



Interactions Between Carbon Markets, Green Certificate Trading and Green Power Trading in China

Review Paper

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Sino-German Cooperation on Emissions Trading Systems, Carbon Market Mechanisms, and
Industry-related N₂O Mitigation

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1. China's ETS as An Approach to Control GHG Emissions

To address climate change and achieve its carbon emissions peaking and carbon neutrality (CPCN) targets, China, in addition to traditional policies such as adjusting energy mix and upgrading industrial structure, has also gradually introduced market-based mechanisms, persistently promoted the construction of a national carbon market, established a voluntary GHG emission reduction trading, given full play to the role of the market and continued to improve the level of support to address climate change.

Emissions trading system (ETS) is also called as “cap and trade system”, it imposes a cap on the total emissions for covered sectors. The authority issues tradable allowances not exceeding the cap. Each allowance typically corresponds to one ton of emissions. Entities covered by the ETS are then allowed to trade allowances and resulting in a carbon price. As a legally defined and artificially created market, ETS was originally designed to incentivize emissions reduction and lower GHG abatement costs. Emissions trading is a major institutional innovation that leverages market-based mechanisms to control and reduce GHG emissions, as well as promote green and low-carbon development, providing an effective way to manage the interaction between economic development and carbon abatement.

NDRC approved local pilot emissions trading in Beijing, Tianjin, Shanghai, Chongqing, Guangdong, Hubei and Shenzhen in 2011 and online trading has begun since 2013. China's pilot carbon markets included nearly 3,000 key emitters from more than 20 sectors, including power, iron and steel and cement, laying a foundation and accumulating valuable experience for the construction and operation of the national carbon market. By the end of 2021, the accumulative volume of allowances traded in pilot carbon markets are nearly 500M tCO₂, with a turnover of RMB 12.2 billion and an average transaction price of about RMB 25 per tCO₂, positively contributing to GHG emission control as well as explorations on pathways towards carbon peaking in pilot provinces and cities¹.

In 2017, the National Development and Reform Commission (NDRC) issued the National Carbon Emissions Trading System Construction Plan (Power Generation Sector), marking the official opening of the construction of the national ETS in China. The Construction Plan clearly stated that “we shall launch a national ETS with the power generation sector as a starting point, develop national unified emission data reporting, registration, trading and settlement systems, steadily develop the design of the carbon market in three phases”. After the stable and healthy operation of the carbon market for the power generation sector, the coverage of the national ETS will be gradually expanded to iron&steel, non-ferrous metals, building materials, chemicals, petrochemicals, papermaking, civil aviation.

In 2018, the work function to address climate change and emission reduction in China reshuffled from NDRC to the Ministry of Ecology and Environment (MEE). As the competent authority for ETS, the MEE released a series of policies centrally in late 2020, including: the Measures for the Administration of Carbon Emissions Trading (Trial), which clarified various definitions of the national carbon market, laying a foundation for the stable operation of the national carbon market; the List of Key Emitters Included in the Management of National Carbon Emissions Trading Allowances for 2019-2020, which clearly defined power generation entities (including captive power plants) that emit more than 26,000 tons of carbon dioxide equivalent (comprehensive energy consumption is about 10,000 tons of standard coal) in any year from 2013 to 2019 are covered by the national ETS; the Implementation Plan for Setting and Allocating National Emissions Allowances

¹ Data Source: China Beijing Green Exchange.

for 2019-2020 (Power Generation Sector), which announced the allocation methods for different types of generating units and the corresponding carbon emission limits per unit of electricity (heat) supplied; the Guidelines on Enterprises' GHG Emissions Accounting Methodology and Reporting (Power Generation Facilities) and the Guidelines on Enterprises' GHG Emissions Reporting and Verification (Trial), which provided guidance for accurately grasping the data related to allowance allocation, submittal and compliance in the power generation sector, and consolidating the data basis for the national carbon market to expand the coverage and improve the allowance allocation methods.

On July 16, 2021, the national carbon market officially launched online trading, incorporating 2,162 key emitters from the power generation sector and covering about 4.5 billion tCO₂ emissions annually, making it the largest carbon market in the world. As of March 4, 2022, the accumulative volume of carbon emission allowances traded in the national carbon market are 188Mt, with an accumulative turnover of RMB 8.18 billion and an average transaction price of RMB 43.51 per tCO₂.

2. Market-based Mechanisms Supporting China's Renewable Energy Development

Since Renewable Energy Law enacted, China's renewable energy development has made remarkable achievements. However, in the context of the CPCN goals, pushing forwards energy revolution in an in-depth approach will bring new opportunities for renewable energy development. In 2022, the 14th Five-Year Plan for Renewable Energy Development that issued by the State clearly raises the “market-oriented” as one of main principles; makes market mechanisms play a decisive role in resource allocation as well as creates a fair, open and full competition market environment. At present in China, the main market mechanisms related to renewable energy power are CCER trading, green energy certificate trading and green power trading².

2.1 CCER

To guarantee the orderly conduct of voluntary emissions reduction trading activities, mobilize the whole society to consciously participate in carbon abatement activities, accumulate experience and lay the technical and rule basis for a cap-based carbon market, NDRC formulated the Interim Measures for the Administration of Voluntary GHG Emission Reduction Trading (hereinafter referred to as the “Interim Measures”) in 2012.

The Interim Measures clarified the definition of China's Certified Emission Reduction (CCERs), i.e., the GHG emission reductions registered in the national voluntary GHG emissions reduction registry after quantifying and certifying GHG abatement outputs from renewable energy, carbon sinks, methane utilization and other projects in China. It stipulated that CCERs shall be traded in the exchanges filed with the national competent authority and in accordance with the trading rules established by the exchanges. In early 2015, NDRC issued the Announcement for the Operation and Account Opening of the National CCER Registry, officially putting the CCER registry into operation. In the same year, the Guangzhou Emissions Exchange completed the first online CCER transaction in China, with a trading volume of 200,000 tCO₂e and a turnover of RMB 2 million, opening the curtain for voluntary carbon market in China.

According to the disclosed information by the NEA³, the competent authority has filed 200 CCER methodologies, 9 exchanges, 12 DOEs and 1,315 projects by now, while it also issued emission reduction credits of around 78M tCO₂e in total from about 400 projects (454 batches). According to 234 published projects (254 batches) with 53 Mt tCO₂e credits in the Online CCER Information Platform, half of them is from wind power and solar PV power generation, with issued emissions reductions accounting for 30% of the total. In addition, there are also 32 hydropower projects with the issued emission reductions accounting for 1/4 of the total.

² NEA, 14th Five-Year Plan for Renewable Energy Development.

³ NEA, Reply to the Proposal No. 4659 of 3rd Meeting of 13th National People's Congress http://zfxgk.nea.gov.cn/2020-09/23/c_139540319.htm

Fig. 1 CCER Project Types and Sources published by online Platform

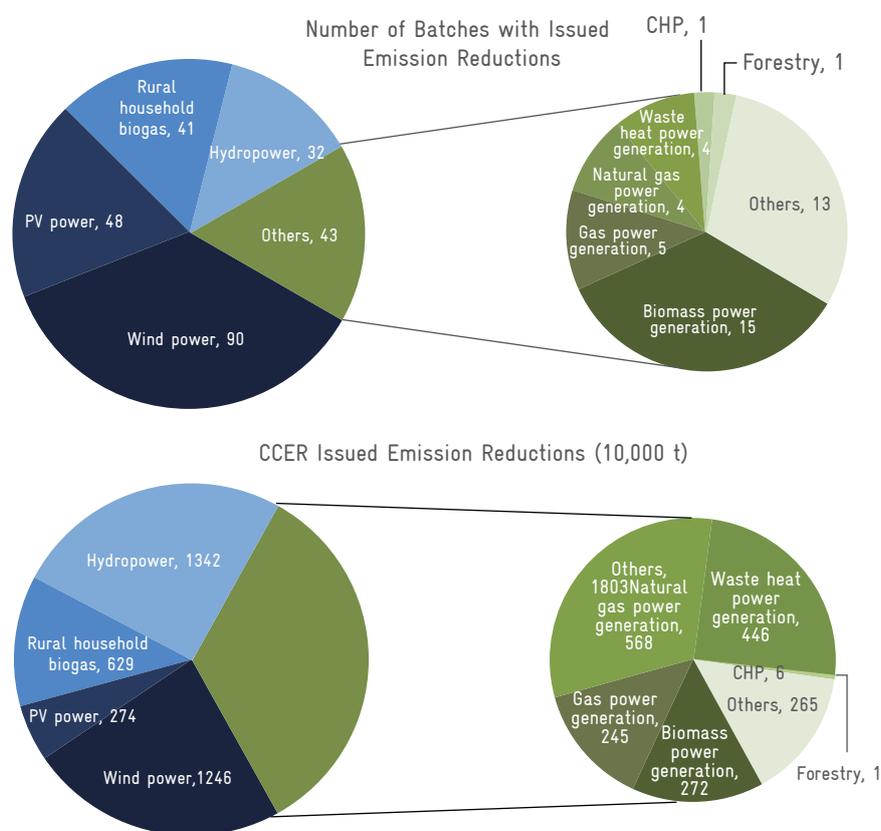


Chart Source: China's Carbon Market Reviews 2021 (Sino Carbon)

CCER trading allows non-key emitters to enter carbon markets and provides a trading platform for these enterprises to sell their issued CCERs, thus introducing an offset mechanism for China's ETS. This means that key emitters covered by ETS may purchase allowances in the national carbon market, or purchase project based CCERs to offset their carbon emissions and fulfil compliance obligations. Therefore, the CCER offset will not only help expand participants in the carbon market, promote the development of environmentally friendly industries such as forestry and clean energy by means of market-based compensation, but also reduce the compliance costs of obligated enterprises in the ETS. Each pilot carbon market has made provisions on the use of CCER offsets for compliance, including the project types, source regions, timing, and specific operational procedures for CCERs, as well as the offset ratio of CCERs. (See table 1)

To further improve and standardize CCER system and promote green and low-carbon development, in accordance with the requirements of streamlining administration, delegating power, strengthening regulation, and optimizing services, NDRC issued the Announcement on the Suspension of the Acceptance of Applications for the Filing of Methodologies, Projects, Emission Reductions, Approval and Certification Bodies and Trading Bodies for CCER in 2017; in 2020, the MEE issued the Measures for the Administration of Carbon Emissions Trading (Trial), which clearly stated that "key emitters may use CCERs to offset carbon emission allowances each year"; in 2021, the MEE issued the Notice on Facilitating the Carbon Emission Allowances Surrendering in the First Compliance Cycle of the National ETS, which clearly stipulated that the offset ratio of CCERs shall not exceed 5% of the emission allowances subject to surrender, and shall not come from emission reduction projects included in the national carbon market.

