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CHINA'S NATIONAL ETS AND THE POWER MARKET: HOW THE ETS CAN ACHIEVE SIGNIFICANT EMISSION REDUCTIONS

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EXECUTIVE SUMMARY

China's national emissions trading system (ETS) is intended to serve as the primary tool in assisting China to meet its "dual carbon" target of CO_2 peaking before 2030 and carbon neutrality by 2060. In its first phase, it covers the power sector and approximately 40 percent of China's national emissions. However, some critical challenges need to be overcome before the ETS can fulfil its emissions reduction potential in the power sector by driving the switch away from coal, toward renewables and low-carbon fuels, through the carbon price. This issue paper examines these challenges in relation to both the ETS itself and its interactions with the power market and proposes a policy pathway to address these challenges and unlock their potential to drive significant and cost-effective CO_2 emissions reductions in the power sector and raise large amounts of revenue to fund the transition to carbon neutrality across the expanding ETS sectors.

Key requirements for the power market include speeding up the introduction and expansion of spot power market pilots leading to the establishment of spot markets nationwide by 2030, incorporating ETS carbon costs in the medium- and long-term market tariff and removing limits on cost fluctuations, and establishing cross-provincial regional markets that account for carbon costs and can be connected to form the national market.

For the ETS, key reforms include harmonizing the power sector benchmarks (BMs) into one coal BM and then one combined BM for coal and gas; ensuring BM levels are in line with power sector and national emissions targets, the pathway to carbon neutrality, and best practice in the sector; introducing auctioning for the power sector at an initial low level but increasing to full auctioning over a defined time period; establishing an auction revenue fund to finance investments for clean energy and carbon neutrality transition; introducing an absolute ETS cap in line with national emissions targets and the required burden for ETS sectors to contribute to achieving those targets; and introducing compliance obligations for gas power plants.

Finally, an essential element to implement and coordinate these reforms, which span the responsibilities of different ministries, will be interministerial cooperation, supported by relevant technical working groups and overseen at a high level with strong political will, involving the Ministry of Ecology and Environment (MEE), the National Development and Reform Commission (NDRC), the National Energy Administration (NEA), and the Ministry of Industry and Information Technology (MIIT).

The current limitation in the ability of the ETS to drive emissions reductions in the power sector is one of the most significant challenges and opportunities facing China's national ETS.

INTRODUCTION

China's newly established national emissions trading system (ETS) is expected to serve as the primary tool in assisting China in meeting its "dual carbon" target of CO_2 peaking before 2030 and carbon neutrality by 2060. It is the largest ETS globally, accounting for 40 percent of China's CO_2 emissions and more than 10 percent of worldwide emissions, with the potential to double its current size once industrial sectors are added. In its initial phase, it covers the power sector, in particular more than 2,000 enterprises operating coal- and gas-fired power stations.

In its initial design, thermal power plants are given free allowances based on emissions intensity benchmarks and their level of power generation and must surrender at least enough allowances to cover their total CO_2 emissions by the compliance deadline. Those who are short of allowances can purchase them from those with a surplus, at the National Carbon Emission Trading Center in Shanghai. The cap on total emissions of this system is therefore a function of the level of output, rather than being an absolute cap as in other ETSs, such as those in the EU, California, and Korea. The first compliance period of the national ETS covered emissions performance in 2019 and 2020; the second is expected to cover performance in 2021 and 2022, with future performance covered in subsequent compliance periods.

With almost all of China's thermal power generators covered in the ETS, China's power sector characteristics and ongoing power market reforms will impact the ability of the ETS to achieve its potential in driving significant and cost-effective CO_2 emissions reductions. This paper discusses the characteristics of China's power sector, progress in market reform, the national ETS, the current limitations in the ability of the ETS to drive emission reductions in the power sector, and proposed options to address these issues.

The ability to drive emission reductions in the power sector is one of the most significant challenges and opportunities facing China's national ETS. An indication of the potential benefits at stake can be seen in the performance of the EU's ETS in successfully driving significant emissions reductions in the EU's power sector through fuel switching from coal to gas and renewables, generating huge amounts of revenue to fund clean energy and carbon neutrality transition, and playing a key role in the EU's policy mix to achieve net-zero greenhouse gas (GHG) emissions. Valuable experience is also being gained in Korea on how to achieve an effective ETS – power market interaction in an Asian context more similar to that in China. The learning points from these systems and other international best practice inform this paper, while focusing on China's unique context, challenges, and solutions.

CHINA'S POWER MARKET

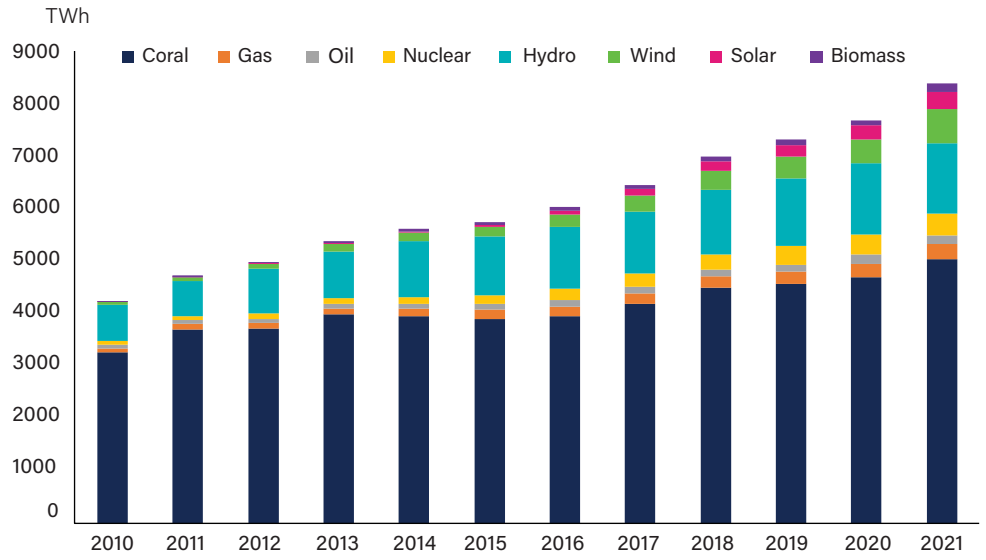
Background

China's vast amount of power generation, at 8380 TWh in 2021, is more than a quarter of the global total. It has been rising in recent years due to rapid economic growth. The majority of power generation, more than 60 percent, is from coal, although investment in renewable energy continues to increase with a target to boost wind and solar capacity to 1200 GW by 2030, from the current level of 660 GW. The recent trends in power generation and fuel mix are shown in Figure 1.

