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THE TRANSITION FROM AN INTENSITY TO AN ABSOLUTE EMISSIONS CAP IN CHINA'S NATIONAL EMISSIONS TRADING SYSTEM

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EXECUTIVE SUMMARY

The unique characteristics of China's economic development and electricity marketization have resulted in the implementation of a bottom-up intensity-based emissions cap in China's national emissions trading system (ETS) in its early stages. However, the efficacy of the bottom-up cap-setting approach remains controversial, particularly with regards to achieving emission reduction goals and cost effectiveness. In response to China's "dual carbon" targets and updated Nationally Determined Contributions (NDC), China's national ETS shall gradually shift towards a real cap-and-trade system, with a transition period when a hybrid system, which has an absolute control cap besides the intensity cap, is implemented.

This research analyzes the cap-setting approaches used in China's ETSs, the underlying reasons for choosing intensity caps in China, and major issues related to the transition from an intensity cap to an absolute cap in China's national ETS. Based on this research, key suggestions regarding next steps include:

- Impacts of a change in cap-setting approach, especially on the sectors, companies, regions and the overall economy, should be carefully analyzed, suitable measures to mitigate risks of carbon leakage ensured and a transition roadmap prepared.
- Absolute cap-setting approaches in China's ETS pilots should be carefully analyzed to identify the most appropriate elements for the national system. Furthermore, it will be beneficial if one or more pilots could be selected to test proposed approaches including their technical, as well as social and political aspects.
- Policy tools should be established to address possible serious unexpected surpluses or shortages of allowance supply under an absolute cap. To address oversupply these can include market stability operations, allowance banking and long-term stability and predictability in system design; whilst to address shortages these can include auctioning allowances with a price floor, sales of allowances at fixed prices and reserved allowances for new entrants.

This research analyzes the cap-setting approaches used in China's ETSs, the underlying reasons for choosing intensity caps in China, and major issues related to the transition from an intensity cap to an absolute cap in China's national ETS.

- An absolute cap should initially be set at a relatively loose level and strengthened gradually. Making a start on the transition process is more important than having a very tight absolute cap at the start.
- In the transition period, suggested as 2026-2030, the national system's actual emissions cap would be affected by both an intensity-based cap and an absolute control cap. If the intensity-based cap determined by the allocation approaches is not higher than the absolute control cap, the actual cap will be determined by the intensity cap. Otherwise, allocations would be adjusted to the absolute control cap level. A feasible approach to establish the control cap in this period could be to determine emissions "caps" for each covered sector and aggregate them.
- After 2030 when China will have reached its carbon peaks, it should be easier to predict emissions trajectories, based on which an absolute cap derived directly from national mitigation targets could be set.
- To make the division of mitigation responsibility between ETS and non-ETS sectors more equitable and minimize the total mitigation costs of the whole country, it will be necessary to carefully analyse mitigation potential and costs at a sectoral level.

1. INTRODUCTION

Reasonable cap-setting guarantees the scarcity of carbon allowances; therefore, the determination of an allowance supply cap is deemed a critical foundation for the ETS. An excessively loose cap would result in low carbon prices and inactive carbon trading, while a very strict cap would lead to high costs for enterprises participating in the ETS and could negatively affect their development. Many of the international ETSs' failures are attributed to cap-setting issues. For example, in the EU ETS's first and second phases, an overly loose cap resulted in excess carbon emissions permits and extremely low carbon prices.

On July 16, 2021, China's national emissions trading system (ETS) launched online trading, making it the world's largest ETS in terms of covered carbon emissions. The ETS has become one of the most crucial tools for China to achieve its "dual carbon" targets, that is, peaking CO_2 emissions before 2030 and achieving carbon neutrality before 2060.