At present, about 60 million tons of CCERs have been used in the pilot carbon markets and the national ETS as offsets, of which approximate 34 million tons have been used for offsetting during the first compliance period of the national ETS. Until Dec 2021, the total turnover volume of CCER trading is about 443 Mt, of which 176 Mt in 2021, accounting for about 40%⁴. According to the data disclosed by the Shanghai Environment and Energy Exchange, the CCER price rose from RMB 10/t in January 2021 to RMB 35/t by the end of 2021. However, compared to allowance price in the national ETS, using CCER as offsets can still lower the compliance costs of enterprises.

Table 1 Provisions on the Use of Offsets for Compliance in Domestic Carbon Markets⁵

Pilot	Indicator Type	Use Ratio	Geographical Restrictions	Time and Type Restrictions
National Carbon Market	CCERs	The offset ratio shall not exceed 5% of emission allowances subject to submittal	NA	NA
Beijing	CCERs and Carbon Emission Reductions from Energy Efficiency Projects and Forestry Carbon Sink Projects	The offset ratio shall not exceed 5% of the allowance amount issued to key emitters in the year	CCERs generated from projects outside Beijing shall not exceed 2.5% of the allowance amount issued in the year; priority shall be given to using CCERs from regions that have signed cooperation agreements with Beijing	CCERs generated after January 1, 2013, emission reductions from energy efficiency projects; Carbon sink projects started after February 16, 2005; Not from HFC _s , PFC _s , N ₂ O and SF ₆ gases and hydropower projects; Emission reductions not from the fixed facilities of key emitters within the administrative jurisdiction of Beijing
Tianjin	CCERs	The offset ratio shall not exceed 10% of enterprises' actual emissions in the year	Priority shall be given to using emission reductions generated within the Beijing-Tianjin-Hebei region; CCERs within the emission boundaries of covered enterprises in Tianjin and other pilot carbon markets may not be used	Actual emission reductions generated after January 1, 2013; From CO ₂ gas projects only; Excluding hydropower projects
Shanghai	CCERs	The offset ratio shall not exceed 5% of the allowance amount obtained by pilot enterprises through allocation in the year	NA	Actual emission reductions generated after January 1, 2013

4 Data Source of CCER trading: https://mp.weixin.qq.com/s/Sek5DZfu0ui3loQ_p5r3Uw

5 References: Measures for the Administration of Carbon Emissions Offsetting in Beijing (Trial), Notice on Matters Relating to the Use of Offsetting Mechanism in the Pilot Carbon Emission Trading in Tianjin, Notice on the Provisions on the Use of Offsetting Mechanism in the Pilot Carbon Emission Trading in Shanghai [HFGHZ[2015] No. 3], Notice on Matters Relating to the Carbon Emissions Offsetting Mechanism in Hubei Province in 2018, Working Guidelines for Emission Control Enterprises to Use CCERs or PHCERs to Offset Actual Carbon Emissions in 2019 in Guangdong Province, and Provisions on the Administration of Offset Credits in the Carbon Emissions Trading Market in Shenzhen (Temporary).

Chongqing	CCERs	The offset ratio shall not exceed 8% of approved emissions	NA	Emission reduction projects put in operation after December 31, 2010 (excluding carbon sink projects), and from energy conservation and energy efficiency, clean energy and non-hydro renewable energy, carbon sinks, energy activities, industrial processes, agriculture, waste treatment and other areas
Hubei	CCERs	The offset ratio shall not exceed 10% of enterprises' initial annual carbon emission allowance	CCERs outside the boundaries of enterprises and organizations included in the management of carbon emission allowances within the administrative jurisdiction of the province	CCERs generated from rural biogas and forestry projects that have been filed with the State; Project generation areas are the poverty-stricken counties (designated by the state and the province) in urban agglomeration (Hubei) region in the middle reaches of the Yangtze River; Project entry period is from January 1, 2013 to January 1, 2015
Guangdong	CCERs and PHCERs	The offset ratio shall not exceed 10% of enterprises' actual emissions in 2019	At least 70% of the CCERs submitted shall be provincial CCERs	CCERs from CO ₂ and CH ₄ projects account for 50% of all GHG emission reductions; CCERs from hydropower projects, not from power generation, heat supply and waste energy (including waste heat, waste pressure and waste gas) utilization projects from fossil energy sources such as coal, oil and natural gas (excluding CBM), and not from other pilot areas
Shenzhen	CCERs, PHCERs and other CERs	The offset ratio shall not exceed 10% of control units' annual emissions	NA	From wind power, solar power and waste-to-energy projects in Shenzhen; From rural household biogas and biomass power generation projects, clean transportation emission reduction projects and marine carbon sequestration emission reduction projects in Shenzhen and regions that have signed regional strategic cooperation agreements on carbon trading with Shenzhen; Nationwide forestry carbon sink projects and agricultural emission reduction projects

2.2 Renewable Energy Certificates (RECs)

In order to guide the whole society to consume green power, improve the subsidy mechanism for wind power and solar PV power generation and broaden the funding source of renewable energy subsidy, in January 2017, the NDRC, the Ministry of Finance (MOF) and the National Energy Administration (NEA) jointly issued the Notice on the Trial Implementation of the Issuance and Voluntary Subscription and Trading Systems for Renewable Energy Certificates (FGNY[2017] No. 132), specifying that from July 2017 onwards, a voluntary subscription system for renewable energy certificates (RECs) will be implemented on a trial basis nationwide.

The REC is an electronic certificate with a special identification code issued by the State for each MWh of on-grid non-hydro renewable power production, which is the confirmation and attribution of non-hydro renewable energy generation and the sole proof of the consumption of green power. In line with common international practices, the REC represents the environmental value of renewable power. Renewable energy generation plants may capture environmental value gains through the sale of RECs; while buyers of RECs will receive the right to declare that they have consumed green energy. However, unlike international practices, only onshore wind power and solar PV power production (excluding distributed solar PV power generation) may apply for RECs through the Information Management System for Renewable Energy Power Generation Projects in accordance with the relevant requirements.

After REC is sold, the corresponding amount of electricity will no longer be subsidized by the national renewable energy feed-in tariff fund. The State encourages government agencies at all levels, enterprises, public institutions, social organizations and individuals to voluntarily subscribe RECs, which shall not be re-sold after subscription. The National Renewable Energy Information Management Center is responsible for issuing certificates to institutions and individuals who purchase RECs.

The REC trading system is usually a complement to the Renewable Portfolio Standard (RPS). In 2019, the NDRC and NEA jointly issued the Notice on Establishing a Sound Mechanism for Guaranteeing the Consumption of Renewable Energy, setting the weight of responsibility for the consumption of renewable power by provincial administrative regions. Market entities concerned fulfil the consumption responsibility mainly by consuming renewable power and the following supplementary (alternative) methods may also be adopted: ① purchase of surplus renewable power consumption from market participants who have over-achieved their annual consumption; ② voluntary subscription of RECs, with the equivalent amount of renewable power corresponding to RECs being counted as consumption.

With the large-scale development of wind power and solar PV power generation and rapid technological advances, conditions for grid parity have already matured in some regions. In 2019, the NDRC and NEA issued the Notice on Actively Promoting the Work Relating to Unsubsidized Grid Parity for Wind Power and Solar PV Power Generation, proposing “to encourage grid-parity projects and low feed-in tariff projects to obtain reasonable income compensation through REC trading”. The State will guide the market trading of RECs through various measures. At present, depending on whether the renewable energy projects generating the RECs are subsidized or not, RECs can be divided into two categories: subsidized and grid-parity RECs. The price of subsidized RECs has remained high because once they are sold, the corresponding amount of electricity will no longer be eligible for state subsidies⁶; whereas grid-parity RECs come from grid-parity new energy projects, or those whose subsidy period has expired, so their price is relatively low.

⁶ Subsidized Recs 'maximum transaction price = (benchmark feed-in tariff for wind power/PV power projects - the local benchmark tariff for desulphurized coal-fired generation) x 1000; the price of the grid-parity REC is determined according to market conditions, and the first transaction price was RMB 50 per certificate, i.e. RMB 0.05/kWh.

