THE GUANGDONG CARBON EMISSIONS TRADING SCHEME: PROGRESS, CHALLENGES AND TRENDS

HARVARD PROJECT ON CLIMATE AGREEMENTS

Supported by Energy Foundation China

In Collaboration with the Research Center for Climate Change, Guangdong University of Technology

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RESEARCH CENTER FOR CLIMATE CHANGE, GUANGDONG UNIVERSITY OF TECHNOLOGY

The Research Center for Climate Change, Guangdong University of Technology (GDUT-RCCC) promotes low-carbon and green development and provides technical consultancy and research support on climate change. With extensive background in environment, mechanics, statistics, transportation, and economics, the GDUT-RCCC team includes approximately 30 professionals in three institutes, specializing in low-carbon strategy and policy, carbon markets, and low-carbon technologies, respectively. Researchers are currently studying, among other topics, allowance allocation and the MRV system of the Chinese national and the Guangdong provincial carbon market; a low-carbon city development index system; and carbon-emission-peaking theory. GDUT-RCCC's clients include agencies of the Chinese central government and of provincial and municipal governments — and some international governmental bodies and non-governmental organizations.

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THE GUANGDONG CARBON EMISSIONS TRADING SCHEME: PROGRESS, CHALLENGES AND TRENDS[1]

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1. INTRODUCTION

Guangdong Province ranks first in economic output among China's provinces: its total GDP, which exceeded 10 trillion RMB (equivalent to around $1.6 trillion) in 2019, accounts for about one-tenth of that of China as a whole and is comparable to the total GDP of developed countries such as Canada and South Korea. Levels of economic development vary significantly across different regions within the province, with the Pearl River Delta region, which accounts for 30% of Guangdong's land area, producing more than 80% of GDP.

Overall energy efficiency in Guangdong is at an advanced level in China: with secondary industry (mainly refers to manufacturing, power and construction industries) accounting for nearly 40% of the province's economic output, energy consumption per unit of GDP remains the second lowest in the country, behind only that of Beijing, which is dominated by the service industry. Guangdong's primary energy consumption structure is relatively balanced: as the proportion of traditional fossil energy has declined, the contribution from clean energy sources such as natural gas, nuclear energy and renewable energy has gradually increased to 40%. For the 13th Five-Year Plan period (2016–2020), the central government assigned Guangdong Province the most stringent energy conservation and emission reduction targets in the country. With the introduction of China's pledge to achieve carbon neutrality by 2060 and its approaching 2030 target for reaching peak carbon emissions, Guangdong, as a relatively developed province, is expected to shoulder even greater responsibility for emissions reductions. In general, Guangdong has a relatively developed economy, a low-carbon industrial and energy structure, and a relatively high level of energy-use efficiency, but the problem of unbalanced and insufficient development remains significant. Thus, the cost of further emission reductions will be relatively high.

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In response, Guangdong Province introduced a market-based mechanism to help achieve its emission reduction targets at a low cost. Guangdong's carbon emissions trading scheme (ETS) pilot was officially launched at the end of 2013 and has now entered its eighth compliance year. The Guangdong ETS now includes companies with annual CO_2 emissions of more than 20,000 tons in six industries: electric power, cement, steel, petrochemical, paper-making, and civil aviation. The number of companies is about 250, covering about 65% of Guangdong's CO_2 emissions. Through continuous innovation, the province has gradually established a complete, open, transparent and efficient carbon emission management system and ETS, with a volume of allowances that ranks among the top in the world. Guangdong's system enjoys good compliance, supports active allowance trading, and has produced remarkable emission reduction effects.