There are two main approaches to setting emissions caps in ETSs: a "top-down" approach usually establishing an absolute cap and a "bottom-up" approach usually establishing an intensity-based cap. In its early stages, China's national ETS adopted a bottom-up intensity-based approach to set the emissions cap, which differs significantly from the top-down absolute cap approach of "cap-and-trade" systems in many other jurisdictions. However, as climate change intensifies and China aims to achieve its dual carbon targets, the current bottom-up approach could result in uncertain carbon emissions caps and cost ineffectiveness and could hinder the promotion of enterprises' long-term emissions reductions. To ensure the achievement of the dual carbon targets and optimize the facilitative role of the ETS, China must transform the cap-setting

Policymakers must consider three critical issues when setting the cap: the cap level should align with the region's overall emissions reduction targets; a balance should be struck during the distribution of emissions reduction responsibilities between covered and uncovered sectors; and there should be a balance between emissions reduction efforts and system costs.

approach from bottom up to top down in its national ETS. This transformation is a critical step toward improving the ETS and achieving China's carbon mitigation goals.

2. KEY ISSUES ON AND APPROACHES FOR CAP SETTING

2.1 Key issues on cap setting

The cap-setting process for an ETS is influenced by several factors, including scope and coverage, emissions reduction targets, and future economic growth rates. Policymakers must consider three critical issues when setting the cap: (1) The cap level should align with the region's overall emissions reduction targets, with the uncertainty of future economic growth considered. (2) A balance should be struck during the distribution of emissions reduction responsibilities between covered and uncovered sectors, considering their relative abilities to reduce emissions. (3) There should be a balance between emissions reduction efforts and system costs, considering factors such as cost and efficiency, availability of data, public acceptance, and relationships with external stakeholders.

By addressing these three critical issues, policymakers can set an effective cap that balances all the factors mentioned above.

2.2 Cap-setting approaches

There are two primary ETS cap-setting approaches: the absolute (top-down) cap-setting approach and the intensity-based (bottom-up) cap-setting approach. In the top-down approach, the government sets an absolute cap based on factors such as emissions reduction targets, potential for emissions reduction, and the costs of covered industries. The bottom-up approach involves determining the number of allowances for individual enterprises according to a specific allocation rule and then aggregating these allowances to obtain the overall ETS cap.

2.2.1 Top-down approach

The top-down approach, also known as the absolute cap-setting approach, sets the upper limit for emissions first and then determines the specific distribution approach and number of allowances.

The top-down approach is considered the most common cap-setting approach for an ETS, as it provides advance certainty for both regulatory bodies and market participants. It is widely used in established ETSs in developed countries and regions. For instance, the EU ETS and the California system determine the cap first and then use cross-sector corrections to coordinate allowance allocation approaches and emissions caps.

However, several factors could cause the actual emissions to deviate significantly from the projected emissions, such as unexpected changes in economic development and carbon emissions growth, the uncertainty of energy price changes, emissions reduction technology innovation, and even sometimes the quality of emissions data. Moreover, the government may set a higher upper limit of emissions to ease the pressure from enterprises, economic development, and political resistance, leading to excessive distribution of allowances and a decrease in price. This issue has been observed in the early phases of the EU ETS and the Regional Greenhouse Gas Initiative (RGGI), among others. To address the possible issues brought about by the inflexibility of an absolute cap, some systems have established reserved allowances, including new entrants reserves and price containment reserves. Many systems, including China's pilot ETSs and the EU ETS, have a New Entrants Reserve (NER) mechanism to

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allocate free allowances to new installations and installations that significantly increase their output levels. To maintain price stability, some systems also set up price containment reserves, for example, the Market Stability Reserve (MSR) of the EU ETS. If the total number of allowances in circulation exceeds the threshold levels, specific numbers of allowances will be placed in the MSR, thus reducing the volume of allowances to be auctioned; in case of lower numbers of allowances in circulation than the predetermined level or excessive price fluctuation, allowances would be released from the MSR. Similarly, under the California Cap-and-Trade Program, a certain number of allowances from the cap are set aside each year in an Allowance Price Containment Reserve. If the quarterly auction clearing price is greater than or equal to 60 percent of the lowest Reserve tier price, the California Air Resources Board (CARB) will offer allowances through reserve sales at fixed prices and through a price ceiling sale if no allowance remains in the first or second tier of the Reserve.