In 2020, the State released the Opinions on Promoting the Healthy Development of Non-hydro Renewable Energy Power Generation, which clearly stated that REC trading under the RPS would be implemented since January 1, 2021, while market-based approaches would be employed to continuously expand the trading scale of the REC market and promote REC trading.

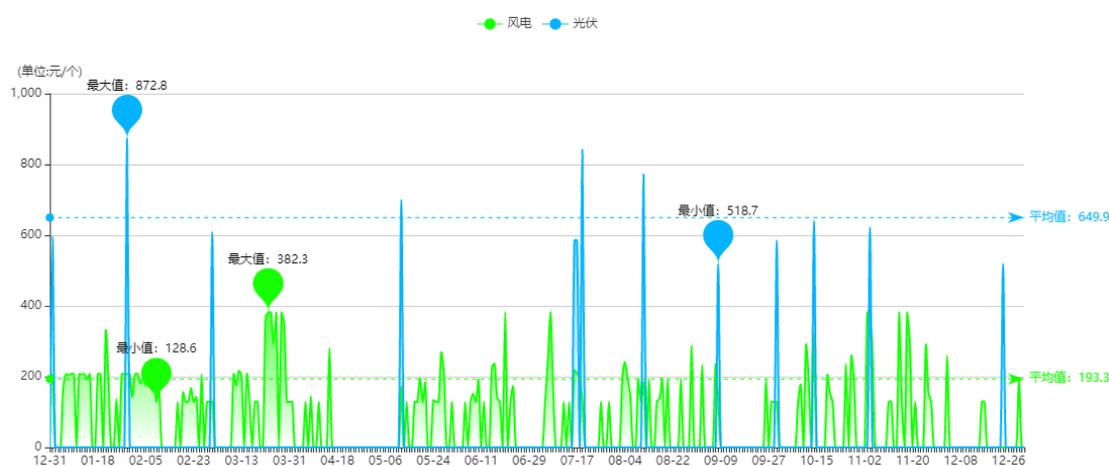
In 2021, the number of wind power RECs traded in China were 13,181, of which subsidized ones accounted for 28% of the total, with an average transaction price of RMB 193 per certificate; the number of solar PV RECs traded totaled 9,967, of which only 15 subsidized RECs were traded, with an average transaction price of RMB 650 per certificate. Unsubsidized RECs accounted for 84% of the total, with an average transaction price of RMB 50 per certificate.

Table 2 Trading Volume and Transaction Price of Wind Power and Solar PV Subsidized RECs

	Trading Volume		Average Price (RMB/certificate)	
	Subsidised	Unsubsidised	Subsidised	Unsubsidised
Wind Power	3737	9444	193.3	50.02
Solar PV	15	9952	649.9	50.02

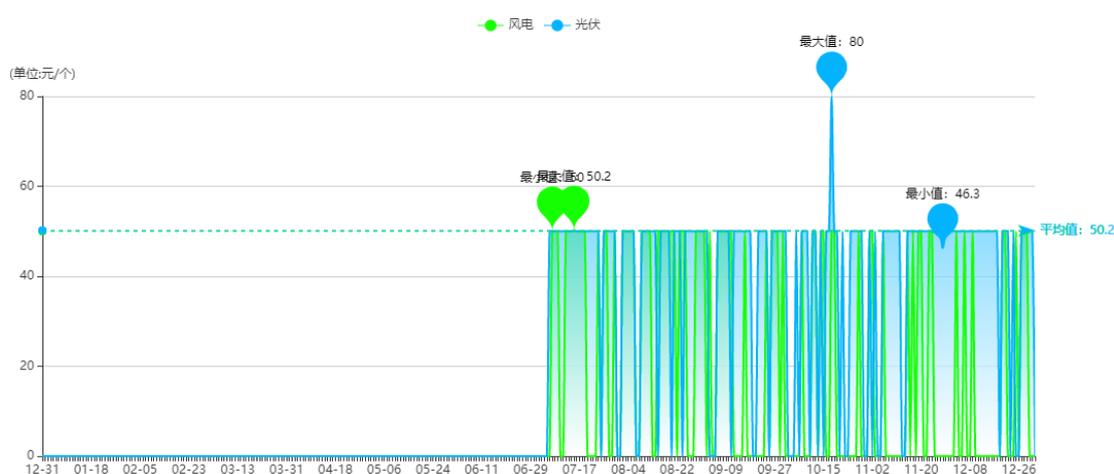
Data Source: China RECs Subscription and Trading Platform

Fig. 2 Daily Trading Volume and Transaction Price of Subsidized RECs



Data Source: China RECs Subscription and Trading Platform

Fig. 3 Daily Trading Volume and Transaction Price of Unsubsidized RECs



Data Source: China RECs Subscription and Trading Platform

2.3 Green Power Trading

To implement strategic deployment to achieve CPCN targets, push forward the new power system construction, accelerate the establishment of a market-based system and a long-term mechanism to promote green energy production and consumption. In September 2021, the NDRC and NEA formally approved the Work Plan for Pilot Green Power Trading (hereafter referred to as the “Work Plan”), kicking off green power trading in China. In January and May 2022, the Guangzhou Electricity Trading Center and the Beijing Electricity Trading Center respectively released the Implementation Rules for Green Power Trading, which details operation, price, settlement, green certificate transfer and other methods and processes regarding green power trading, which provide support for the normalization of green electricity trading.^{7 8}

Green power product refers to the on-grid electricity from wind power, solar PV and other renewable energy power generation plants that meet the national requirements. At present, it is mainly on-grid electricity from wind power and solar PV power generation. It can be gradually expanded to the on-grid electricity from other power sources in accordance with related national requirements in future. Green power trading refers to medium and long-term power transactions with green power products as the subject matter, to meet the needs of power generation enterprises, power sales companies, power users and other market entities to sell and purchase green power products and provide green power certificates for power users of green power products.

According to the Work Plan as well as Implementation Rules, the market participants in green power trading include currently solar PV and wind power plants on the power generation side, which may be extended to eligible renewable energy sources such as hydropower in future; and electricity sale companies and power consumers on the power consumption side currently, which may be gradually extended to emerging entities such as electric vehicles and energy storage in future. Other entities involved in green power market trading also include market operators, i.e., power grids responsible for green power

⁷ Implemented Rule Issued by Beijing Electricity Trading Center

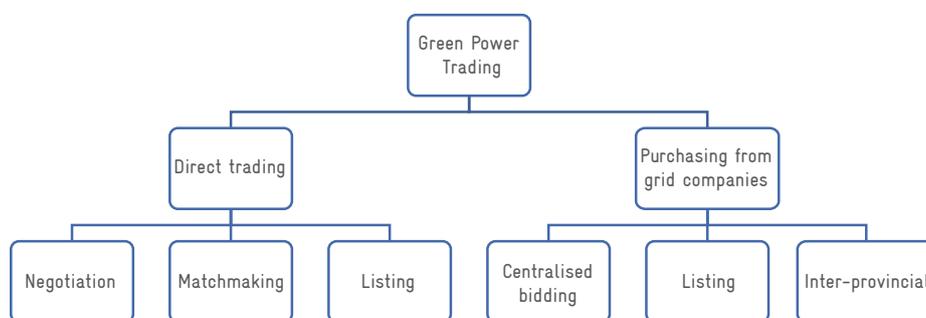
⁸ Implemented Rule Issued by South-Grid Electricity Trading Center

transmission, power trading centers responsible for implementing and managing green power trading, power dispatching institutions that guarantee the preferential implementation of green power trading contracts, and the National Renewable Energy Information Management Center that issues green certificates to power production.

Green power trading can be divided into two ways: direct trading and purchasing from grids. The direct trading mainly applies to the intra-provincial market and parties to the transaction may agree on the amount of electricity traded and the transaction price through bilateral negotiation, centralized matchmaking and listing, then sign bilateral trading contracts and thus realizing the precise matching of green power supply and demand. If the demand for green power consumption cannot be met, power consumers may purchase from grids for green power products they guarantee to acquire, mainly through centralized bidding (grid agent guarantee declared volume-price), listing (grid agent guarantee listed volume-price) and inter-provincial trading (grid agent intra-provincial power purchase demand). Inter-provincial market trading can achieve optimal allocation of green power through market-based mechanisms, expanding the scope of green power trading and contributing to a society-wide philosophy of green power consumption.

Wind power and solar PV power generation that are not included in the national feed-in tariffs subsidies fund is prior to participate in green power trading; wind power and solar PV power that have been included in the national feed-in tariffs subsidies fund participates in green power trading voluntarily, traded green electricity will no longer receive subsidies nor be counted in their reasonable utilization hours. Distributed new energy resources can participate in green power transactions in aggregation way. Therefore, green power trading can realize the shift from quantitative pricing under the planning system to the volume-price composition under market-oriented decisions, sharing subsidies through market-based mechanisms and easing the pressure of subsidy shortfall.

Fig. 4 Methods of Green Power Trading



The Work Plan proposes an initial annual (multi-month) trading cycle, while encouraging market entities to enter long-term (5-10 years) power purchase agreements (PPAs), thus establishing a long-term mechanism to boost the development of green power. The Implementation Rules specifies process for different trading cycle such as year (many years), month (multi-month) and days (ten days, weeks). China's green power trading has given full play to the platform role of the power trading centers, allocated RECs to power consumers based on the results of green power trading settlements and achieved the linkage of the environmental value of green power from the trading source to the "consumption certification". In this process, the trading platform has ensured the accuracy and timeliness of the transfer of RECs, avoided double counting of environmental interests, and strengthened the linkage between green power and RECs. However, there are still issues of harmonization, integration and linkage between green power and RECs in China that need to be addressed⁹.