2. KEY ELEMENTS AND CHARACTERISTICS OF GUANGDONG ETS

2.1 Open and transparent policy system

The Guangdong ETS has established a hierarchical, science-based, standardized, open and transparent policy and regulatory system. In 2013, the Guangdong Provincial People's Government issued the "Guangdong Carbon Emissions Trading Pilot Work Plan," which provided a general layout and guiding principles for the development of the pilot trading system. Guangdong then promulgated "Guangdong Carbon Emission Management Trial Measures" as a general management document to clarify the carbon emission reporting and verification system, allowance management system, and trading system, as well as supervision and management and other relevant provisions. According to the framework provided by these documents, the competent authorities formulated "Implementation Rules for Carbon Emission Allowance Management" and "Implementation Rules for Carbon Emission Information Reporting and Verification of Guangdong Enterprises" as supporting documents; authorities also formulated an "Implementation Plan for Annual Carbon Emission Allowance Allocation in Guangdong Province" (which included a list of the covered enterprises), "Guidelines for Carbon Dioxide Emission Information Reporting of Guangdong Enterprises" and "Carbon Emission Verification of Guangdong Enterprises."

Guangdong has been committed to creating an open, transparent and predictable market environment for carbon trading, and among pilot regions it has taken the most effective steps toward information disclosure by making the above-mentioned policy documents available in full to the public over the years. Using this information, enterprises can calculate their carbon emissions, free allowances, and current-year profits and losses from allowances (based on annual production and operation plans), and reasonably arrange their production and carbon emission management activities while developing carbon asset management strategies to maximize the cost-effectiveness of their emission-reduction efforts. This open and transparent policy system has significantly enhanced confidence among enterprises that participate in emissions trading and improved the stability and predictability of the Guangdong ETS.

2.2 Multi-party participation in the carbon market management system

In the process of developing its ETS, Guangdong has gradually established a management system that is led by the government but involves many parties.

The government coordinates and manages the ETS pilot project. Under the guidance of the Leadership Group of Guangdong Province for Addressing Climate Change, Energy Conservation and Emission Reduction and the Joint Conference of Guangdong Province National Low Carbon Province Pilot, the Department of Ecology and Environment of Guangdong Province is specifically responsible for organizing, implementing, coordinating, and supervising the trading pilot. A two-level provincial and municipal management mechanism has been implemented, and a Guangdong Provincial Carbon Emission Permits Management and Trading Working Group was set up, with personnel drawn from relevant supporting research institutions, to carry out research and implement the ETS.

Stakeholder participation has been promoted at the institutional level.

- **First,** a provincial allowance review committee was established. The core document of the ETS, the allowance allocation plan, had to be reviewed and approved by the allowance review committee before it could be submitted to the provincial government for approval and issued for implementation. The allowance review committee is composed of representatives from relevant government departments, experts and scholars in related research fields, and industry associations and enterprises (more than two-thirds of members are experts and scholars).
- **Second,** a technical evaluation group was established to evaluate the allowance plan. This group is responsible for collecting opinions from a wide array of enterprises, providing timely feedback to competent authorities and making suggestions on allowance management. The technical evaluation group is composed of industry associations, enterprise representatives and research institutions.
- **Third,** a systematic and comprehensive training program has been conducted every year. As part of this program, Guangdong organizes training for local government authorities, covered enterprises and verification agencies to improve the basic capacity of all market participants and to hear opinions and suggestions from all parties on the ETS. Since the early development of the Guangdong ETS, more than 8,000 personnel have received training.
- **Fourth,** the competent authorities organized symposiums. At key decision points during planning and preparation for the pilot program, opinions and suggestions from industry associations, enterprises, research institutions and investment institutions were solicited, in a timely way, through these symposiums.

- Institutionalizing and normalizing this mechanism for democratic supervision and consultation not only effectively supported competent authorities as they considered the demands of various stakeholders in the policy formulation and implementation process, thereby guaranteeing the fairness and scientific nature of decision-making, it also greatly reduced the space for free exercises of discretion by competent authorities and played an important role in reducing the risk of administrative corruption.