2.2.2 Bottom-up approach

The bottom-up approach, also known as the intensity or relative cap approach, sets the emissions cap mainly by aggregating allowances allocated to each installation according to the allocation approaches.

The number of allowances distributed to installations when an intensity-based approach is used depends on the specific benchmarks and the actual output levels of the installations, rather than being set in advance. The benchmarks used for allocation are often determined by the distribution condition of carbon emissions intensity data of enterprises in relevant sectors, as well as technology feasibility and fairness. This flexible cap helps control the cost of the entire system during periods of rapid economic growth and reduces the risk of ETS failure during economic recessions.

Although the intensity-based cap is generally more politically acceptable to governments, enterprises, and consumers, especially at the beginning, controversies still remain regarding the certainty of emissions reduction results, cost efficiency, economic efficiency, administrative cost, and benchmark design. Furthermore, in the design of the intensity cap, fewer benchmarks within one sector may encourage the adoption of advanced technologies but may also have a greater impact on backward enterprises. In the initial stages of ETS construction, the bottom-up approach is often adopted to gain political support or reduce political objections and adapt to the possible great uncertainties regarding economic development and sometimes emissions data. For example, China's national ETS uses this cap-setting approach for the first and second compliance phases.

2.2.3 Comparison of the two approaches

Academic research generally finds that the intensity-based approach is less cost-effective than an absolute cap. Goulder et al.[1] argue that China's national ETS is actually a tradable performance standard (TPS) system and the endogeneity of the allowance allocation under the TPS gives rise to an implicit output subsidy, which could undermine cost-effectiveness of the system compared to a cap-and-trade system. Research has shown that the total cost of a TPS system is about 47 percent higher than that of a cap-and-trade system using matched analytical and numerical solving models.[2] Output-oriented standards, which actually subsidize output, will result in higher marginal costs of control for society at a given emissions reduction target and is not an optimal policy solution.[3] De

In China's national ETS, the cap is currently determined by the bottom-up approach, resulting in an intensity-based cap with no predetermined absolute cap.

Vries et al.[4] suggest that the long-run equilibrium output of a company does not depend on the emissions trading form, but a cap-and-trade system outperforms an intensity-based trading system in terms of long-run welfare with free entry and exit. Simulation results of the U.S. electricity market by Zhang et al.[5] indicate that a cap-and-trade system is more effective than tradable performance-based policies.

3. CAP SETTING IN CHINA'S NATIONAL ETS

3.1 Intensity-based cap in China's national ETS

According to the "Measures for the Management of Carbon Emissions Trading (Trial)" issued by China's Ministry of Ecology and Environment (MEE) on December 25, 2020, the cap-setting and allowance allocation under China's national ETS must consider various factors, such as economic growth, industrial structure adjustment, energy structure optimization, and cooperative control of air pollutant emissions. The "Implementation Plan of Allowances Cap and Distribution of National ETS in 2021 and 2022 (Power Generation Industry)" outlines the cap-setting approach of China's national ETS, which involves the following three steps:

1. In accordance with allowance allocation methods and benchmarks, the provincial-level ecology and environment authorities calculate the number of allowances to be allocated to each facility in 2021 and 2022, considering the actual installation outputs and relevant correction coefficients.[i]

2. The annual number of allowances to be allocated to each major emitting company is calculated by summing up the corresponding allowances for each facility within the company. The allowances to be allocated to companies in a region are then aggregated to form the annual allowance cap for that administrative region.

3. The MEE totals up the annual allowance cap of each provincial-level region to get the annual national allowance cap.

Typically, the carbon emissions and output data of key emitting enterprises are verified by a third party and reported before April of the second year. Since the number of allowances to be distributed in the current year is based on the real output of the same year, the national ETS follows a two-step allocation approach.