The transaction price for green power products is formed by power generation enterprises, power consumers and electric power companies jointly through bilateral negotiations, centralized matchmaking and other market-based approaches. There is no restriction on the transaction price of green power in the Work Plan, and the transaction price should be higher than the feed-in tariff approved by power generation enterprises, and the acquisition price of grid companies, in order to fully reflect the green and environmental value of electric energy. The Work Plan stipulates that proceeds from the transaction price higher than the approved feed-in tariff, will be allocated to the corresponding power generation enterprises, to recognize their contribution to green energy development and to support them to further develop green energy; the portion of the transaction price higher than the acquisition price of the grid companies will be compensated to the new energy power generation enterprises involved in the trading, the relevant investors and operators who promote the consumption of new energy, in order to stimulate new energy power generation enterprises and relevant parties to actively participate in green power trading and provide market entities with sound and user-friendly green power trading services. In addition, the Implementation Rules further proposes that in the initial stage of the pilot green power trading, the upper and lower limit of the transaction price should be set with reference to the supply and demand of green power products, and the limiting will be gradually cancelled when the market matures.

According to the information announced at the kick-off meeting for pilot green power trading, the first batch of green power transactions saw 7.935 billion kWh of electricity traded on September 7. Among them, 6.898 billion kWh electricity was traded in the operating area of the State Grid Corporation of China (SGCC) and 1.037 billion kWh in the operating area of the China Southern Power Grid (CSG). According to preliminary statistics, the first batch of green power transactions may reduce fossil fuel consumption by 2.436 M tce (307gce/kWh), equivalent to an emission reduction of 6.0718 M tCO₂ (765.2 gCO₂/kWh)¹⁰. The green power transaction price is RMB0.03/kWh -RMB0.05/kWh higher than the local medium and long-term power transaction price.

¹⁰ www.gov.cn/xinwen/2021-09/09/content_5636363.htm

3. Prices in Each Market

3.1 Carbon Allowance Prices

The national ETS launched online trading in July 2021. At the beginning of the trading period (July-August 2021), the average daily transaction price of the national carbon market fluctuated between RMB50-60/tCO₂; from August onwards, the average daily transaction price became less volatile and decreased slightly; from September to early December, the average daily transaction price was basically stable at around RMB40/tCO₂; in mid-December, with the arrival of the compliance period, the average daily transaction price began to climb, reaching RMB60/tCO₂ by the end of the year. Overall, the average daily price of allowances traded during the first compliance period in the national carbon market fluctuated within the range of RMB40-60/tCO₂ and remained basically stable.

Compared to the national carbon market, pilot carbon markets witnessed more volatile carbon prices. In 2021, the transaction price in Beijing carbon market experienced a significant decline and then a sharp recovery, with an average carbon price of approximately RMB60/tCO₂, slightly higher than that in the national carbon market. In addition to Beijing carbon market, Tianjin, Shanghai, Hubei, Chongqing and Guangdong carbon markets maintained a transaction price of RMB30-40/tCO₂ in 2021; Shenzhen carbon market witnessed more volatile prices, basically at around RMB20/tCO₂ in 2021, lower than that in the national carbon market.

Fig. 5 Average Daily Prices of Bulk Agreements and Listing Agreements in the National Carbon Market

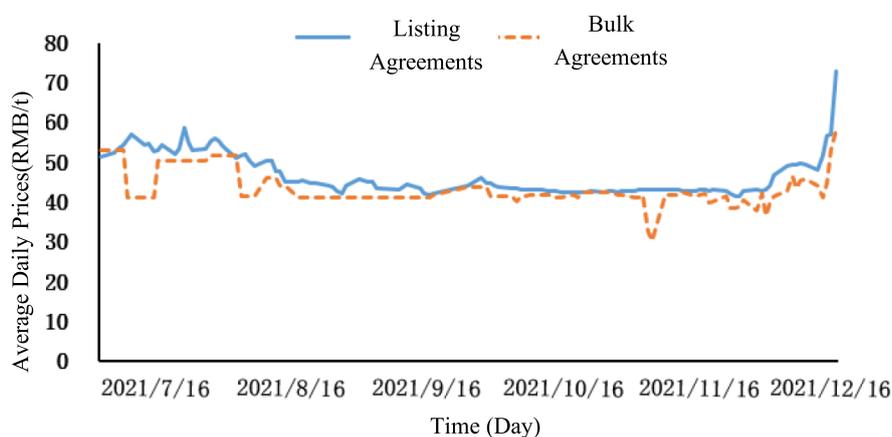


Chart Source: China's Carbon Market: Reviews and Prospects (2022)

Fig. 6 Trends in Average Daily Transaction Prices in Pilot Carbon Markets from 2013 to 2021

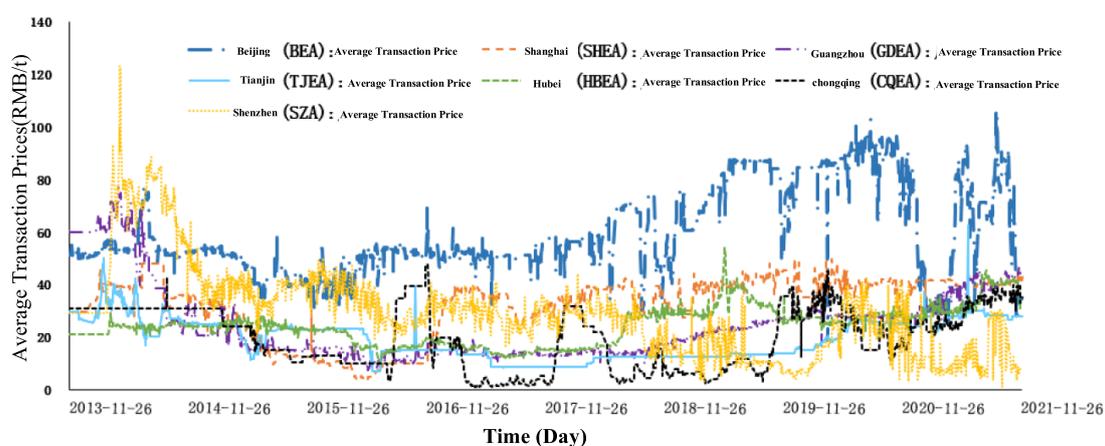


Chart Source: China's Carbon Market: Reviews and Prospects (2022)

3.2 CCER Prices

As the first compliance period of the national ETS approached, the willingness of key emitters to trade CCERs as offsets increased significantly, with rising CCER trading activity and transaction prices. In Shanghai carbon market, for example, the daily volume of CCERs traded has remained above 100,000 t since late October 2021, and the transaction price has risen considerably, from RMB20/tCO₂ to around RMB35/tCO₂¹¹.

According to the Carbon Price Index report published by the Research Center of Sustainable Development at Fudan University, which forecasts the prices of Chinese Emission Allowances (CEAs) and of CCERs in various carbon markets in March 2022, the prices of CCERs showed an upward trend with the rising price of CEAs in the carbon market and remained at RMB 40--50/tCO₂¹².

Table 3 Forecast Carbon Prices (March 2022)

Product Type	Buying Price	Selling Price	Middle Price
CEAs	55.90	60.45	58.08
CCERs in the national carbon market	46.40	50.60	48.50
CCERs in Beijing and Shanghai carbon markets	44.47	49.00	46.73
CCERs in Guangzhou carbon market	47.13	53.00	50.07
Other CCERs	41.55	46.20	43.88

¹¹ Carbon Offsets Market Rises in Volume and Price CCER [【tanjiaoyi.com--the world's leading Chinese portal for carbon markets】](http://tanjiaoyi.com)

¹² Fudan Carbon Price Index in March 2022- Research Center of Sustainable Development, Fudan University (fudan.edu.cn)

3.3 REC Prices

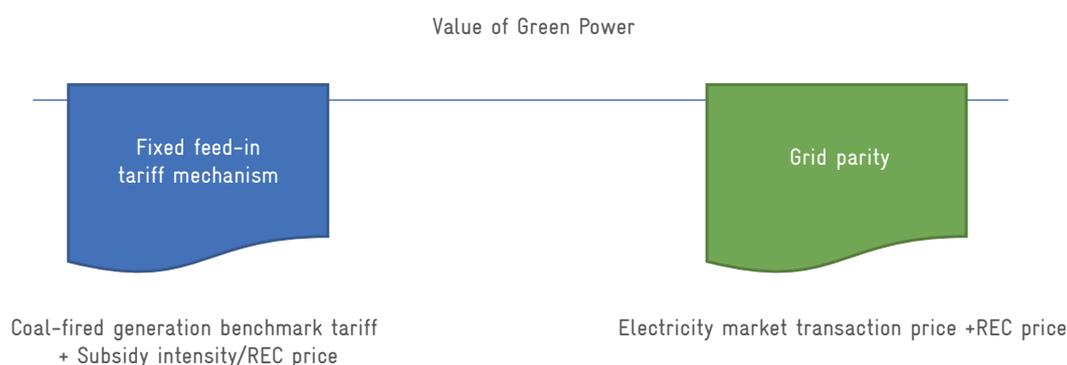
The value of green power can be reflected differently in different power pricing mechanisms. Therefore, China's REC prices can also be divided into subsidized REC prices and unsubsidized REC prices.