China's power system is highly regulated with generation and consumption mostly planned and approved centrally despite several rounds

Issues facing the power market include a failure to efficiently match supply with demand, insufficient incentives to transition from coal toward clean energy, difficulties in recovering initial costs of generation units, and insufficient policy coordination and responsiveness across key stakeholders.

FIGURE 1: **CHINA'S POWER GENERATION BY SOURCE 2010–2021 (IN TWH)**



Source: Refinitiv, 2022

of power sector reforms.[1] These controls are intended to manage the supply-demand balance and achieve safe and stable operation of the grid. Planned power generation is purchased by the power grid companies – the State Grid and the China Southern Power Grid – at a state-regulated price, although the grid companies are permitted to purchase power surplus to the generation plan at a reduced price. The power tariff for different technology types is based on "average costs + revenues" approach rather than the "marginal costs" in liberalized power markets.

Power generation is regulated under the "fair dispatch" rule,[2] whereby local government departments assess the forecast electricity consumption for the next year and allocate a total amount of power generation to each power plant based on an approximately equal quota rule.[i] The generators then sign an annual generation contract with the government based on the allocation and the regulated on-grid prices approved by the provincial planner. Power station dispatch aims to ensure that all units generate a fixed amount of power and fixed profits, reducing investment risks but limiting returns for investors. In an environment of rapid economic and electricity demand growth and long-term scarcity of electricity supply, the regulated mechanism has generated stable revenue expectations, attracted capital to achieve rapid capacity growth, and largely met the power demand of China's economic development with limited shortages.

Aerial view of electricity pylons and a big electrical substation at Shanghai city, China (Getty Images)

[i] This dispatch rule generally assigns all generating plants an equal number of hours to operate each year, regardless of their actual operating costs.

There has been a huge increase in the amount of China's overall power generation that is covered by market-based transactions.

However, the power market is facing multiple issues, including a failure to efficiently match supply with demand, a lack of incentives for the transition away from coal and toward clean energy, difficulties in recovering the initial costs of generation units, and a lack of policy coordination and responsiveness across key stakeholders in the power sector. To some degree, this has led to a situation where the power sector has held back economic and social progress, reflected in underutilization of generation assets, overinvestment in emissions-intensive projects, and renewables curtailment.

Recent developments in power market reform

In autumn 2021, many provinces in China experienced power shortages due to surging coal prices[ii] curbing availability of coal-fired power stations. This crisis not only shifted the policy priority to ensuring energy security[3] but was also a catalyst to speed up power market reform as regulators scrambled to solve the conflict between "market-coal" and "plan-tariff", i.e., the stark contrast between fluctuating coal prices and rigid electricity prices.

In October 2021, in a surprise move, the National Development and Reform Commission (NDRC) announced reforms to the coal-fired power tariff (Document No.1439) and expanded the coverage of power trading. This was seen as a key milestone in China's power market reform and signalled further acceleration in the process. Document No.1439 widened the coal-fired benchmark tariff fluctuation band from previously +10 percent and −15 percent to ±20 percent. This enabled further pass-through of coal prices to the tariff and partly offset the pressure on coal plants' profitability. It is noted that energy-intensive industry users and spot-trading volumes are not subject to this limit.[iii] The document also requires all coal-fired generation, as well as all industrial and commercial users, to purchase electricity from the market, either directly or via grid companies.[iv] This vastly expands the coverage of power trading. In 2022, it is expected that more than 70 percent of China's overall power generation will be covered by market-based transactions, up from 45 percent in 2021. As a consequence, the concept that electricity prices can both rise and decrease and will be determined by market supply and demand is now well established.

The reform gathered further speed in November 2021 with the "Guidance on Establishing National Unified Electricity Market System," which was approved at the meeting of the Deepening Reform Committee.[v] The Guidance sets a clear roadmap for China's power sector reform, aiming to establish a multilayer power market system, as shown in Figure 2, consisting of mid- to long-term, spot and ancillary services markets and gradually integrating the provincial and regional power markets into a national market.[vi] This process will take place in two phases, with the establishment of the system by 2025 and completion by 2030.

In the meantime, the regulators are proceeding with expansion of the spot-trading pilots. In 2022, the first batch of eight spot-trading pilot provinces must enter continuous trading and the second batch of six spot-trading pilots must start. The deepening and further rollout of the spot-trading pilots will continue in coming years. In the meantime, medium- to long-term trading will remain the main trading type until at least 2025, with spot markets being fully developed by 2030.

[ii] Coal prices increased from 400 RMB/tonne to more than 1000 RMB/tonne causing heavy losses for the coal plants.

[iii] For example, aluminum plants in Sichuan provinces reportedly saw their monthly electricity contract transacted at 0.7 RMB/kWh, double the level of the benchmark tariff.

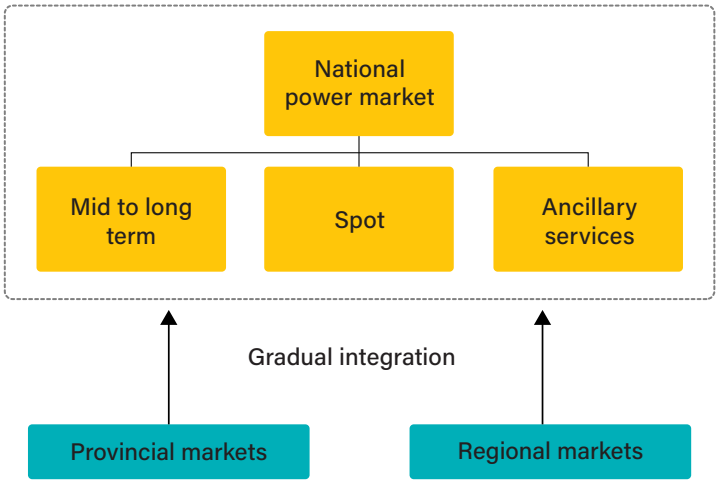
[iv] Before the reform, only 70% of coal-fired generation and 43% of industrial and commercial users bought electricity from the market.