The first step is pre-allocation of allowances. As the actual output level is not available at the time of pre-allocation, the historical output level that has been verified is used at this stage. But to avoid over-allocation, 70 percent of the historical output level or verified historical emissions[ii] are used to calculate the number of allowances to be pre-allocated. These pre-allocated allowances can be used for carbon emissions trading.

The second step is the adjustment of allowances allocated. When the verified actual output level data is available, the provincial authority will be able to determine the final number of allowances that should be allocated to the emitting enterprise. Companies will be asked to return allowances to the authority in case of excess allocation at the pre-allocation stage, and the provincial authorities will allocate additional allowances to companies in case of short allocation at the pre-allocation stage.

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[i] Correction factors are used in China's national system to address the differences of coal power installations regarding cooling methods (water cooling and air cooling), power generation only and cogeneration, and load factors. For example, for air cooling units, the cooling method corrector factor is 1.05 compared to 1.00 for water cooling units; load rate correction coefficients are used to compensate for units operating at low load rates.

[ii] For year 2019–2020, 70 percent of power generation in year 2018 is used and for year 2021–2022; 70 percent of the verified emissions in year 2021 are used.

As a developing country, China is undergoing relatively rapid economic growth, leading to relatively high uncertainty in predicting carbon emissions.

In China's national ETS, the allowance cap is determined by the bottom-up approach, resulting in an intensity-based cap with no predetermined absolute cap.

3.2 Reasons for choosing an intensity-based cap

Many believe that an intensity-based emissions cap is more appropriate than a predetermined absolute cap for China's national ETS considering the following factors:

1. Great uncertainty of China's economic development and carbon emissions growth

Accurately predicting future emissions is a crucial factor in determining the cap and distribution of allowances for an ETS.[6] Developed countries typically have less uncertainty in their predictions due to stable economic development, making it easier to design a cap-and-trade system. However, as a developing country, China is undergoing relatively rapid economic growth, leading to relatively high uncertainty in predicting carbon emissions. Prior to the implementation of China's dual carbon targets, the country had adopted intensity targets with regard to energy consumption control and carbon mitigation. Additionally, macro-level economic and carbon emissions growth is highly uncertain, making it challenging for the Chinese government to establish an absolute cap using a top-down approach.

2. Heavy regulation of the power generation sector

The power generation sector, which is responsible for the largest emissions in China, is the only sector that is now included in China's national ETS. Power generation enterprises are strictly regulated, in terms of both feed-in-tariff and power generation capacity. The feed-in-tariff in most cases is determined by the National Development and Reform

Thermal power generation and solar power station in Shanghai, China./Gettyimages

Commission (NDRC), the national price regulator; the amount of annual power generation from the power companies must comply with the annual dispatching plan developed by relevant authorities or the electric grid companies.[7] Although China is undergoing power market reform, the liberated spot power markets are still in their infancy, and the majority of power generated by different power stations is still controlled by the government. In most cases, power companies are required by the authorities to shoulder social responsibilities; for example, they are not allowed to stop or reduce power generation even if they are losing money due to high fuel prices and low feed-in-tariffs. Power enterprises are thus unable to either pass the carbon cost to downstream consumers or freely adjust their power generation plan to compensate for cost changes. Adopting a poorly designed absolute cap would inevitably disrupt normal electricity supply and thus cause strong political resistance to the ETS.

3. Significant regional differences

An ETS cap will directly affect the costs of covered enterprises, so it is essential to consider the emissions reduction potentials of the sectors and enterprises covered. Moreover, huge regional differences, in terms

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of economic development, industrial structure and its changes, energy consumption and structure, carbon emissions and their characteristics, and enterprise technical levels make cap setting in China even more challenging. The bottom-up intensity method only requires covered companies to improve their production efficiency and does not limit their output levels, thus reducing the costs to be borne by the covered entities. When multiple benchmarks are developed for the power generation sectors, the costs will be further reduced.