Under the fixed feed-in tariff mechanism, the feed-in tariff for renewable power is the local coal-fired generation benchmark tariff plus the state subsidy per kWh of renewable power (i.e., subsidy intensity). After the launch of the REC trading, eligible power generation enterprises may apply for and sell RECs to obtain subsidies in advance to incentive enterprises to produce renewable power through market-based mechanisms. The REC trading related policy specifies that 'the subscription price shall be determined through negotiation between the buyer and the seller or through competitive bidding, which shall not be higher than the subsidy amount from the renewable energy feed-in tariff fund corresponding to the amount of electricity in the REC. Therefore, the maximum price of the REC is the subsidy intensity of the green power. Depending on the subsidy policies, the REC prices for wind power and solar PV projects vary by region. In 2021, the average REC price for subsidized solar PV projects was RMB650/MWh, much higher than that of subsidized wind power projects (RMB190/MWh).

From 2021 onwards, wind power and solar PV power projects enter the era of grid-parity and low tariff across the board. The State has clearly encouraged eligible renewable power generation projects to obtain reasonable income compensation through REC trading in the Notice on Actively Promoting the Work Relating to Unsubsidized Grid Parity for Wind Power and solar PV Power Generation. The RECs applied for and issued for unsubsidized wind power and solar PV power projects are unsubsidized RECs while the corresponding transaction price is the unsubsidized REC price. Starting from June 2021, the unsubsidized REC trading started and its average price has been basically kept at the guide level of RMB 50/MWh.

Compared to subsidized REC prices, unsubsidized REC prices are more competitive in the market and existing REC transactions are dominated by unsubsidized REC transactions. As of March 2022, unsubsidized RECs accounted for more than 95% of the total traded, with wind power and solar PV power plant RECs each accounting for 50%.

Fig. 7 REC Prices and Its Role



3.4 Green Power Prices

The green power price is equivalent to the price of bundled grid-parity green power, which includes both energy value and environmental value. The energy value is reflected by the price at which the green power project is traded in the electricity market, while the environmental value is reflected by the portion of the price that exceeds the local medium and long-term power transaction price.

Statistics show that the environmental value in the green power transaction price may be up to RMB30-50/MWh, which translates into a carbon price of up to RMB40-70/t¹³. However, it is important to note that the environmental value is not listed separately in existing green power trading. Higher coal prices in 2021 led to rising coal power costs, highlighting the advantages of green power. Therefore, the green power transaction price reflects consumer expectations for rising coal power price in the future and cannot be fully attributed to the additional costs, companies are willing to pay to get the environmental value of green power.

The REC price of grid-parity wind power and solar PV power plant projects has dropped significantly since the launch of online trading, with the online listing price standing at RMB50/MWh and the onsite bulk transaction price ranging between RMB20-50/MWh, which is comparable to the environmental value counted in the current green power trading. After the national carbon market launched online trading, the CCER price has gradually climbed to its current level of RMB40-50/tCO₂, which is close to RMB30-40/MWh if converted by an emission factor of 0.8tCO₂/MWh. This shows that the CCER prices are broadly in line with the environmental value of unsubsidized RECs and green power¹⁴.

13 [How to Fully Exploit the Electrical and Environmental Values of Green Power Trading – \(bjx.com.cn\)](#)

14 [How to Develop a New Energy Environmental Value Linkage Mechanism? \(china-cer.com.cn\)](#)

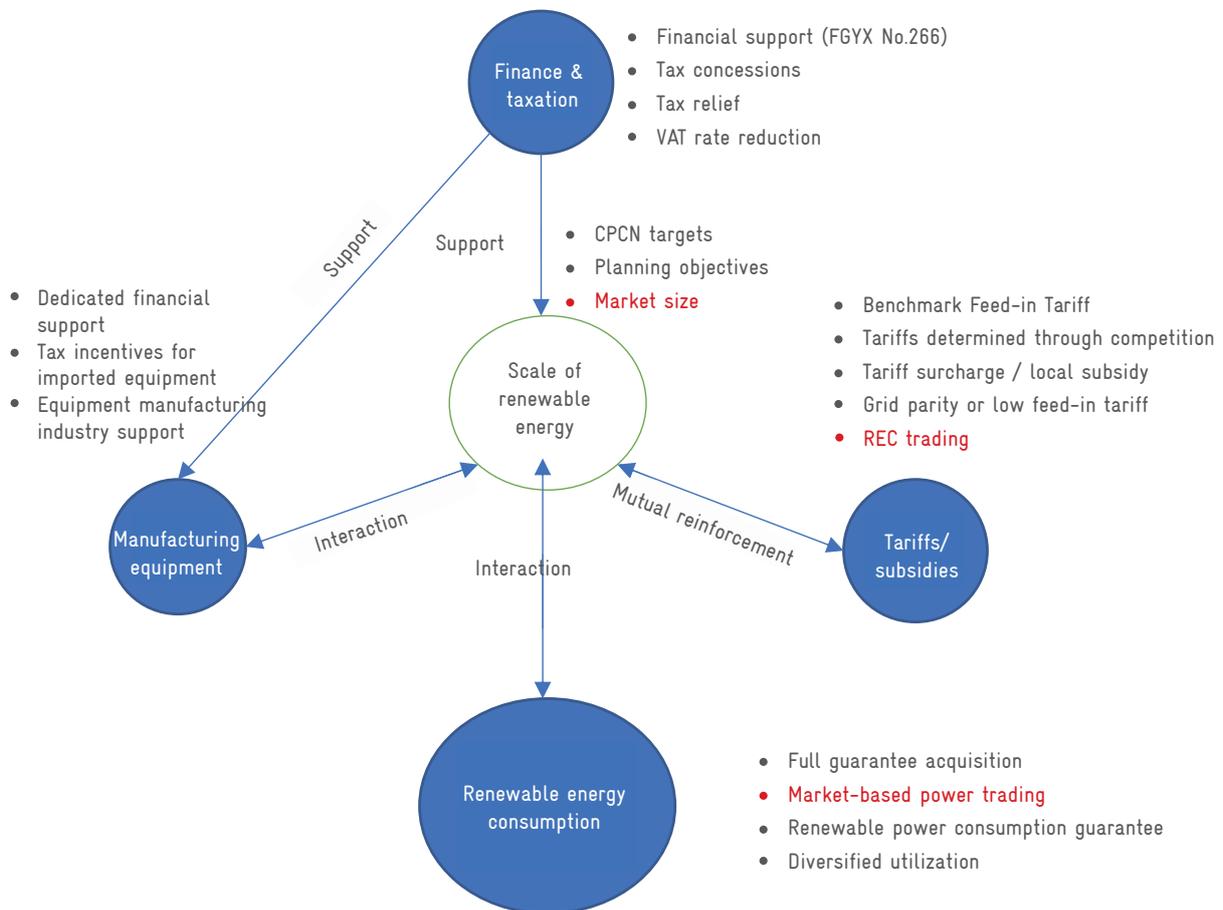
4. RECs and Green Power

Renewable power development is closely related to CCER, REC and green power trading systems, which play different roles in promoting the development of renewable power and overlap to some extent.

4.1 Relationship between RECs and Green Power Trading

In the context to address climate change, the State has announced its CPCN targets. Renewable energy development is key to achieve the CPCN targets. The State has set clear renewable energy development targets to ensure the scale of renewable power development and determine the market capacity. Meantime, the State has introduced a series of policy measures and guarantee mechanisms to promote and guarantee the large-scale development of renewable energy and enhance market competitiveness in terms of finance & taxation, price subsidies and guarantee consumption. REC trading can provide a source of subsidy funding for renewable energy development and contribute to China’s energy transition and air pollution control; provide enterprises and the public with a convenient and authoritative way to consume green power, cultivate China’s green power consumption market and accumulate experience for future mandatory allowance trading.

Fig. 8 China’s Renewable Energy Related Policy System



New energy participation in the electricity market is an inevitable trend. In the Notice on Further Completing the Pilot Work of Electric Power Spot Market Construction released by the NDRC and NEA, it is clearly proposed that new energy projects may participate in the electricity market by signing long-period (e.g. 20 years or more) CFDs with grid companies, consumers and electric power companies; 10% of electricity from new energy projects shall be connected to the grid through market trading competition (not counted in the life-cycle guarantee acquisition hours); and the establishment of green power trading market shall be explored to promote green power trading. Green power attributes shall be restored in the process of promoting pilot green power trading. This is shown in Fig. 9 below.