[v] Formally released in January 2022.

[vi] Unification will be achieved by "establishing uniform trading rules and technical standards." The NDRC and the National Energy Administration (NEA) will set national-level standards including data interface, etc., and push forward to establish a national power exchange.

China's current power market design and operation present a number of barriers to the ability of the ETS carbon price to drive power sector decarbonization.

FIGURE 2: **MULTILAYER POWER MARKET SYSTEM ENVISIONED IN GUIDANCE ON NATIONAL UNIFIED POWER MARKET**



Source: Refinitiv, 2022

CHALLENGES AND SOLUTIONS FOR CHINA'S NATIONAL ETS TO DECARBONIZE THE POWER SECTOR

Issues related to power market interactions

China's current power market design and operation present a number of barriers to the ability of the ETS carbon price to drive power sector decarbonization as follows.

First, with the spot power markets still in their infant stage and the lion's share of power generated by different power stations determined by the government under the "fair dispatch" rule in China, the carbon price currently has almost no impact on the running hours of power stations. This prevents changes toward a lower carbon mix of power station operation, which has been the key mechanism for the success of other ETSs, notably the EU ETS, in driving significant GHG emissions reductions in the power sector.[vii] Currently, the impact of China's national ETS in reducing CO_2 emissions from the power sector is limited to driving up efficiency of the coal fleet,[viii] promoting switching to cleaner coal,[ix] and encouraging closure of aging and inefficient coal plants.

Second, the potential for the carbon price to pass through to electricity prices is very limited except for the minor share of generation currently covered by spot markets.[x] This restricts the ability of the ETS to make renewables more competitive against fossil-fuel power generation and drive demand-side reductions in electricity consumption, thus further inhibiting the potential for power sector CO_2 emissions reductions. Doing so also inhibits interprovincial and interregional renewable energy transmission.[xi]

Third, the national ETS carbon price is not yet accounted for in investment decisions under the central planning of generating sources and is not yet understood to play a role in promoting green investments over the long term as well as phasing out fossil power plants.

It is essential to build up the economic dispatch of power stations as in liberalized

[vii] Where power station dispatch is based on an economic merit order rather than government planning.

[viii] Within specific technical categories.

[ix] Such as co-firing with biomass.

[x] In the mid- to long-term market, the carbon price is not currently considered in the bidding price.

[xi] China's power system has an uneven distribution of resources, with abundant renewables in western provinces, while load centers are in the eastern provinces. Wind and solar on-grid prices are fixed to a benchmark price, and this price plus the transmission tariff are now higher than the local coal power price. Therefore, local governments tend to use cheaper coal power in their own province. Furthermore, allowing local coal power plants to generate more electricity is perceived as being helpful for the local economy.

It is essential to build up the economic dispatch of power stations so that the carbon price can be reflected in dispatch decisions and be passed through to electricity prices, making cleaner generation more competitive.

A bird's-eye view of a wind power plant in Fuzhou, Fujian Province, China (Getty Images)

power markets so that the carbon price can be reflected in dispatch decisions and be passed through to electricity prices, making cleaner generation more competitive. Key steps to move forward include the following:

- **Mid- to Long-Term Market.** In the immediate future, as the mid- to long-term market will dominate, measures should be taken to reflect the carbon price in mid- to long-term contracts. The current pricing mechanism, that is, benchmark tariff + fluctuations with a 20 percent limit, does not allow carbon cost pass-through as carbon costs are not currently included in the benchmark tariff or considered in the fluctuations. To address these issues, rules requiring the carbon cost to be factored into mid- to long-term contract pricing should be introduced, including a gradual removal of the fluctuation limit. At the same time, the current mid- and long-term power trading should break down to finer time horizons such as weekly, multi-daily, and so on, which will help reflect the fluctuations of carbon emissions in power generation more accurately.
- **Spot Market.** A key focus should be the rollout of wholesale spot markets as quickly as possible to establish economic dispatch for the majority of power generation. The first eight provincial pilots for spot trading have all begun continuous trading, albeit only so far covering 5 percent to 10 percent of provincial generation. These shares need to increase. In addition, currently only four pilots allow renewables in spot trading, so the coverage of generation sources needs to expand as well. The second batch of six provincial pilots due to begin trading in 2022 should enter continuous trading by 2023, with a further rollout of pilots to the remaining provinces. When all the provinces have established spot markets by 2025, the nationwide spot market can be developed with "marginal costs" determining wholesale and eventually retail prices instead of the average costs.
- **A Unified and Effective National Power Market System.** Some regional markets covering multiple provinces should be established first, and the political barriers in cross-province trading should be eliminated to facilitate interprovincial trading, particularly for renewable energy. The regional markets and provincial markets can then be gradually harmonized[4,xii] and integrated to form a national power market system.

Issues related to ETS design

The initial phase of implementation of China's national ETS, like other ETSs in their early stages, is aimed at establishing the basic elements of the system, familiarizing participants with its operation and achieving a smooth introduction. As such, it does not yet have the stringent emissions reduc-

[xii] "A major obstacle to tighter integration of provincial and regional power markets is the variety of provincial spot-market designs that have been implemented following Document No.9. Therefore, it is recommended to engage in harmonization efforts that will allow for a more optimal utilization of existing resources."

China's national ETS does not yet have the stringent targets and design elements that would give full play to its potential in achieving significant and cost-effective CO_2 emissions reductions. These should be gradually introduced through strengthening its design and adjusting various settings.

tion targets and design elements that would give full play to its potential in achieving significant and cost-effective CO_2 emissions reductions in the power and energy-intensive industry sectors and becoming one of China's most significant climate policies. These should be gradually introduced through strengthening its design and adjusting various settings, as considered next.

