy installed capacity should reach 770 thousand megawatts with an overall increase of about 250 thousand megawatts compared to 2015, and account for about 39% of the total installed capacity as opposed to 35% in 2015, as well as 31% of the total electricity generated. Gas installed capacity should increase by 50 thousand megawatts to reach over 110 thousand megawatts, accounting for more than 5% of the total installed capacity. Coal-based installed capacity is to be limited under 1.1 million megawatts, with its ratio reducing to 55%.

1.2 Recent Supply and Demand Condition of Electricity in China

China's electricity market has slowed down in its demand growth and the overall surplus of power supply has led to continuous decline of transaction prices. In terms of different regions, the North China Power Grid maintains an overall balance between its regional power supply and demand while the East China, Central China and Southern Power Grids sustain an easing supply-demand balance, whereas the Northeast and Northwest Power Grid is facing excessive supply. It is expected that the average utilization hours of power generating units nationwide will be at around 3,600 hours in 2017 and the average utilization hours of thermal-powered units nationwide will drop to about 4,000 hours.

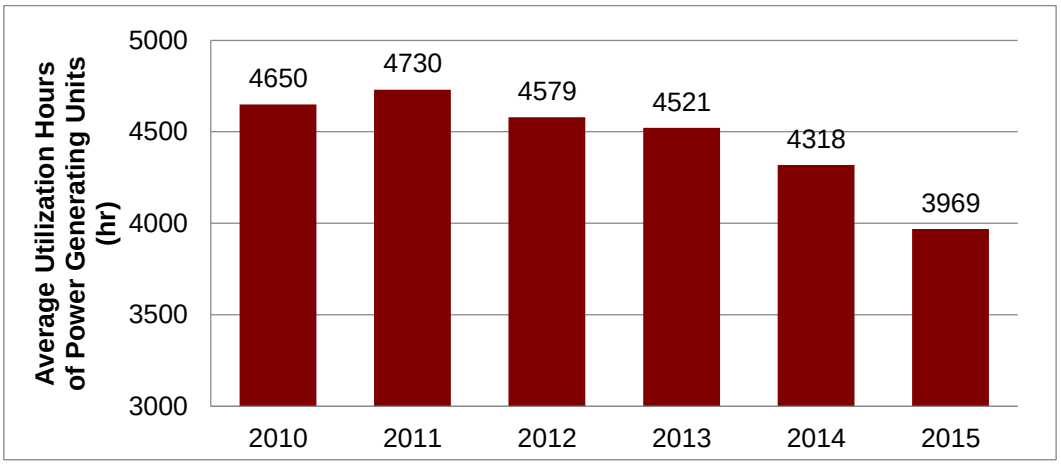

Figure 3: Average Utilization Hours of Power Generating Units Nationwide during 2010-2015

1.3 The Acceleration of the New Electricity Market Reform

China's electricity market reform has undergone four major stages:

The first stage aimed to solve the serious shortage of electricity supply and encourage local governments to finance the power industry.

The second stage has witnessed the promulgation of the Ministry of Electric Power's Institutional Reform Plan and the establishment of the State Power Company, leading to the "separation of functions between governments and enterprises."

In the third stage, the Electricity Market Reform Program proposes "the separation of factory and grid, the separation of mainstay and auxiliary business, the separation of transmission and distribution, as well as competitive bidding."

In the fourth stage, "Several Opinions on Further Deepening the Institutional Reform of the Electric Power Industry", namely the "CPC Central Committee and the State Council's Document No.9" issued in 2015, puts forward the core idea of "taking control of the middle and letting go of the two ends", which means liberalizing the competitive elements, i.e. the tariffs and prices of power generation and electricity retailing, while controlling the naturally monopolistic elements, i.e. the power transmission and distribution, marking the beginning of a new round of electricity market reform. Document No.9 is followed by six supporting documents regarding arrangements in several key areas, including the transmission and distribution tariff, trading mechanism, power generation plan, and retail side reform. These supporting documents carry out the spirit of the new electricity market reform and pave the way for its specific implementation.