Fig. 9 Trading process and key elements of Green Power

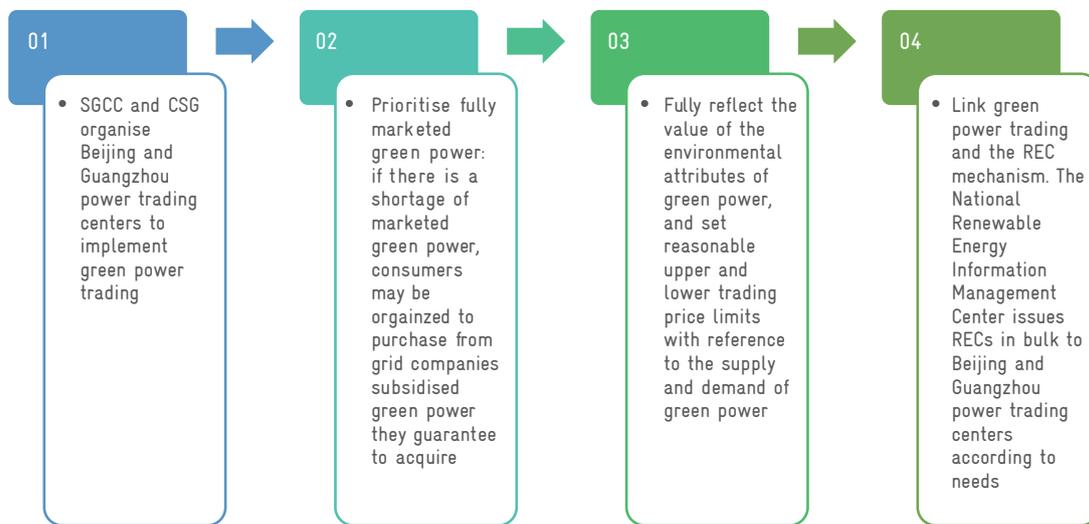
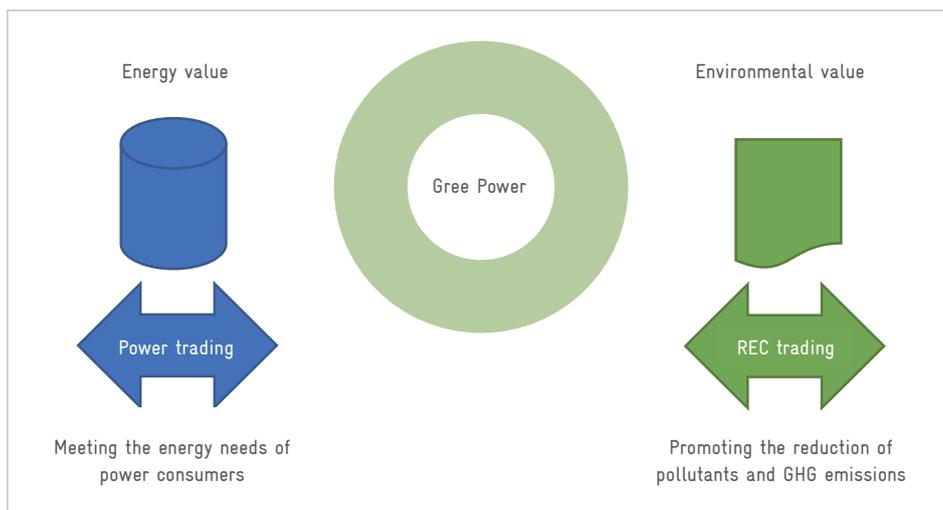


Fig. 10 Attributes and Trading Mechanisms of Green Power



To sum up, both green power trading and REC trading are based on green power. Green power trading ensures “certificate-electricity integration” during the trading using the blockchain technology. The environmental attributes of the green power traded should not be re-asserted on any other occasion, thus avoiding double counting. China’s green power trading is equivalent to bundling RECs for sale. However, at present, China’s green power trading covers wind power and solar PV power projects, while RECs cover onshore wind power and solar PV power plant (excluding distributed) projects, so RECs

and green power trading are not yet fully linked. Moreover, the transaction price in green power trading includes both the energy value and environmental value of electricity, i.e., the value of RECs is not listed separately, so the environmental value of green power is not yet clearly reflected. The launch of the national ETS, the gradual improvement of the power market system, the implementation of the surplus consumption trading under RPS and the development of REC trading, provide the power industry with a market-oriented environment and pattern in which multiple types of market-based mechanisms co-exist to jointly promote the achievement of the CPCN targets.

4.2 Full Integration of Green Power Trading and REC Trading

As mentioned earlier, the letter to approve the Work Plan for Pilot Green Power Trading by NDRC and NEA made it clear “to establish a national unified REC system”. The NEA will organize the National Renewable Energy Information Management Center to issue RECs in bulk according to the needs of pilot green power trading and transfer them to power trading centers, which will then allocate RECs to power consumers based on the results of green power trading.

On the one hand, this clarifies that green power trading is based on RECs and as opposed to bundled REC trading; consumers who purchase green power will receive RECs; on the other hand, it clarifies that green power trading encompasses power trading and corresponding environmental attribute trading and that “certificate and electricity” are integrated. This means that eligible renewable energy projects may participate in green power trading or sell RECs separately. However, there is a need for further harmonization between green power trading and REC trading.

Consistency in project types is the basis for the harmonization of green power and REC trading. The projects currently eligible for green power trading are wind power and solar PV power projects, and other renewable power projects such as hydropower will be covered in the future when conditions permit. In contrast, China’s REC trading clearly covers onshore wind power and solar PV power plant projects, while distributed solar PV power generation projects are excluded from REC application and issuance. Although the current green power trading is dominated by onshore concentrated wind and solar PV power projects, REC trading and green power trading should consider consistent project sources in the future to achieve synergistic development of the two markets.

The mutual complementarity and reinforcement between REC and green power trading should be enhanced. REC trading is flexible as ‘unbundled’ trading, allowing buyers to purchase RECs from any location source and any project source, but with the risk of price fluctuations and instability; green power trading is ‘bundled’ trading where long-term contracts, such as PPAs¹⁵, will be signed. Although the “bundled” approach limits the REC options available to consumers, the longer contract duration (generally 2 years or more) will ensure the stability of the electricity and environmental attribute trading and allow for certain price concessions. At present, the contract length of green power trading in China is mostly a few months to a year, which needs to be continuously improved during the pilot process, so as to bring into play the respective advantages of REC and green power trading and achieve complementarity and mutual reinforcement of the two.

The REC transfer channel between the issuing agency and green power trading agencies should be opened. Since the launch of green power trading in September 2021, Guangdong, Hebei, Shandong, Zhejiang, Jiangsu, Jiangxi and Ningxia provinces have launched a small number of green power transactions, but the REC transfer channel between the National

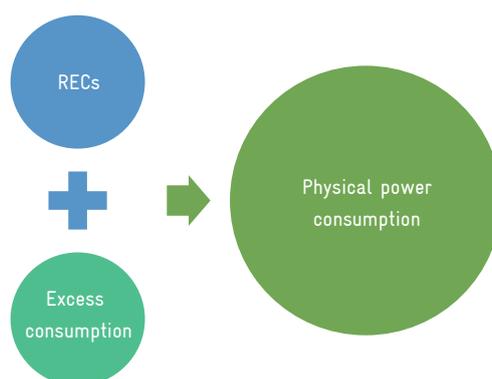
¹⁵ U.S. EPA Green Power Partnership. Understanding Renewable Energy Certificates (RECs) and the Green Power Procurement Process. April 15, 2015. https://www.epa.gov/sites/default/files/2016-01/documents/webinar_20150415_critchfield.pdf

Renewable Energy Information Management Center and power trading centers has not yet been opened. As of the end of March 2022, consumers of green power trading had not yet received their RECs¹⁶. The National Renewable Energy Information Management Center should broaden the trading channels and make good arrangements for issuing RECs, changing ownership, cancelling RECs, as well as recording and tracking information on the whole life cycle of RECs, so as to smooth REC and green power trading, systematically link the national REC subscription platform and the power trading platforms and open special accounts for the Beijing and Guizhou trading centers to promote the smooth delivery of RECs in green power trading.

4.3 Linkage between RECs and the Renewable Energy Consumption Guarantee Mechanism

The State issued the Notice on Establishing a Sound Mechanism for Guaranteeing the Consumption of Renewable Energy in 2019, which stipulated the proportion of renewable power in electricity consumption to be achieved by provincial administrative regions, including the weight of responsibility for the total consumption of renewable power and for the consumption of non-hydro renewable power. Market entities concerned fulfil the responsibility mainly by consuming renewable power while supplementary (alternative) methods may also adopt. These include voluntary subscription of RECs, with the equivalent amount of renewable power corresponding to RECs being counted as consumption; and purchase of the surplus renewable power consumption from market entities who have over-achieved their annual consumption, with the transfer (or trading) price independently determined by both parties. China only implements the voluntary subscription of RECs, while compulsory REC trading has not yet started. As RECs cover few sources of renewable power, most provinces implement mainly the inter-provincial surplus consumption trading organized by the power grid, failing to stimulate consumer demand for RECs (green power).

Fig. 11 RECs and the Consumption Guarantee Mechanism



International experience reveals that the adoption of the “RPS + RECs” mechanism and the establishment of a mandatory REC consumption market is an effective and long-term mechanism in line with market-based principles. China should promote the linkage between REC trading and the consumption guarantee mechanism and accelerate green power consumption, while injecting long-term momentum for renewable energy development. The recommendations include:

¹⁶ RECs, Green Power and CCERs.....How to Develop a New Energy Environmental Value Linkage Mechanism? (bjx.com.cn)

A national unified green power consumption certification system should be established to integrate RECs and green power consumption; the amount of electricity corresponding to RECs held by market entities should be used as the basis for RPS assessment and the assessed market entities may complete the assessment by purchasing RECs (green power); by directly participating in power market trading or purchasing electricity from provincial power grid companies, market entities may complete the assessment under the consumption guarantee mechanism on the one hand, while declare that green power is consumed on the other hand.

In addition, given that the weighting of responsibility for renewable energy consumption covers all renewable energy generation projects, the linkage between RECs and RPS requires the authorities responsible for REC issuance and trading to expand the project types covered by RECs from the current onshore wind and solar PV power plant projects to all renewable energy generation projects, otherwise the integration of RECs and green power consumption cannot be achieved.