- **Power Sector Benchmark Levels.** The CO_2 emissions intensity benchmarks for power stations, combined with the amount of electricity generation, determine the total amount of emissions under the current ETS design. As such, the level of the benchmarks is critical. For the first compliance years (2019 and 2020), the level of the main benchmark for coal-fired power plants (0.877 tCO_2/MWh, for power plants above 300 MW) was slightly above the average emissions intensity of the sector, resulting in surplus allowances. Benchmarks should not be set at such a generous level. Instead, they should incorporate a reduction factor in line with the required reductions for the sector and the pathway to net zero emissions. Preferably a more ambitious target for the power sector should be set, as it is one of the easiest and least expensive sectors to decarbonize[xiii] and should be one of the first to do so, to enable other sectors to decarbonize given the requirement for electrification of the economy and the massive need for renewable energy. The reduction factor should also be at least as ambitious as the power station coal consumption targets.[xiv] While there are views that coal-fired power plants in China are already at world-class levels of energy efficiency and that benchmarks should require only moderate further reductions, it should be remembered that an ETS provides additional ways of compliance even within a tightly controlled power market, including co-firing with biomass and carbon capture and storage, and many more substantial ways once power market reform has progressed further, including phasing out coal-fired plants and shifting to gas and renewables.
- **Power Sector Benchmark Design.** Four benchmarks are currently defined, three for coal power plants differentiated by plant size, and one for gas-fired plants, aiming to reflect different types of allowance needs. The current approach will reward more efficient coal or gas generators within each type and improve the efficiency of the thermal fleet rather than helping phase them out. The current approach will not drive a switch away from coal-fired power generation and may even incentivize construction of new coal-fired plants with emissions intensity below the benchmarks. Despite its inefficiency in energy transition, this approach may fit China's current energy security concerns. However, as more and more renewables and advanced flexible power plants[xv] are in place to provide stable electricity, a single benchmark for coal-fired plants and then a single benchmark for coal- and gas-fired plants[xvi] should be implemented to further disadvantage inefficient coal-fired plants, promote a shift toward lower carbon fuel sources and renewables, and improve the economic efficiency of the ETS.

[xiii] For example, the power sector in the EU will be a very small contributor to GHG emissions by 2030. Emissions have come down a great deal under the EU ETS with this sector seeing the biggest change up to 2030. In the United States, the power sector is also seen as having the most potential for abatement by 2030.

[xiv] The NDRC and NEA have released guidelines on coal plants' retrofitting and upgrading plans and set 300g standard coal/kWh as a target while requiring newly built coal plants to fulfil 270g standard coal/kWh.

[xv] More efficient thermal power plants, such as a gas-peaking plant.

[xvi] Similar to the trends and plans under the Korean ETS.

Once carbon costs can be passed through to electricity prices, full auctioning can be introduced to the power sector to strengthen the carbon price signal, drive the switch away from coal, reduce electricity consumption, and generate huge amounts of revenue for carbon neutrality transition.

- **Indirect Emissions Allocation for Industrial Sectors.** To drive demand-side reductions in electricity consumption (and hence power sector emissions reductions) in advance of full pass through of carbon costs to electricity prices, it will be necessary to provide allocations for indirect emissions in industrial sectors related to electricity consumption,[xvii] when they are included in the scope of the ETS,[xviii] in addition to direct emissions.[xix] Once the power market reform process enables carbon costs to be passed through to electricity prices, indirect emissions allocation will no longer be necessary and should be removed.
- **Compliance of Gas-Fired Power Stations.** It is necessary to remove the current exemption of gas-fired power plants from compliance with the ETS. The objective of the ETS is to incentivize zero carbon generation sources and gas-fired plants need to be in compliance as do coal plants. The reason for their exemption was expensive gas fuel. However, this should be solved by establishing a more competitive power market and ancillary services,[xx] which can compensate the value of gas plants in providing flexibility and peak load.
- **Absolute Cap.** The current output-based ETS cap has a lower cost for enterprises and was politically more acceptable. The shortcoming is that emissions will rise if total power generation increases more than the reduction required by the benchmarks; this approach also provides a subsidy to production. A conventional cap and trade system with an absolute cap will be more economically efficient, and more compatible with China's carbon-peaking and neutrality targets. Introducing an absolute cap will be more feasible following power market reform, when carbon costs can be passed through to electricity prices, although this is not a prerequisite to introducing an absolute cap[xxi] The level of the cap and its trajectory should be in line with China's overall emissions targets and the required contribution to achieving those targets by the ETS sectors. It will still be possible in a capped system to adjust to economic cycles and changes in production, like an output-based system, through appropriate allocation adjustments and market stability measures.
- **Auctioning.** Once power market reforms have enabled carbon costs to be passed through to electricity prices, full auctioning for the power sector can be introduced, similar to the approach in the EU. This will significantly strengthen the ETS carbon price signal, encourage a major switch away from coal, facilitate reductions in electricity consumption, and generate huge amounts of revenue that can be used to support the clean energy and carbon neutrality transition (as discussed below). In advance of full auctioning and given that power companies can already pass through some carbon costs, it is best practice to introduce auctioning at an initial low level and gradually increase, with correspondingly reduced amounts of free allocation. Several of China's pilot ETSs have introduced auctioning

[xvii] Based on suitable benchmarks of emissions intensity of electricity generation.

[xviii] The scope is expected to include cement, aluminum, and steel sectors in the near future, with other energy-intensive industry sectors to follow.

[xix] Following the practices in China's ETS pilots and the Korean ETS.

[xx] In a well-functioning ancillary services market (balancing market), gas plants can get higher revenues for operating to balance the grid (balancing price can go up to £4000/MWh in the UK), which is much higher than the 1500 CNY/MWh ceiling in several spot power markets.

[xxi] For example, the Korean ETS has been operating with an absolute cap since its start in 2015 without yet achieving full pass-through of carbon costs to electricity prices.

Interministerial cooperation, supported by relevant technical working groups and overseen at a high level with strong political will, should particularly address key details of ETS benchmarks, cap, auctioning and auction revenue fund.

already so there are local experiences to draw from.

- **Auction Revenue Fund.** In combination with the above, establishing an effective fund to support investment in key technologies to achieve clean energy transition and carbon neutrality sourced by ETS auction revenue is a great opportunity for China's national ETS.[xxii] The design and implementation of the fund can benefit from experiences in the EU and the United States, such as the EU's Innovation Fund, EU Member States' funds sourced by EU ETS auction revenue, the U.S. Department of Energy Loans Program, and others and should include mechanisms to improve the viability of projects, such as carbon contracts for difference. Such a fund can be targeted toward strategic decarbonization priorities in ETS sectors, alleviating higher energy costs to vulnerable households and industrial sectors (from carbon cost pass-through), and addressing other social purposes as appropriate.