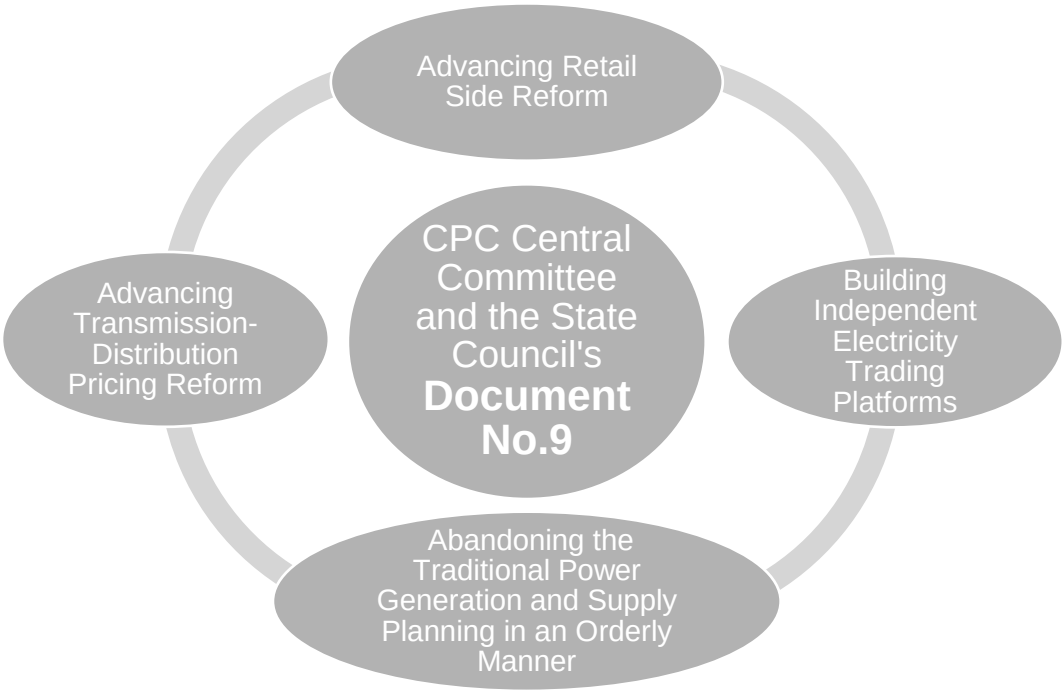

Figure 4: Schematic of the Contents of the Reform in Document No.9

The core content of the new electricity market reform is to break the monopoly of grid enterprises and to change the profit model of electricity generation enterprises and electricity retail companies. Prior to

the new electricity market reform, grid enterprises integrated the transmission, distribution and retailing of electricity all in one. Since the prices in both generation and retail sides were determined by the National Development and Reform Commission, grid enterprises gained all the profits from the price margin. However, after the reform, the generation and retail side prices are both to be determined by market competition. Electricity retail companies are only responsible for electricity transaction, while grid enterprises are only responsible for transmitting and distributing electricity, and collecting corresponding costs.