In consideration of the above factors, at the initial stage, China's national ETS is intensity based and is a multi-sector TPS, with a flexible and unfixed cap. In addition to controlling the direct carbon emissions generated in the combustion of fossil fuels, the ETS also regulates indirect carbon emissions associated with outsourced electricity and heat, making the establishment of an absolute cap difficult. An intensity-based cap brings about not only more flexibility and political acceptance but also benefits when there is a downturn of economic development, as the actual cap will shrink with the lower output level. The aforementioned factors have determined that a TPS system with a flexible cap is more appropriate for China's national ETS at the initial stage.

4. CHINA'S EVOLVING POLICY SITUATION AND NEED FOR AN ABSOLUTE CAP

In September 2020, China pledged to the international community to "reach a peak in CO_2 emissions before 2030 and achieve carbon neutrality before 2060" (the dual carbon targets). Later, at the Climate Ambition Summit, China announced additional targets, including reducing CO_2 emissions per unit of GDP by more than 65 percent from 2005 levels by 2030, increasing the share of non-fossil energy to around 25 percent, raising forest stock volumes by 6 billion cubic meters from 2005 levels, and installing more than 1,200 GW of wind and solar capacity. In October 2021, the Chinese government updated its NDC, aligning it with these goals.

To achieve its dual carbon targets, China has established the "1+N" policy framework. The "1" refers to the "Opinions of the CPC Central Committee and the State Council on Completely, Accurately and Comprehensively Implementing the New Development Concept and Properly Conducting the Work to Achieve Carbon Peaking and Neutrality", as well as the "Action Plan for Realizing Carbon Peaking before 2030" issued by the State Council. These documents play a leading role in the work to achieve carbon peaking and neutrality. The "N" refers to a series of related policy and action documents issued by various national and regional authorities, including implementation plans for different fields and industries in China, as well as supporting systems such as scientific and technological support, financial support, statistical accounting, talent training, and carbon-peaking implementation plans for 31 provincial-level regions. Together, these documents will construct a policy system for achieving carbon peaking and neutrality with clear phased targets, a reasonable labor division, effective measures, and orderly connections.

As a result of China's unique characteristics, adopting an intensity cap for the national ETS in its initial stage is reasonable. However, with the introduction of China's dual carbon targets, problems with an intensity cap have emerged. First, the considerable uncertainty surrounding mitigation benefits associated with an intensity ETS caps increases the

China's dual carbon targets and relevant supporting mitigation policies require greater efforts by all major sectors to reduce and/or peak their carbon emissions with practical and clear sectoral emissions reduction roadmaps, which will minimize the uncertainty of future emissions trajectories and thus the difficulty of setting an absolute carbon emissions cap.

uncertainty in achieving China's dual carbon targets. Second, the absence of an absolute target increases the difficulty of allowance allocation, making the selection of the benchmarks for allowance allocation especially crucial for achieving a specific mitigation target. Additionally, due to the usually increasing output levels of covered sectors, an intensity cap in most cases means a higher emissions cap and lower carbon prices, making it difficult to encourage enterprises to incorporate emissions reduction into their long-term planning.

China's dual carbon targets and relevant supporting mitigation policies require greater efforts by all major sectors, especially the major emitting energy and industrial sectors, to reduce and/or peak their carbon emissions with practical and clear sectoral emissions reduction roadmaps, which will minimize the uncertainty of future emissions trajectories and thus the difficulty of setting an absolute carbon emissions cap. In addition, as China's national ETS gradually matures and becomes more acceptable to major stakeholders, problems such as low cost-effectiveness and great mitigation uncertainty resulting from an intensity cap are becoming increasingly apparent and recognized by a growing number of people. Moreover, with carbon-peaking targets and/or plans being put forward for more and more major emitting sectors that China's national ETS plans to cover, it is imperative that an absolute cap is established, with the only issues remaining to be debated being the cap level and when such a cap should be introduced. China has accumulated more than 10 years of experience with ETS pilots, including cap setting and allowance allocation, and in some pilots, a top-down cap-setting approach has been tried, although it has not played a crucial role. The gradual improvement of the quality of carbon emissions data has provided a foundation for accurate cap setting. These factors may help reduce the degree of difficulty of establishing a top-down absolute cap in China's national ETS and facilitate the transition to such a cap from the current intensity cap.