Coordination among relevant authorities

As the interaction of the ETS with the power market is a critical factor in determining its effectiveness in reducing power sector CO_2 emissions, the coordination between the Ministry of Ecology and Environment (MEE), responsible for the ETS; the National Development and Reform Commission (NDRC), responsible for power market reform[xxiii] and leading the work related to China's "1 + N" policy framework for delivering carbon peak and neutrality targets; and the National Energy Administration (NEA), responsible for detailed aspects of power market reform[xxiv] is crucial. An overview of authorities regulating China's power sector is given in Figure 3.

Closely related to this group, and another key organization to cooperate with the MEE is the Ministry of Industry and Information Technology (MIIT), which is responsible for the industrial sector CO_2 peaking roadmap.

Interministerial cooperation, supported by relevant technical working groups and overseen at a high level with strong political will, should particularly address the following:

- **ETS Benchmark Design and Levels.** Timing of the transition to more harmonized CO_2 emissions benchmarks for free allocation of emissions to the power sector and the levels of those benchmarks, accounting for power sector carbon peaking and neutrality targets, as well as clean energy transition targets.
- **Absolute ETS Cap.** Timing of the introduction of an absolute ETS cap and the level of cap, accounting for progress with power market reform and alignment of ETS cap with sectoral and national carbon peaking and neutrality targets, as well as clean energy transition targets, considering the relative contribution of the power sector to achieving China's overall carbon emissions reduction targets.
- **Auctioning.** Timing of the introduction of ETS allowance auctioning for the power sector, the level of the auction share, the trajectory of the increase of the auction share in time, and the timing of full auctioning, accounting for the extent of carbon cost pass-through to electricity prices as power market reform progresses further.

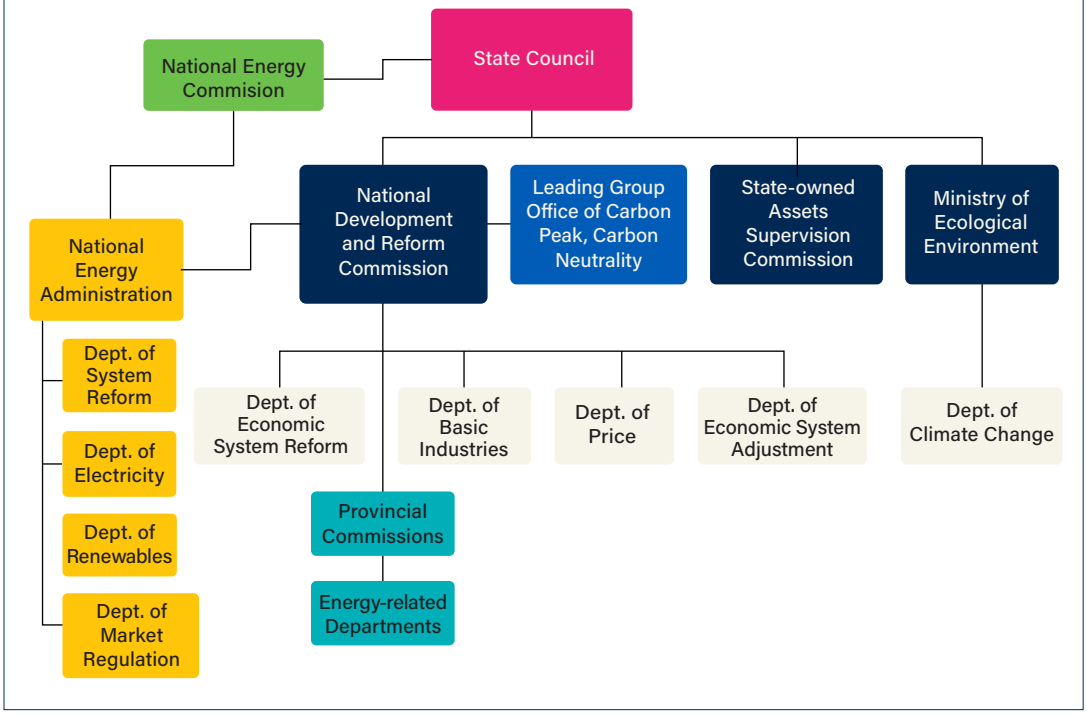
[xxii] For example, the EU ETS has generated approximately $120 billion in auction revenue, and California's Cap-and-Trade Program has generated $18 billion.

[xxiii] In the NDRC, the Economic System Reform Department leads power sector reform; the Economic System Adjustment Department is in charge of demand-side management and reform related to administrative generation planning; and the Basic Industry Department is in charge of integrating the power industry plan within the macroeconomic development plan, ensuring the targets of power sector reform do not collide with the broader national economic targets.

[xxiv] Four departments in the NEA are also involved in the power sector reform. The Electricity Department focuses on fossil fuel power generation planning and grid planning, electric vehicle charging facilities, and incremental distribution grid reform. The Renewable Energy Department is in charge of renewable energy development and integration. The Energy System Reform Department is in charge of institutional aspects of the reform. The Market Regulation Department is responsible for regulation of the power sector.

It will be important to keep the further development of the national ETS in sync with the pace of the power market reform and boost cooperation between the environment regulators and energy policy regulators.

FIGURE 3: **AUTHORITIES REGULATING CHINA'S POWER SECTOR**



Modified from source: IEA, Power sector reform in China: An international perspective, 2018

- **Auction Revenue Fund.** The uses of auction revenue (including to fund the transition to clean energy and carbon neutrality in ETS sectors and support sectors vulnerable to higher electricity prices), the funding mechanisms, and other relevant details.

PATHWAY TO ACHIEVE EFFECTIVE ETS–POWER MARKET INTERACTION AND SIGNIFICANT POWER SECTOR DECARBONIZATION

Both China's national ETS and its power market reform made breakthroughs in 2021, with further deepening of the power market reform and strengthening of the national ETS planned in the next few years.[xxv] It will be important to keep the further development of the national ETS in sync with the pace of the power market reform and boost collaboration between the environment regulators and energy policy regulators.