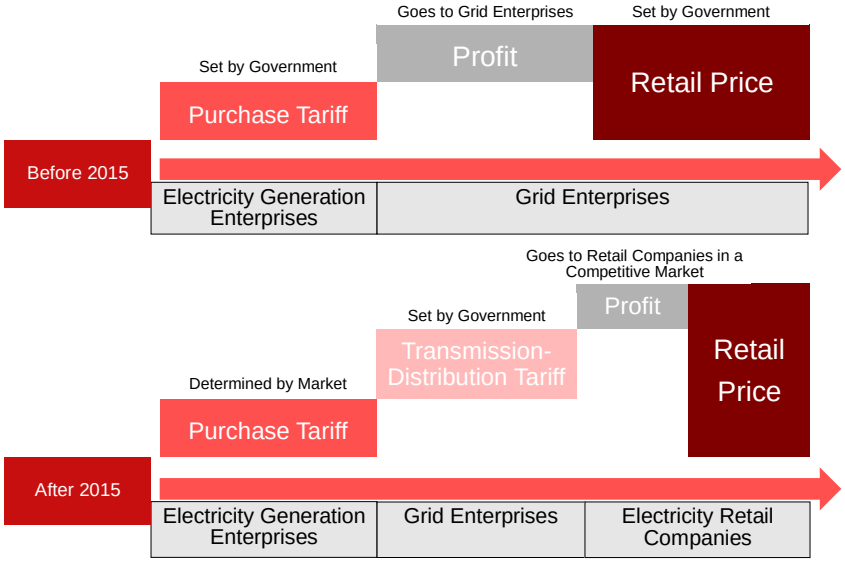

Figure 5: Schematic of Profit Models on Generation and Retail Before and After the New Electricity Market Reform

As the new electricity market reform accelerates, a profound revolution has unfolded in the power industry, introducing effective competition in electricity generation and retail and helping the power grids develop in a coordinated and healthy way. The building of a more dynamic, more efficient, fairer and more convenient electricity market can also bring huge benefits to the economic development of China in the following aspects.

(1) Establishing a new competitive framework for electricity purchase and retail by introducing competition on the generation and retailing side;

(2) Achieving an optimal allocation of resources by establishing a market-oriented pricing mechanism;

(3) Bring benefits to consumers by reducing their electricity consumption costs;

(4) Increasing the service level by granting options to consumers;

(5) Advancing energy conservation and emission reduction as well as the development of clean energy;

(6) Boosting the overall operation efficiency of the power industry;

(7) Attracting social investment and accelerating local economic development.

2. Participation of China's Power Industry in Regional ETS

With intensive emissions, the power industry has always been a key industry in terms of carbon emission control. The power industry has a number of advantages, e.g. a high degree of industry concentration, a decent database, a low risk of carbon leakage, and relatively low management costs. Therefore, all 8 regional ETS have covered the power industry. The policy design in each pilot slightly differs from the others, providing helpful experience for the design of the national ETS. Power industries in the eight markets have gradually established their corresponding carbon management systems, and therefore carbon emission control has officially become a critical mission for China's power industry.

2.1 Emission Sources and Allowance Allocation in Power Industry in Regional ETS

Tables 1~3 show the emission sources and allowance allocation methods of power industries in each regional ETS. It is visible that emissions from fossil fuel combustion, desulfuring processes, and net purchased electricity are universally covered. As the power industry has a relatively simple product with a decent database, most regions adopted benchmarking methods for allowance allocation.

Table 1: The Scope of GHG Emission Accounting and Reporting by Power Industry in Regional ETS

	Direct Emission Sources				**Indirect Emission Sources**		
	Fossil Fuel Combustion from Fixed Installations	Fossil Fuel Combustion from Mobile Sources	Desulfuring Process	Others	Net Purchased Electricity	Net Purchased Heat	Others
Shenzhen	√	√	√	Fugitive Emission	√	√	Net Purchased Steam and Coal
Shanghai	√						
Beijing	√				√		
Guangdong	√	√	√				
Tianjin	√	√	√		√	√	
Hubei	√	√	√		√		
Chongqing	√	√			√	√	
Fujian	√	√	√		√		

Table 2: Allowance Allocation Methods in Power Industries in Regional ETS

Regions	Free Allocation Methods
Shenzhen	Benchmarking Method
Shanghai	Benchmarking Method
Beijing	For Existing Units: Historical Intensity Method For Newly Installed Units: Benchmarking Method
Guangdong	For Coal-Powered and Gas-Powered (Including Heat Generation, Combined Heat and Power Generation) Units: Benchmarking Method For Units Enabling Comprehensive Utilization of Resources (Using Coal Gangue, Oil Shale, Coal Water Slurry and Other Fuels) and Heating Boilers: Historical Intensity Method.
Tianjin	For Existing Units: Historical Intensity Method For Newly Installed Units: Benchmarking Method
Hubei	Benchmarking Method
Chongqing	Enterprise Self-Declaration
Fujian	Benchmarking Method