5. EXPERIENCES OF SETTING AN ABSOLUTE CAP IN CHINA'S PILOT ETSs

Although no pilot ETS in China has relied solely on an absolute cap to control emissions, some do have experiences of establishing an absolute cap, mainly a control cap that cannot be exceeded and has no impact on allocation if the number of allowances is lower than that cap. Some pilots do not have an absolute cap for the whole system, but they have tried to establish the upper limit of allowances to be allocated for some sectors. The approaches that have been used in this process may also be useful to the national system if an absolute cap is to be established.

In China's pilot ETSs, three main types of top-down approaches have been adopted for determining an absolute emissions cap[8]: (1) determining the cap based on projected regional emissions and historical emissions share of ETS sectors, (2) obtaining the cap through the accumulation of emissions targets for the covered sectors, and (3) determining the cap by using a reduction rate to the historical ETS emissions.

Although most ETSs in other jurisdictions adopt absolute emissions caps, some systems, such as those in New Zealand and Saitama and Tokyo, established intensity caps in the initial phases, and some have already transitioned from intensity targets to absolute targets. The cap-setting practices in the EU ETS have also changed between the

The first step could be changing to a hybrid approach to determine the cap, that is, a combination of top-down and bottom-up approaches, just like the practices in some of China's pilot ETSs.

second and third phases, transitioning from a decentralized cap setting by aggregating national caps determined by the member states to a centralized cap setting.

6. TRANSITION FROM AN INTENSITY TO AN ABSOLUTE CAP

China's current economic development and power sector characteristics have determined that a bottom-up and intensity emissions cap is most appropriate for China's national ETS, making it essentially a TPS system. However, the importance of transitioning to a cap-and-trade system with an absolute cap is increasing as the system continues to mature and is expected to play a more significant role in helping China achieve its more ambitious mitigation target. The first step could be changing to approaches used to determine the emissions cap from a bottom-up approach to a hybrid one, that is, a combination of the top-down and bottom-up approaches, just like the practices in some of China's pilot ETSs. To achieve such a transition and finally build a real cap-and-trade system, possible impacts of such a transition should be carefully considered and an active but feasible roadmap prepared.

As discussed, different approaches have been used in China's pilot systems for establishing an absolute cap, and those approaches should be carefully analyzed to identify the most appropriate one that could be used in the national system. Special attention should be given to the differences between the national system and the pilots in terms of system design, for example, the sectors covered and the allocation approaches. Different sectors may have different development paths and future emissions trends; even for the same sectors, the national-level development and the provincial-level development could be very different, considering technological competitiveness and policy constraints.

Data is the basis for determining the emissions cap, and different approaches may require different types and levels of data, for example, aggregated emissions of the whole region or emissions intensity of major products, so data availability and quality should be carefully considered. Data is a complicated issue in China, as both the national and pilot systems cover indirect emissions from consumption of outsourced electricity and heat, making it unfeasible to directly use the inventory data. China's national system has been in operation for almost two years, and the historical emissions since 2013 of companies/installations in several major emitting sectors, including iron and steel and cement, have been reported. However, it should be noted that the reported data may be obtained using different accounting approaches, such as using default values or measured parameters; thus, data from different years may not be comparable and sometimes the differences of installation-level data could be huge. Taking the allocation benchmarks used for allocation in year 2019–2020 and in year 2021–2022 as an example, the difference could be as high as 6 percent–7 percent, mainly caused by the increasing rate of using real monitored parameters.