This paper has considered the current status of China's national ETS and power market reform and future plans, as well as best practice in other jurisdictions, to identify a policy pathway for effective interaction between the ETS and the power market that will facilitate the significant CO_2 emissions reductions in China's power sector that are possible and needed.

In summary, the suggested policy pathway toward 2030 to achieve an effective interaction between China's national ETS and its power market and significant CO_2 emissions reductions in the power sector is presented in Table 1.

[xxv] In April, the Communist Party of China Central Committee and the State Council jointly released a guideline on accelerating the establishment of a national unified market, aimed at ending local protectionism and unifying the fragmented market to remove key hurdles to economic growth. It mentioned the unified power market, energy market, and carbon market, demonstrating the focus on market-based mechanisms.

This paper presents a suggested policy pathway toward 2030 to achieve an effective interaction between China's national ETS and its power market and significant CO_2 emissions reductions in the power sector.

TABLE 1: **PATHWAY FOR ETS TO INTERACT WITH POWER MARKET AND ACHIEVE ITS EMISSIONS REDUCTION POTENTIAL**

	BY 2023	BY 2025	BY 2030
ETS			
1. Power sector BMs	Replace three coal BMs with a single coal BM Ensure BM levels are in line with power sector emissions reduction target and national pathway to carbon neutrality	Replace coal and gas BMs with a combined coal + gas BM Ensure BM level is in line with power sector and national targets	Ensure BM levels represent best practice of covered installations such as lowest 10 percent emissions intensity
2. Auctioning for power sector	Introduce auctioning for the power sector at an initial low level, such as 3 percent to 5 percent of total power sector allocation Establish an auction revenue fund (see below)	Establish a date for full auctioning of the power sector (see below) Increase auction share in line with pathway to full auctioning	Further increase auction share in line with pathway to full auctioning
3. Other relevant aspects	Introduce gas power plant compliance obligation		Introduce absolute ETS cap (see below) Remove indirect emissions allocation
POWER MARKET			
1. Mid- to long-term market	Include ETS carbon costs in benchmark tariff	Break down to finer time horizon such as weekly, multi-daily, etc.	Remove the limit on tariff fluctuation
2. Spot market	Introduce spot-trading to third batch of pilots (covering 20 provinces from 14 currently) Start continuous spot trading for second batch of pilots Include renewables in all spot-trading pilots	Introduce spot trading to cover remaining provinces Start continuous spot trading for third batch of pilots	Implement nationwide spot power market with continuous spot trading in all provinces[a] Ensure renewables fully participate in spot trading and remove guaranteed purchase hours for renewables
3. Other	Establish cross-province regional markets for mid- and long-term trading	Establish cross-province regional markets for spot trading Ensure ETS carbon costs are accounted for in cross-provincial transmission tariff setting to compensate export of green electricity.	Integrate regional markets to establish a national power market system
COORDINATION AMONG AUTHORITIES			
1. Power sector emissions reduction targets	NDRC, NEA, MIIT, and MEE work together to align timing, level, design, and trajectory of ETS benchmarks and absolute ETS cap with power and industrial sector carbon peaking, carbon neutrality, and energy transition targets, as well as power market reform progress. In doing so, they jointly research key issues and solutions to balance other competing objectives, including energy security, affordability, and industry competitiveness.		
2. ETS auctioning	MEE works with NDRC and NEA to assess and monitor the impact of ongoing power sector reform on carbon cost pass-through to wholesale and retail electricity prices to optimize the timing of the introduction of auctioning of ETS allowances for the power sector, the level of the auction share, the trajectory of its increase in time, and the date for full auctioning.		
3. ETS auction revenue fund	MEE works with NDRC, NEA, and MIIT to design and establish the ETS auction revenue recycling system, considering the uses of revenue, financing mechanisms, and other implementation details.		

NOTES

[a] Marginal costs of generation determine wholesale power price

The ultimate challenge in accomplishing this is raising the ambitions of the two markets and enhancing the coordination among ministries.

The interaction of the power market and ETS is a critical topic for countries with emerging ETSs, particularly those with heavily regulated power sectors, such as China. Recent power market reform efforts in China make more effective interactions feasible, as well as bring the opportunity to unlock the national ETS's potential for cost-effective and deep decarbonization of China's economy. In doing so, the timing of these systems' coevolution is vital. Our proposed pathways above take into account both existing plans and the additional ambitions required for both schemes, learning from international experiences to meet emission reduction targets and to develop more robust and sustainable power systems.

Currently, both schemes are progressing in the right direction, while the actions should be accelerated and harmonized. The ultimate challenge in accomplishing this is raising the ambitions of the two markets and enhancing the coordination among ministries, both of which require support from high-level officials who can impose overall planning, implement effective interministerial coordination, and remove obstacles brought on by vested interests by strengthening the regulation and enforcement of these schemes.

China is not the only country tackling these problems. Korea, a neighbouring country, faces similar issues, while a significant step was made in 2022 by introducing the environmental merit order mechanism, which allows carbon costs to be reflected in the wholesale electricity market. International communication and cooperation thus could also help China in overcoming these issues.

ANNEX

I. HISTORY OF POWER MARKET REFORM IN CHINA

China's energy regulators are aware of the shortcomings of the inefficient regulated power market and have implemented power sector reforms in the past 20 years.[5]

Back in 2002, China launched the first round of power sector reforms focusing on the "separation of power plants and grids, separation of main and auxiliary business, breaking monopoly, bidding on power grid, and electricity tariff reform."[6] However, this first round of reforms was incomplete and was called off in 2005. Industrial and commercial electricity prices remain high and renewables curtailment remains an issue. Other difficulties include low energy efficiency in power generation, barriers between provinces that hindered interprovincial trade, absence of price signals, and lack of policy clarity regarding investment in power generation.

In order to tackle these problems and further improve the power sector, China launched a new round of power sector reforms in 2015.[7] This second round of reforms was marked by the release of several opinions of the CPC Central Committee and the State Council on Further Deepening the reform of the Electric Power System", which is often referred to as "Document No.9." The most fundamental and significant content of Document No.9 is the goal of establishing a "fair, normative, efficient, competitive, open-access, and non-discriminative" electricity wholesale market to trade electricity through a market-based mechanism. It also includes key areas such as establishing relatively independent power exchanges, improving overall planning of power system development and government regulation, and so on. The deepening reform draws on experiences from international electricity market development, aiming to transform electricity pricing from central pricing to market-based pricing. It wanted power generation to be determined by market demand rather than state planning and to gradually move from medium-and long-term trading to spot market trading.