Table 3: Power Industry Benchmarks in Different ETS Pilots

	Shenzhen (2016)		Guangdong (2017)			Shanghai (2016)			Hubei (2016)	Fujian (2016)		Beijing (New Generators)	
Coal-Powered Units（tCO_2/MWh）	0.8718		Over 1000MW		0.800	Ultra-supercritical	Over 1000MW	0.7440	0.7524	Ultra-supercritical	0.8206	N/A	
			600-1000 MW	Ultra-supercritical	0.825		660-1000MW	0.7686	0.7650				
				Supercritical	0.845	Supercritical	Over 900MW	0.7951	0.7841	Supercritical	0.8614		
				Subcritical	0.800		600-900MW	0.7954	0.8050				
			300-600MW	Non-CFB Units	0.905	Subcritical	Over 600MW	0.8155	—	Subcritical	0.8789		
				CFB Units	0.927		300-600MW	0.8218	0.8135				
			Below 300MW	Non-CFB Units	0.965	Medium Pressure	12-300MW	1.1203	—	Ultra-high Pressure	1.0607		
				CFB Units	0.988					High Pressure and Below	1.2616		
Gas-Powered Units（tCO_2/MWh）	9E Units Natural Gas Power Plants	0.4657	Below 390MW		0.440	E[1]	0.4636		—	0.3682		E (Heat-Electricity Ratio≤0.3)	0.368
	Cogeneration 9E Units LNG Power Plants	0.4765										E (Heat-Electricity Ratio＞0.3)	0.341
	9E Units LNG Power Plants	0.4604	Above 390MW		0.390	F	0.3800					F Heat-Electricity Ratio≤0.3)	0.345
	9F Units LNG Power Plants	0.4098										F (Heat-Electricity Ratio＞0.3)	0.312
Oil-Powered Units（tCO_2/MWh）	—		—			0.7658			—	—		—	
Heat Generating Units（tCO_2/GJ）	—		—			—			—	0.1101 (Coal-Powered)		0.05978 (Gas-Powered)	

[1] E and F represents E-type gas-powered units and F-type gas-powered units respectively.

2.2 Impact of Regional ETS on Power Industry

Currently, a total of 179 electricity generation enterprises are included in regional ETS, including 86 in Guangdong, 24 in Hubei, 23 in Fujian, 17 in Tianjin, 14 in Shanghai, 8 in Shenzhen and 7 in Beijing. The impact of regional ETS on the power industry is mainly reflected in the allowance control and the corresponding implementation risk. Beijing and Tianjin mainly adopt the historical intensity approach, in which the amount of free allowances is determined based on emission intensity of the enterprises in the past years. Such allocation method is highly acceptable by the general industry but is discouraging model enterprises in terms of emission reduction in the industry. Guangdong, Shanghai, Shenzhen, Hubei and Fujian adopted a benchmarking method, in which the amount of free allowances is determined according to industry emission benchmarks. This method benefits enterprises with progressive emission reduction achievements, forcing the industry to adopt advanced technologies related to energy conservation and emission reduction. Consequently, this method exerts more pressure on enterprises in terms of emission reduction. In general, regional ETS are currently operating independently and with a limited scale. With inadequate market liquidity and a relatively low carbon price, the impact of regional ETS on electricity generating enterprises is yet very limited, especially in the aspects that are directly linked to their economic benefits such as production and operation, energy saving, technologic innovation, and electricity generation costs. However, as the ETS pilots are getting mature in their operation, and the awareness of enterprises is continuously improved, more and more electricity generating enterprises have realized the influence that the carbon market may impose on their development and started to respond.