Transition to a real cap-and-trade system means more rigid emissions limits and possibly a higher cost for covered sectors and installations, and there will inevitably be concerns that this may negatively affect the development of relevant sectors and the whole economy. To ease these concerns and make more informed decisions, it will be useful to do some analysis on the possible impacts of such a change on the sectors and the economy, as well as associated measures to mitigate risks of carbon leakage. Usually,

The most important consideration should be to make a start on the transition process to an absolute cap, rather than focus on establishing a very tight absolute cap, because to strengthen an absolute cap is usually easier than to transition from an intensity cap to an absolute cap.

such analysis is done based on projections of aspects such as future economic and sectoral development and emissions, mitigation cost and potentials, and so on. In addition, historical data obtained during system preparation and operation could also be used, for example, the data from 2019–2022. Based on this historical data, the impacts of different absolute cap-setting approaches, including on different sectors, companies, and regions, could be analyzed and compared. This will help not only identify the most appropriate absolute cap determination approach for the national system but also understand the impact of differences compared to the current design with an intensity cap.

Pilot ETSs in China are still operating and their value of testing different policy options should be continuously explored. It would be useful if one or several pilots could be selected to test the absolute cap-setting approach(es) to be used in the national system from not only technical aspects but also social and political aspects. To ensure that the testing is useful to the national system design, it is preferable that the pilots selected are comparable to the national system in key aspects, such as sectoral coverage.

In case the absolute cap-setting approach is used in the national system, policy tools need to be established to address possible serious surpluses or shortages of allowance supply, which may be caused by many unexpected situations, including a downturn of economic development and poorly designed mitigation targets. Such policies include possible allowances auctions with a price floor, sale of allowances with fixed prices, and reserved allowances for new entrants to address shortage of supply, as well as market stability operations, allowance banking, and long-term stability/predictability in terms of system design to address possible short-term and long-term oversupply of allowances. It should be noted that none of these policies is currently available in China's national system, although some of them, for example, auction and allowances banking, are mentioned in the interim management rules or have been intensively discussed.

To facilitate the acceptance of the transition by all major stakeholders, especially those that are particularly concerned about economic development, the absolute cap should at the beginning be set at a relatively loose level and strengthened gradually through various means. The most important consideration should be to make a start on the transition process to an absolute cap, rather than focus on establishing a very tight absolute cap, because to strengthen an absolute cap is usually easier than to transition from an intensity cap to an absolute cap.

In terms of the timelines for such a transition, a two-stage process could be proactive as well as feasible. In the first phase, 2026–2030, the national system's actual emissions cap will be affected by both an intensity-based cap and an absolute control cap. If the intensity-based cap to be determined by the allocation approaches is not higher than the absolute control cap, the actual cap will be determined by the intensity cap. Otherwise, the allocation approaches will be adjusted to reduce the intensity-based cap to the absolute control cap level; in this case, the actual cap will be determined by the absolute control cap. During this period, most major emitting sectors will still be in the process of making efforts to achieve the carbon-peaking target, which will make the precise projection of the ETS covered emissions and China's total emissions very difficult; thus, the control cap should not be established directly with a top-

To make the division of mitigation responsibilities between the ETS sectors and non-ETS sectors more equitable and thus minimize the total mitigation costs of the whole country, mitigation potential and costs at the sectoral level must be analyzed carefully.

down approach connecting it to China's total national emissions. Considering the fewer uncertainties related to sectoral projections, a more feasible approach could be to establish an emissions cap for each covered sector and to get the system's control cap by aggregating the sectoral caps. The sectoral caps will reflect the mitigation contributions each sector is expected to make to facilitate the achievement of national mitigation; thus, there will be an indirect connection between the aggregated control cap and the national mitigation target. In the second phase, the period after 2030, as China will have already reached its carbon peaks, it should be relatively easier to predict the sectoral and national emissions trajectories, based on which an absolute cap derived directly from the national mitigation target could be established. To make the division of mitigation responsibilities between the ETS sectors and non-ETS sectors more equitable and thus minimize the total mitigation costs of the whole country, mitigation potential and costs at the sectoral level must be analyzed carefully.

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