As a conclusion, China has not yet adopted a mandatory REC trading system, and the purchase and sale of RECs is entirely voluntary. Applications for new CCER projects are also on hold. The portion not clearly defined under the REC and CCER systems has not yet caused substantial economic or policy implementation problems for enterprises. However, with the reintroduction of CCER-related policies and the launch of a mandatory REC trading system, conflicts between the REC and CCER systems will be inevitable.

5. The Green Power Market and Carbon Markets

5.1 Accounting of Indirect Emissions in the National ETS

Currently, in the national carbon market, key emitters are required to account for both their own direct emissions related to fossil fuels consumption and indirect emissions from the consumption of purchased electricity. Under the current accounting methodology, the emission factor of the corresponding regional or national power grid is used to calculate indirect emissions from purchased electricity, and the actual emission factor of the electricity consumed by the enterprise in case of direct power supply is not considered.

Taking cement enterprises as an example in order to encourage enterprises to consume green power, CO₂ emissions from electricity consumed by cement clinker production of key emitters can be calculated as the amount of electricity supplied from the grid and fossil fuel-fired captive power plants consumed by cement clinker production, less the amount of electricity supplied by waste heat and green electricity data for that production section, and multiplied by the national electricity weighted emission factor, which can be expressed as follows:

$$E_{\text{purchased el,t}} = (AD_{\text{grid}} + AD_{\text{captive}} - AD_{\text{waste heat}} - AD_{\text{green el,t}}) \times EF_{\text{el,t}}$$

Where,

$E_{\text{purchased el,t}}$ represents emissions from electricity consumed by cement clinker production, in tCO₂;

AD_{grid} represents grid electricity consumed by cement clinker production, in MWh;

AD_{captive} represents electricity supplied from fossil fuel-fired captive power plants consumed by cement clinker production, in MWh;

$AD_{\text{waste heat}}$ represents the amount of electricity supplied by waste heat for that clinker production section, in MWh;

$AD_{\text{green el,t}}$ represents green electricity consumed by cement clinker production, in MWh;

$EF_{\text{el,t}}$ represents national grid emission factor, in tCO₂/MWh.

5.2 Cross-market Trading

Although the national ETS currently only covers power generation enterprises, as coverage continues to expand in the future, non-power generation key emitters in carbon markets may also purchase green power to reduce indirect emissions from electricity consumption. At the current carbon price of around RMB55/t, the marginal cost of carbon abatement is approximately 4.3 cents/kWh, roughly the same as the additional cost required to purchase green power. In the long run, if the carbon price rises as expected, the cost of green power is likely to fall as technology advances and scales up, making it

a more economically efficient option for enterprises to purchase green power to deduct their carbon emissions¹⁷. However, several issues need to be addressed for connecting green power trading and carbon markets.

Clarifying the attributes of green power. Definitions of green power and project types covered across markets should be harmonized. The scope and criteria for issuing RECs vary by national circumstances, but they usually cover wind power, solar power, small hydropower, biomass power, geothermal power and tidal power. China's current REC and green power trading only cover onshore wind power and solar PV power plant projects. The scope of projects covered by green power and RECs should be clarified as soon as possible, otherwise only wind power and solar PV projects will be able to link with carbon markets, thus undermining the healthy and sustainable development of other renewable energy generation projects.

Avoiding double counting. The risk of duplicate applications and double counting of CCERs and RECs should be avoided. China issued the Announcement on the Suspension of the Acceptance of Applications for the Filing of Methodologies, Projects, Emission Reductions, Approval and Certification Bodies and Trading Bodies for Voluntary GHG Emissions Trading in 2017. The existing CCERs were all issued before 2017. At present, China's green power trading mostly comes from grid-parity onshore wind power and solar PV power plant projects, and there is no overlap between them and CCER projects. However, after the relaunch of CCERs, it should be clarified that whether the same project can apply for both CCERs and RECs to avoid double counting of emission reductions.

Harmonizing emission factors. The emission reductions corresponding to RECs need to be harmonized with the indirect emissions deducted in carbon markets. The emission reductions corresponding to RECs can be calculated based on the baseline emission factor of the regional grid for the emission reduction project, which, according to the latest 2019 emission factors, varies significantly from region to region, from 0.6565 tCO₂/MWh for CSG Regional Grid to 0.8719 tCO₂/MWh for the Northeast China Regional Grid. However, in the national carbon market, enterprises choose to account for indirect emissions from electricity using the national average emission factor for electricity, the latest version of which is 0.581 tCO₂/MWh. The huge discrepancy between the two needs to be addressed to link the green power trading and carbon markets.

5.3 RECs, Green Power Trading and CCER Trading for Offsetting

In July and September 2021, China launched the pilot national carbon emissions trading (i.e., the national carbon market) and green power trading, thus creating a co-existence situation of three market-based mechanisms: REC trading, green power trading, and carbon trading including carbon emission allowances and CCERs.

CCER, REC and green power trading markets are all voluntary and relatively independent in terms of rules, but inextricably linked in many ways, including policy objectives, market-based mechanisms and participating entities, which needs to be reviewed. Information on the three voluntary market-based mechanisms in terms of purpose, project types, trading products, units, etc. are summarized in the table below.

¹⁷ http://www.eco.gov.cn/news_info/45873.html The Impact of Carbon Neutrality on the Electrolytic Aluminium Industry (eco.gov.cn)

Table 4 Comparison of the Main Differences between CCERs, RECs and Green Power¹⁸

	CCERs	RECs	Green Power
Purpose	Provide key emitters with a means of compliance other than allowance trading to help them complete emission reductions; incentivize non-covered carbon market entities to actively reduce emissions	Relieve the pressure of the government subsidy funding gap; help enterprises complete allowances in line with renewable power consumption responsibility weighting targets	Monetize environmental value of renewable power and encourage its development; help enterprises complete renewable power consumption
Renewable Energy Project Sources	New energy projects that meet methodological requirements	Non-hydro renewable power, including onshore wind and solar PV power (excluding distributed projects)	Green power, currently wind power and solar PV, which could be extended to other renewable power projects such as hydropower in the future
Trading Places	Filed Emissions Exchange	Online RECs Purchase Platform	Beijing and Guangzhou Electricity Trading Centers
Trading Products	CCERs	RECs	Green power consumption certificates +RECs
Unit	1 tCO ₂ e	1MWh	1kWh

Under the current trading system, CCERs and RECs are two processes that operate in parallel, where the same project may apply for both CCERs and RECs. RECs allow eligible power generation enterprises to receive subsidies in advance, while CCERs help enterprises gain additional carbon asset income from emission reductions generated by their projects.

Besides, REC trading and CCER offsetting are carried out in two markets involving different mechanisms, entities and accounting methodologies. The buyers of CCERs are usually the key emitters included in carbon markets and the CCERs can be used to as offset in the national ETS, thus achieving low-cost compliance; while the buyers of RECs are broader in scope, including those subjects to the weighting targets for the consumption of renewable power and other organizations and individuals who voluntarily purchase RECs. The RECs purchased may help them fulfil the renewable power consumption requirements and prove that the electricity they consume is green, thus achieving corresponding CO₂ emission reductions.

In terms of implementation difficulty, green power and RECs are relatively simple and easy to implement, with high transparency, strong regulatory and binding mechanisms and lower transaction costs. In terms of coverage, the potential coverage of carbon markets is broader, which includes not only allowance allocating design to promote renewable energy development and energy efficiency improvement but also guide wider industrial restructuring.

¹⁸ DeHeng Law Offices | Analysis of the Existing Problems of RECs, Green Power and Carbon Trading and Exploration on the Linkage Mechanism (dhl.com.cn)

6. Addressing Potential Carbon Border Tax

As part of the EU “Green New Deal”, the European Commission proposed the “Carbon Border Adjustment Mechanism” (CBAM) and published a draft CBAM in July 2021 and planned to legislate on it. Due to its extensive and profound impact, the CBAM has attracted much attention from the international community. Under the CBAM, EU intends to impose “tariffs” on iron&steel, cement, aluminum, fertilizers and electricity, etc. imported from countries and regions with relatively lenient carbon emission restrictions, which is seen as an effective tool to address carbon leakage. The European Commission, the European Council and the European Parliament have successively released their own proposals on CBAM, the final proposal may be adopted within this year (2022).

6.1 Carbon Border Adjustment Mechanism (CBAM)

As the allowance price rises and free allowances are gradually reduced, enterprises in EU may shift their investments and production to countries outside their borders or give up market share to competitors, leading to a growing risk of carbon leakage. In July 2021, EU proposed in its “Green New Deal” to implement tariffs or other price regulation measures on imported goods based on their embodied GHG emissions, i.e., the CBAM, with a view to gradually replacing the existing EU measures to prevent the risk of carbon leakage, such as free allowances and financial compensation for enterprises.

The CBAM is a key component of EU’s carbon market reform. EU intends to improve the effectiveness of the carbon market by reducing free allowances internally and adopting the CBAM externally, thereby achieving a 55% reduction in emissions by 2030 compared to 1990 and achieving carbon neutrality by 2050. EU carbon market currently only covers local products. To further improve the effectiveness of the carbon price mechanism, EU plans to gradually abolish the issuance of free allowances and ensure that imported products bear the same carbon cost as local products by implementing the CBAM, i.e., countries and regions with strict carbon reduction policies require the imported (exported) carbon-intensive products to pay (refund) the corresponding taxes or carbon allowances, thus avoiding carbon leakage due to the reduction of free allowances.