Research institutions have provided systematic technical support for the ETS. The ETS involves interaction and coordination among various market participants: For example, the effectiveness and cost of the monitoring, reporting and verification (MRV) mechanism, which is highly correlated with the allowance allocation method, need to be balanced. This balancing requires applying principles of game theory to interactions between government, enterprises and third-party verification agencies, since the allowance allocation method has potentially differentiated impacts on different stakeholders. Thus, a research institution that is relatively independent from the above-mentioned parties needs to design the mechanism to achieve the desired balance between policy effects, technical optimization and the interests of relevant parties. Guangdong tasked a research institution that is relatively independent from the government, enterprises and verification agencies with:

1. supporting the design of the market mechanism and managing technical aspects of the carbon market;
2. assisting the competent authorities in carrying out macro-situation research and scenario analysis;
3. predicting how implementation of the MRV system and allowance allocation methodology would affect the market, industries and individual enterprises; and
4. developing a proposal that balances policy effects and implementation costs for competent authorities to reference in their decision making.

2.3 Strict and meticulous data quality assurance system

A strict and meticulous system for reporting and verifying information about enterprise carbon emissions is a cornerstone of Guangdong ETS.

Regarding data management:

- **First,** an industry reporting technical expert group was set up to provide a channel for answering questions about relevant issues during the enterprise reporting process and to reduce errors in reporting.

- **Second,** the verification and audit of enterprises needs to be 100%: 100% verification of enterprise report data and 100% expert audit of verification results. Enterprises for which problems are found during the audit process will be re-verified; enterprises for which no problems are found will be randomly sampled, and a certain percentage will also be re-verified. After re-verification, a second expert audit will be conducted until all problems were resolved.

Regarding the management of the verification agency:

- **First,** government funding was used to commission the verification, a list of domestic third-party verification agencies was assembled through a public bidding process, and verification costs were centralized through the provincial finance department to ensure that the verification results were objective, independent and impartial.
- **Second,** the verification requirements were clear, the verification agencies were systematically trained before conducting the verification, the verifiers were required to be licensed, and the verification agencies were required to establish an internal technical audit system.
- **Third,** a system for blacklisting verification agencies and a performance assessment mechanism were established, emissions report verification performance assessment was conducted (according to "Guangdong carbon emissions information verification work management assessment methods"), assessment results were made available to the public, and agency rankings were directly tied to verification qualifications and task allocation, with the understanding that major technical errors or violations could trigger inquiries and warnings, and that serious cases could result in agencies being blacklisted or disqualified from verification.

2.4 A stringent, yet flexible, guided compliance mechanism

The Guangdong ETS compliance mechanism is mainly based on guidance and supplemented by penalties, with multiple measures taken into consideration to ensure timely compliance by enterprises. The compliance mechanism includes three types of measures:

- **First** are incentive measures. According to the "Guangdong Carbon Emission Management Trial Measures", enterprises that have fulfilled their responsibilities will be prioritized in national efforts to support low-carbon development, energy conservation and emission reductions, renewable energy development, sustainable economic development and other objectives, including through projects or financial support.

- **Second** are communication and guidance measures. Guangdong attaches great importance to communicating with enterprises and avoids relying solely on coercive force to ensure compliance with the carbon market. When enterprises face compliance difficulties, the competent authorities and the carbon trading working group communicate and coordinate with the enterprises to understand their practical difficulties and formulate suggestions to assist them. If communication with local and municipal authorities is ineffective, provincial departments conduct interviews with affected enterprises to guide them to achieving full compliance. Penalty procedures are implemented only when communication and coordination measures remain ineffective.

- **Third** are punishment measures. Such measures include fines for enterprises that fail to comply on time and for misrepresentation or concealment of data and other violations. Fines can be doubled in the future depending on the degree of noncompliance; other penalties can include announcing and disclosing corporate violations to the public and entering them into the enterprise's credit record. Under a financial credit information reporting agreement between the Guangdong Provincial Government and the People's Bank of China, information about enterprises with major violations can be entered directly to the financial credit system of the central bank; a bad credit record would then directly affect access to financing for these enterprises. Under this stringent yet flexible guided compliance mechanism, Guangdong has achieved 100% compliance with its carbon trading system since the launch of the pilot program more than seven years ago—a record that provides strong assurance that its carbon market will achieve emission reduction targets.