Through this round of reform, market experiments have been underway and deepening in all provinces in the past seven years. By the end of 2018, two national power exchange centers and 32 provincial power exchange centers (covering all provinces of mainland China) had been established to support market-based electricity transactions and medium- and long-term power markets. The national power exchange centers in Beijing and Guangzhou are mainly responsible for implementing interprovincial and interregional transactions and national directives. Eight provinces including Guangdong and Shandong started spot-trading pilots in 2017, although the spot-trading volumes only cover less than 5 percent–10 percent of the provincial generation. In 2021, the sum of all market-based electricity transactions in China was 3779 TWh, accounting for 45 percent of the total Chinese electricity consumption and more than tripling the level of 1000 TWh in 2016.

II. FIRST YEAR OF CHINA'S NATIONAL ETS

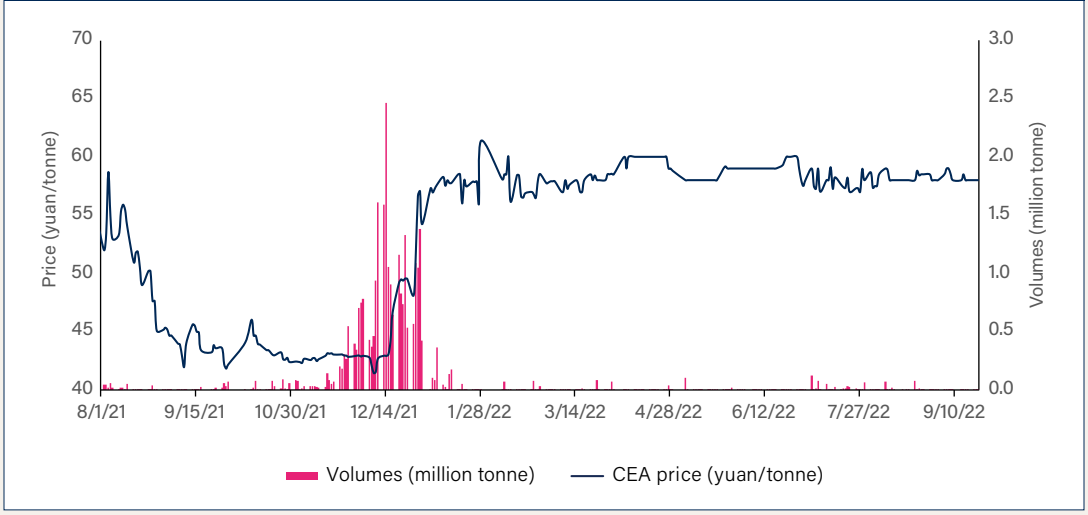
In 2021, China launched the long-awaited national ETS after a decade in the making.[8] It covers more than 2,000 enterprises in the power sector and annual emissions close to 4.5 billion tonnes of CO_2 per year, or around 40 percent of China's total. Unlike similar schemes elsewhere, such as in the European Union, China's allocation of emissions allowances is not decided upfront via an absolute cap but is based instead on benchmarks of emissions intensity (tCO_2/MWh).[9] One allowance means a company can emit 1 tonne of carbon. Enterprises whose thermal power plants' emissions intensity is above the benchmark will need to purchase allowances from those plants that are more efficient and below the benchmark intensity. China has chosen the intensity-based target for its ETS instead of an absolute emissions target considering growing energy demand and consistency with intensity-based energy and CO_2 targets at the national level. In addition, companies can cover up to 5 percent of their compliance obligation with China Certified Emissions Reductions (CCER), which are credits issued from gov-

ernment-certified domestic emissions reduction projects. Example activities include renewable power generation, forestry projects, and waste-to-energy projects.

In terms of trading, the national ETS's performance in the first year was limited. The price of the China Emission Allowance (CEA) has been relatively low at between RMB 40 and RMB 60 since it launched trading on July 16, 2021, averaging RMB 43.85 (€6)/t in 2021's 114 trading sessions.[10] A total of 179 million tonnes were transacted. This price level is just a fraction of the price in more mature ETSs, such as the €80/t in the EU's ETS. Thus, it currently only has negligible impacts in terms of driving emissions reduction. In addition, the dominance of over-the-counter trading and low trading volumes of most of the sessions indicate that the level of liquidity still has some room to improve. Daily trading volumes stayed very low at only several hundred thousand tonnes but surged to a million tonnes per day in December just before the year-end compliance deadline. This "tidal" pattern is largely due to two factors. First, only spot trading is allowed at the moment, and there is a lack of derivatives products to hedge risks.[11] This means that compliance entities have little incentive to buy or sell well in advance of the compliance deadline and are more willing to trade near final compliance. Second, there is a high degree of concentration in China's national ETS with the top 10 major utility groups covering more than half of the emissions and allocation. These large groups often prefer to transfer allowances internally among their own enterprises before trading with external participants. Lengthy internal approval processes for carbon allowance procurement in large state-owned enterprises also resulted in a more clustered trading pattern. For example, the major utility Huadian Group announced that it began allowance trading on November 26, 2021, and finished all the transactions and surrendering of allowances by December 14.

On December 31, 2021, the Ministry of Ecology and Environment officially announced that the first compliance period had been successfully completed.[12] The compliance rate was 99.5 percent based on covered emissions. This means that the majority of the 2,162 power sector enterprises in the scheme surrendered allowances before the deadline, meeting their compliance obligation for the 2019–2020 period. The MEE did not disclose the official data on verified emissions and allocation. Refinitiv Carbon Research estimated the final verified emissions for the two-year period to have been 8.68 billion tonnes, against a known total allocation of 9.01 billion carbon

FIGURE 4: **CHINA NATIONAL ETS DAILY CLOSING PRICE OF ALLOWANCES AND TRADING VOLUMES IN 2021 AND 2022**



Source: Refinitiv, 2022

emissions allowances. This leaves a surplus of 360 million allowances after accounting for around 30 million CCER usage. This overhaul is mainly due to rather generous benchmark as the government preferred a soft start to the system.