2.3 Coping Methods of Power Industry towards Regional ETS

In regional ETS, the electricity generating enterprises' response to the carbon market is mainly reflected at the level of second-tier companies and power plants, while the action at the group level is relatively limited. Key actions include:

(1) Actively working on allowance surrender and the implementation. Since the launch of Shenzhen pilot in 2013, electricity generating enterprises involved in regional ETS have actively participated in the reporting, verifying and trading processes and have started implementation in accordance with corresponding regulations. The implementation rate remains at over 95% overall, and reaches nearly 100% in the power industry.

(2) Scientifically review whether existing assets can be developed into CCER projects. A number of electricity generating enterprises have already assessed their emission reduction project resources and successfully developed several CCER projects.

(3) Actively promoting carbon financial innovation so as to vitalize carbon assets as well as to broaden investment and financing channels. Guangzhou University City Huadian New Energy Co., Ltd. piloted the first domestic carbon emission allowance online mortgage financing business in Guangdong Province. The CGNPC Wind Power Co., Ltd. in Shenzhen issued the first domestic carbon bonds with yields gaining from fixed income and floating income. The fixed income is linked with the benchmark interest rate and is guaranteed by the investment income from wind power projects, while the floating income is the gain from carbon assets, which is linked to the CCER generated by the completed wind power projects.

3. Prospect of China's Power Industry Participating in the National ETS

As an important basic industry in China's national economy, the power industry accounts for more than 60% of China's total energy consumption and about 40% of China's total carbon dioxide emissions. Therefore, the effectiveness of carbon emission management in the power industry will directly affect the healthy operation of the national ETS and the green and low-carbon development of the national economy. It will also act as a core industry under the control of the national ETS.

The intended allowance allocation method for the power industry in the national ETS will be the benchmarking method. Opinions from industry and enterprise representatives have been extensively solicited while formulating the detailed allocation scheme, and the corresponding calculations have concluded in main. At the same time, major domestic electric power groups have pondered over their experience from the participation in regional ETS and started to prepare for the national ETS, laying a good foundation for China's power industry to participate in the upcoming national ETS.

3.1 Allowance Allocation in Power Industry in the National ETS

In May 2017, the Training Session on the Pilot Calculation of National ETS Allowance Allocation held in Sichuan disclosed a discussion paper on the allowance allocation plan for the power industry. The general idea of allowance allocation is based on benchmarking and pre-allocation. The specific calculation formula is provided as follows:

Total amount of allowance = total allowance for power generation + total allowance for heat generation

Calculation of allowance for power generation units:

Total allowance for power generation units = power supply × benchmark × cooling mode correction factor × heat supply correction factor × fuel cal. value correction factor

The emission benchmark is divided into 11 categories based on units' different pressures, capacities and fuel types. The emission benchmarks for each category are as follows:

Table 4: Benchmark for Power Industry in the National ETS

Unit Type	Benchmark（tCO_2/MWh）
Ultra-supercritical 1000MW	0.8066
Ultra-supercritical 600MW	0.8267
Supercritical 600MW	0.8610
Supercritical 300MW	0.8748
Subcritical 600MW	0.8928
Subcritical 300MW	0.9266
High / Ultrahigh Pressure Below 300MW	1.0177
CFB IGCC 300MW and Above	0.9565
CFB IGCC Below 300MW	1.1597
Gas-Powered F-Level and Above	0.3795
Gas-Powered Below F-Level	0.5192

For cooling mode correction factor, water-cooling is 1 and air-cooling is 1.05. As for heat supply correction factor, it is 1 - 0.25 × heating ratio for coal-powered power plants and 1 - 0.6 × heating ratio for gas power plants. Fuel calorific value correction factor only applies to CFB IGCC units; therefore other units use the default value, 1, in calculation. For CFB IGCC units, the correction factor equals 1.03 for units utilizing coal with calorific value under 3000 kcal, and goes to default, i.e. 1, for units utilizing coal with calorific value over 3000 kcal.