2.5 Continued innovation to develop a hybrid paid and free allowance allocation system

Since its inception, the Guangdong ETS has used a combination of paid and free allowance allocation and it is the first of China's domestic carbon market pilots to implement institutionalized allowance auctions.

Regarding the paid portion of the allowance allocation: Guangdong continues to explore various bidding price mechanisms starting from an initial fixed reserve price and transitioning to a tiered reserve price (in which each auction gradually increases the reserve price). This mechanism has been further optimized to incorporate a floating reserve price (i.e., the policy reserve price, which is based on the average transaction price in the secondary market three months before allowances are issued by auction) that aims to create a linkage between primary market and secondary market transaction prices, and gradually realize the benefits of price discovery and market linkage. As of March 2020, Guangdong had organized 18 auctions of paid allowances, which had generated auction revenues in excess of RMB 800 million. These auctions improve enterprises' understanding of "scarce resources and valuable use" of carbon emission allowances;

auction revenues have also been used to provide financial support for low-carbon development in Guangdong Province.

For free allocation, Guangdong considers efficiency and fairness, and mainly relies on the benchmarking method, but also applies emissions-based and intensity-based grandfathering methods. The aim is to gradually allocate all free allowances using the benchmarking method. In the early period of Guangdong's pilot system, enterprises with single products and comparable production processes, such as electricity power generation and cement production, were selected for initial implementation of the benchmark method. These enterprises account for about 60% of all covered emissions in the province; the grandfathering method was applied to remaining enterprises. In 2015, after two years of data accumulation, coal-fired cogeneration units with established operations and a relatively large share of emissions were selected and their allowance allocation was optimized from the emissions-based grandfathering method to the benchmarking method.

In 2016, Guangdong extended the benchmarking method for combined heat and power (CHP) units to gas-fired CHP units, and adopted the same benchmarks as those for pure generation units. Allowance allocation for newly incorporated papermaking and civil aviation enterprises is also based on the benchmarking method. In 2019, the benchmark applied to the steel sector was optimized from four to seven subdivisions. Overall, the scientific basis for allowance allocation has been further enhanced. At the moment, the benchmarking method is being applied to enterprises that account for around 90% of all covered emissions. Benchmarks for each industry are set with reference to advanced examples within the industry, and the benchmark values for many industries—such as electricity, cement and papermaking—are continuously adjusted downward in subsequent compliance years to gradually increase pressure on enterprises to further reduce emissions and to prompt efforts to accelerate the low-carbon transformation.

2.6 Pre-issuance of allowances and limited approval systems that achieve control of emissions and reduce impacts from economic fluctuations

In 2020, the cap of the Guangdong ETS was 465 million tons, including allowances for covered enterprises and reserve allowances. The total volume of allowances was set using a mix of top-down and bottom-up methods, taking into account local emission reduction targets, economic development trends, industry composition and other factors. The aim was not only to put pressure on enterprises to reduce their emissions, but also to meet reasonable needs for enterprise growth and major project construction, thereby ensuring the healthy and sustainable development of the Guangdong ETS.

To ensure that the overall emissions target is achieved and that carbon intensity decreases every year, the Guangdong ETS includes a mechanism for pre-issuing allowances and controlling the impact of macroeconomic fluctuations by keeping the total volume of allowances within a certain range through a production-capacity cap.

First, pre-allowances are issued at the beginning of the compliance period according to the enterprise's production in the previous year. Actual production by the enterprise in the current year is then determined at the end of the compliance period using verified results, and a final allowance volume is approved according to the benchmark for that type of enterprise. If the final allowance volume exceeds the pre-allowance amount, additional allowances are refunded to the enterprise. In the reverse case, excess pre-allowances are returned to the allowance reserve. Allowances can also be replenished from the reserve so that there is no increase in the overall volume of allowances. Actual production by enterprises is limited by a production capacity "ceiling." For example, the steel industry's pig iron and crude steel production, for purposes of calculating the industry's allowance, cannot exceed the approved capacity for these enterprises. These measures act as buffer against the impact of economic fluctuations that could otherwise lead to excessive allowance shortages or surpluses. In this way, they reduce the negative impact of macroeconomic uncertainty on the emissions trading market and help achieve a certain degree of balance between controlling overall emissions versus controlling emissions intensity.