The CBAM is primarily aimed at emission-intensive and trade-exposed (EITE) sectors. The EU carbon leakage list was updated in 2019 in accordance with the requirements of the 4th phase of EU carbon market (2021-2030) and it is likely that emission-intensive industrial products such as cement, iron&steel, aluminum, fertilizers and all basic chemicals, as well as the electricity sector, will be probably included in the CBAM at the initial phase. According to the CBAM proposal of the European Commission in July 2021 and the Economic, the initial scopes of the CBAM are limited to cement, electricity, fertilizer, iron&steel and aluminum sectors. While in June 2022, the European Parliament formed its first view of CBAM proposal, compared to versions from EUC, the EP version postpones the official implementation time of CBAM from 2026 to 2027 and involve additional sectors like organic chemicals, plastics, hydrogen and ammonia into CBAM coverage as well. Eventually, CBAM will cover all products in the EU ETS.

The CBAM requires reporting of embedded indirect emissions in the imported products. In the CBAM proposals of EUC, the transition period of CBAM is from 2023 to 2025, which importers are required to submit quarterly CBAM reports containing information on the quantities of imported products, the embodied direct and indirect emissions of the products and the carbon price level in the country of origin, etc.; while in the implementing period since 2026, only the “explicit carbon price” of exporting countries are recognized and direct emissions are taxed. However, the first review of CBAM proposal from EU Parliament intends to tax indirect emissions from purchased electricity and electricity as well. The progress of the CBAM to include embodied indirect emissions from products may be brought forward.

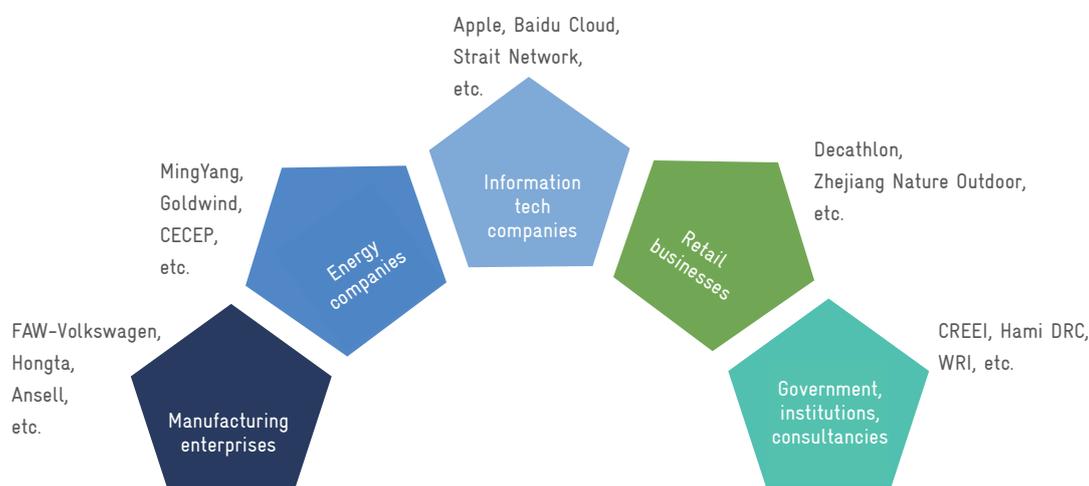
6.2 Market-based Measures as One Solution to International Carbon Tax

EU has been already requiring enterprises to assess, report and calculate the carbon footprint costs of their products. With the implementation of the carbon neutrality target, EU may soon make the same requirements for enterprises exporting products to Europe. In the context of global low-carbon transition, Chinese enterprises should take proactive measures.

A green low-carbon industry and international trade system based on green energy consumption is gradually taking shape, and the demand for green power consumption will rise rapidly. With the implementation of the carbon neutrality target, a general global consensus has been formed on green power consumption and major international and domestic enterprises have put forward their own plans to achieve carbon neutrality; more and more large multinational companies and Internet enterprises have joined the RE100 Initiative; the progress of corporate carbon targets and green power consumption performance have become increasingly important evaluation indicators for capital markets and fund companies. In the future, influenced by EU's carbon tariff policy and other factors, China's export-oriented enterprises are bound to accelerate their green energy consumption transition, greatly increasing the demand for green power consumption and REC subscription.

To date, more than 300 enterprises have participated in the REC subscription in China, with over 1.65 million RECs subscribed and 95.5% of them from grid-parity projects. Participating entities include manufacturing enterprises, energy companies, information tech companies, retail businesses and government, institutions and consultancies (Fig.12 below). Since 2020, manufacturing and export trading enterprises have been increasingly active in subscribing RECs¹⁹.

Fig. 12 Types of Entities Participating in REC Subscription



There is uncertainty as to whether EU will recognize Chinese carbon market as a carbon pricing system. EU's recognition of the country of origin's existing carbon pricing system is a prerequisite for importers to claim for carbon tariff deductions. CBAM defines the carbon price as "the monetary amount paid under a GHG emissions trading system in the form of carbon tax or allowances", which can be interpreted that the carbon price recognized by EU is the explicit carbon price reflecting corporate abatement costs through carbon tax or emissions allowances. Currently, China's carbon market only covers the

19 Based on expert reports from the National Renewable Energy Information Management Center

power generation sector and allocates allowances for free. For that reason, there is some uncertainty as to whether EU will recognize China's carbon pricing system. In this regard, China may make efforts as follows:

- 1 Accelerating the inclusion of sectors covered by CBAM into the national carbon market, thereby creating favorable conditions for dialogue with the EU on the implementation rules of the CBAM;
- 2 Taking into account actual domestic situation and requirements of international carbon pricing mechanisms when designing the allowances cap and allowance allocation for the sectors covered by CBAM to create favorable conditions for exporting Chinese goods to EU;
- 3 Urging EU to recognize existing carbon costs of goods exported from other countries and minimizing the negative impact on trade of the combined effect of domestic policies of exporting countries and the CBAM.

The electricity-carbon market linking should be enhanced to transfer the abatement effect of implicit carbon price to the explicit carbon price side. China has already established green power trading and REC trading markets, while China's RECs have been successfully recognized by international organizations such as RE100. Enterprises may purchase green power as well as RECs and declare that they have avoided CO₂ emissions by consuming renewable power. Chinese enterprises in steel and other export-oriented industries can use green power and RECs to indirectly fill the possible allowance gap. On the one hand, multiple collaborated market-based mechanisms can be leveraged to regulate carbon prices, thus relieving enterprises pressure from paying the double carbon price levied by the domestic carbon market and CBAM; on the other hand, rising demand for green power by enterprises should be stimulated to increase the green power premium and promote the sustainable and healthy development of green power.

7. Conclusion and Recommendations

To make better use of market-based mechanisms to promote the development of renewable energy and further control and mitigate GHG emissions, the relevant government authorities may promote the joint development and synergy of carbon markets and the green power market from the following aspects:

Strengthening policy collaboration. It is suggested to strengthen the connection of multiple market-based mechanisms, as well as clarify various trading interfaces between electricity and carbon markets from the perspectives of scope of issuance, price mechanism, trading forms, trading channels, certification system establishment and incentive mechanism, thus realizing the integration of various trading mechanisms such as RECs and green power trading, RECs/green power and RPS, RECs and carbon markets, etc., avoiding double counting and trading of environmental interests in different markets, giving full play to the environment pricing of green power and contributing to China's CPCN targets.

Improving market linking. It is recommended to give full play to the advantages of optimal allocation of market resources, release reasonable carbon price signal and the environmental value of green power through linking various market-based mechanisms, to encourage the large-scale development of renewable energy on the one hand and achieve low-cost abatement under market-based mechanisms on the other hand. When formulating policies such as carbon allowance allocation and carbon emission benchmarks, full consideration should be given to the effective transmission of carbon costs in the electricity market; when designing carbon credit mechanisms such as CCERs, attention needs to be paid to the linking with REC trading; when developing carbon emission accounting methodologies, the indirect emission accounting deduction mechanism for RECs and green power in key emission control enterprises needs to be clarified, so as to create a favorable environment for the steel, aluminum and cement industries to cope with the CBAM in the future.

Full consideration should also give to the synergy between green power and the national carbon market, the electricity market and the CBAM. To ensure the healthy and sustainable development of all types of renewable energy technologies, the scope of REC issuance should be expanded as soon as possible in accordance with China's overall emission reduction targets and the power generation costs and abatement potential of renewable power technologies.

Deepening mechanism design. Efforts should be made to rationalize the design of RECs and green power trading models, draw on the international green power PPA model, as well as the combined trading model of voluntary subscription and compulsory purchase of international RECs, move from voluntary subscription trading of RECs to compulsory purchase combined with the renewable energy consumption guarantee mechanism and improve the complementary advantages of the two trading models of green power and RECs in China. Moreover, explorations can be made in the following aspects: developing a tracking and certification system for the whole life cycle of RECs issuance, trading and cancellation; establishing a green energy consumption evaluation, certification and labelling system; developing green power consumption certification standards; and actively promoting mutual recognition of China's RECs with international RECs and other standards, so that green values are effectively transmitted to the product side, satisfying the social responsibility needs of Chinese enterprises while maintaining international competitiveness.

Fig.13 Main Modules for Mechanism Design