Calculation of allowance for heat generation units:

Total allowance for heat generation units = heat supply × heat supply emission benchmark

The heat supply emission benchmark equals 0.1118 tCO_2/GJ for all coal-powered units, and 0.0602 tCO_2/GJ for all gas units.The allowance for an enterprise is initially estimated based on their product output in 2015. 70% of the allowance calculated this way will be allocated in advance in the pre-allocation phase. After the final amount of allowances is calculated based on the enterprise's actual output, any excess allowance will be collected and deficit will be complemented after the verification of the compliance year.

Adopting the benchmarking method, advanced units in the power industry are more likely to obtain allowance surplus while inefficient units may face serious allowance deficit. As the operation of the market the allowance allocation method continues to improve, the number of benchmark categories in the power industry may be reduced, which means that the pressure on small and inefficient units will be further intensified.

3.2 Impact of the National ETS on Power Industry

The launch of the national ETS will have a huge impact on electricity generating enterprises. On one hand, the national ETS will put pressure on enterprises in terms of emission reduction, and affect the enterprises' power generation costs, energy-conserving management, investment structure and business profits. On the other hand, the launch of the national ETS also brings new opportunities to the power industry in the following aspects:

(1) The carbon market broadens the emission reduction channels for electricity generating enterprises, enabling them to accomplish their emission reduction tasks through market instruments. Some key technical indicators of China's power industry such as coal consumption rate and line loss rate have already reached an international advanced level, which leaves limited spaces for emissions reduction. With the market mechanism, enterprises can reduce their emission reduction costs and achieve their energy-saving and carbon-reduction goals at a relatively lower cost;

(2) The carbon market has also provided enterprises with leading emission reduction technologies with a new aspect of profit growth. Considering the fact that the benchmarking method will be universally adopted in the power industry in the national ETS, enterprises with progressive emission reduction efforts are expected to make good profit from the carbon market.

3.3 Coping Methods of Power Industry towards the National ETS

In order to better cope with the upcoming national ETS, CEC (China Electricity Council) took the lead in setting up a carbon trading working group for the power industry in 2015. Its member companies include the seven major power generation groups, i.e., Huaneng, Datang, Huadian, Guodian, SPIC, Shenhua and Yudean. Its main task is to establish a carbon trading communication and coordination mechanism at the industry level, strengthening the communication and information exchange in terms of electricity generating enterprises' participation in carbon trading and carbon emission reduction.

Meanwhile, a number of China's power groups have taken actions at the enterprise level in order to speed up the arrangement in managing carbon emission and carbon assets, so as to promote energy conservation and carbon reduction. Specifically:

(1) Establish an enterprise-level carbon asset management mechanism, and build a carbon asset management information platform. The Big Five represents a number of major electricity generating enterprises, who have successively set up specialized carbon asset management agencies and introduced carbon emission management regulations at the headquarter level, forming a low-carbon evaluation and management mechanism. In addition, enterprises including Huadian Group have also built corporate carbon asset management information platforms, collecting data from various sources, enabling the interconnection of information, and thereby enhancing the efficiency in carbon asset management.

(2) Conducting emission data accounting. Emission data is the basis for both managing carbon emissions and establishing enterprise-level emission management strategies. Enterprises such as Huadian Group have conducted comprehensive carbon emission data accounting in their subordinate power plants in accordance with the corresponding standards and requirements, to acquire their emission data and to better understand their emission pattern.

(3) Systematically advancing emission management capacity building in electricity generating enterprises. Carbon emission management is a highly specialized task, which requires dedicated knowledge and experience from the implementing personnel during MRV, trading and implementation processes. Electricity generating enterprises such as the Big Five have systematically launched their capacity building programs on carbon emission and carbon asset management, further enhancing the specialized knowledge and skillsets of managerial staff at all levels on managing carbon emissions responding to the carbon market.