China's national ETS will undergo continuous improvement with the policy framework becoming stronger and more complete, allowance allocation rules becoming stricter, and trading liquidity increasing further. The next compliance period will cover both 2021 and 2022.[13] It will then have impacts on generation decisions in contrast to back-dated coverage[xxxvi] in the first compliance period. Sector expansion and the introduction of more types of trading participants and carbon derivatives will take place later. Meanwhile, the eight existing provincial pilot ETSs will gradually integrate with the national ETS. Going forward, the national ETS will make enterprises more aware of carbon costs and more focused on reducing emissions and will help China achieve its carbon peak and neutrality pledge through the ETS cap and associated climate finance mechanisms.

III. THE ROLE OF THE ETS IN A LIBERALIZED POWER MARKET SUCH AS THAT IN THE EU

In the EU, the ETS is the cornerstone of its climate policy and contributes to the rapid greening of the European power sector. Theoretically, the introduction of an ETS and carbon price will increase costs for higher-emitting power generation sources and make zero-emitting nuclear and renewables more cost competitive.[14] The liberalized power market in Europe has played a key role in empowering this potential of the carbon price signal. The EU electricity market is based on "economic dispatch," and generation technologies are ranked into "merit order" based on their short-run marginal costs. With variable costs at near zero and no carbon costs, renewables are then more competitive, followed by nuclear. Thermal power plants are disadvantaged as they need to include carbon costs in their marginal costs.

Hence, the EU ETS price could drive "coal to gas" switching in the wholesale power market by altering the economics of coal and gas plants and improving the relative economics of renewables. Coal-fired power generation has twice as much carbon costs per MWh than gas-fired plants since it emits more CO_2 per MWh. Higher carbon prices will increase the costs of operating coal plants, making them less profitable to run compared to gas equivalents. The actual realized amount of coal to gas switching will depend on the electricity mix and market prices of coal and gas.[xxxvii] For example, the switching has occurred more frequently in Germany and Spain due to relatively large gas- and coal-fired installed capacity than in coal-dominated Poland and the Czech Republic.

In addition, since the wholesale power price is determined by the generation costs of the marginal generator, often a coal or gas plant, the carbon price gets passed through to the electricity price. This will encourage savings in electricity consumption, thus also reducing emissions from the power sector.

Beyond the short-term horizon, the carbon price will in the long run drive capacity investment from carbon-intensive to cleaner resources. The carbon price is a parameter in determining the future revenues of power sector investment and provides power enterprises with an incentive to invest in cleaner resources, since clean resources do not have to pay the carbon price and benefit from higher energy prices in wholesale energy markets. Meanwhile, as the electricity mix becomes cleaner, more carbon-intensive resources are much less likely to be dispatched and thus suffer financial losses, thus enabling their faster phaseout.[15]

[xxxvi] The first compliance period covered 2019–2020, while the allocation plan issued at the end of 2020 and actual trading started in 2021. This backdated setup had little impact on 2019–2020 emissions.

[xxxvii] Since late 2021, due to skyrocketing gas prices in Europe and gas supply constraints, the carbon price of €80/t has been unable to drive coal to gas switching in the power sector, and coal-fired plants remain cost competitive. This situation is expected to last longer with gas prices projected to stay elevated due to tight supply throughout 2023.

ENDNOTES

1 ECECP report, "Electricity markets and systems in EU and China: Towards better integration of clean energy sources," July 2020, http://www.ececp.eu/en/electricity-market-eu-china/.

2 IEA, "Power sector reform in China: An international perspective," 2018. https://iea.blob.core.windows.net/assets/95fa6240-a316-4b9e-b5fa-40d8d265150e/Insights_Series_2018_Power_Sector_Reform_in_China.pdf.

3 Xinhua News, "Premier Li Keqiang held National Energy Commission meeting," October 2021, http://www.gov.cn/xinwen/2021-10/11/content_5641907.htm.

4 ERI, "China energy transformation outlook 2022," June 2022, https://www.cet.energy/2022/06/28/ceto_2022/.

5 IEA, "China's Power Sector Reforms: Where to next?" July 2006, https://iea.blob.core.windows.net/assets/028dc34c-a495-475b-8b54-e691176d4533/ChinasPowerSectorReformsWheretonext.pdf.

6 State Council, "Notice on the Issuance of the Electric Power System Reform (the Document No.5)," February 2002, http://www.gov.cn/zhengce/content/2017-09/13/content_5223177.htm.

7 Guo et al., "Power market reform in China: Motivations, progress, and recommendations," Energy Policy, Vol. 145, October 2020, 111717.

8 Refinitiv Perspectives, "China's national carbon market exceeds expectations," July 2021, https://www.refinitiv.com/perspectives/future-of-investing-trading/chinas-national-carbon-market-exceeds-expectations/

9 Zhang et al. "Theory and practice of China's national carbon emissions trading system," Management World, No. 8, 2021.

10 China Dialogue, Tan Luyue, "The first year of China's national carbon market, reviewed," February 2022, https://chinadialogue.net/en/climate/the-first-year-of-chinas-national-carbon-market-reviewed/.

11 Oxford Energy Forum, February 2022, https://www.oxfordenergy.org/publications/oxford-energy-forum-the-2021-energy-crisis-implications-for-chinas-energy-market-and-policies/.

12 China Ministry of Ecology and Environment, "National ETS's first compliance cycle has completed successfully," December 31, 2021, https://mee.gov.cn/ywgz/ydqhbh/wsqtkz/202112/t20211231_965906.shtml.

13 Caijing, "How can the national carbon market come out of the doldrums?" June 2022, https://finance.ifeng.com/c/8GqNLdP6cQ6.

14 Regulatory Assistance Project (RAP), "Designing power markets to maximize the effectiveness of carbon pricing: Lessons from international experience," May 2020, https://www.raponline.org/wp-content/uploads/2020/06/rap_dupuy_weston_kadoch_cowart_designing_power_markets_maximize_effectiveness_carbon_pricing_may_2020.pdf.

15 Carbon Tracker, "The energy complex has EU coal generators in a chokehold. Are policymakers and investors prepared for what comes next?" October 2019, https://carbontracker.org/reports/apocoalypse-now/.