3. SUMMARY OF RESULTS FROM THE IMPLEMENTATION OF THE GUANGDONG ETS

3.1 Since the beginning of the carbon market: absolute emission reductions with consistent scope of coverage

In recent years, Guangdong has continued to improve its carbon trading system and optimize its methods for allowance allocation. Results in terms of emissions reductions by covered enterprises have been remarkable. A comparative analysis of compliance data from the Guangdong ETS in 2013, when it was launched, and 2019 reveals that, during this period, total carbon emissions from Guangdong's secondary industries increased by only 3.1%, and carbon emissions per unit of GDP fell significantly, by 21.6%. Under the premise that the scope of the market, in terms of covered enterprises, was consistent from 2013 to 2019, the province's electricity, cement, iron and steel, and petrochemical enterprises achieved absolute emission reductions of 12.3%, effectively slowing the rise in total emissions from secondary industries. The implementation of the ETS has put greater cost pressure on producers that have not modernized their operations and pushed these enterprises to gradually exit the market. Since being incorporated into the carbon market, 66 enterprises have chosen to shut down or suspend their production, or have reduced their operations and emissions to below the control threshold. The total annual emissions for these enterprises reached 14.8 million tons. The implementation of the ETS has effectively advanced Guangdong's goal of eliminating inefficient production capacity and achieving energy conservation and emission reduction targets.

3.2 Active market transactions and increased awareness of enterprise carbon asset management

Guangdong's trading program has steadily ranked first among China's various pilot carbon markets. As of March 26, 2021, a total of 175 million tons of emission allowances have been

traded (spot transactions) in Guangdong's pilot market, with a total transaction amount of RMB 3.646 billion. Based on these figures, the province accounts for 38.8% and 34.7% of total allowance volume and transaction amounts for China's seven pilot programs, firmly in first place. Guangdong is also the first and currently the only pilot market in China where spot trading has exceeded 100 million in allowance volume and RMB 3 billion in transaction amount. In 2020, trading volume was up by 2,469% compared with the early stage of the pilot launch (in 2014), and allowance prices were 419.9% higher compared to the lowest price seen in the program's history—indicating a positive trend in market development as measured by trading activity and rising volume and price for traded allowances. Even during the COVID pandemic, the Guangdong ETS showed modest resilience and was less affected in general by the pandemic, with year-on-year carbon prices rising by 35.9% in 2020. In recent years (2019–2020), the volume of spot trading in the Guangdong ETS has exceeded that in the European Energy Exchange (EEX) over the same period, ranking among the top in the world. The positive development of the Guangdong ETS has attracted attention from a wide range of investment institutions within and outside the province and abroad. Trading by institutional investors accounts for more than 70% of the total trading volume. As a main driver of trading, investment institutions are playing a beneficial role in promoting price stability in the Guangdong ETS and are enhancing the role of the carbon market in bringing about emission reductions.

Incentives for enterprises to participate in carbon trading and carbon asset management have increased significantly. In recent years, the concentration of trading activity near the end of the compliance period has tended to decrease, from a few concentrated trading peaks over a short period at the beginning of the pilot launch to a number of smaller trading peaks distributed across the entire compliance period. This is an indication that trading behavior in the carbon market is becoming increasingly mature. Most enterprises have moved from passive acceptance of the carbon market to active enhancement of their emission reduction activities, submitting allowances and certifying emission reductions on the system in advance to demonstrate compliance. The province's compliance rate has remained at 100% for many years.

4. CHALLENGES AND PROSPECTS FOR THE GUANGDONG ETS

4.1 Further optimization of allowance allocation methods for complex industries

The gradual transition from free allocation based on emissions-based grandfathering to benchmarking methods for allocation is a common trend in major international carbon markets. Benchmarking methods often require more refined data to establish a comparable product benchmark. This can be a significant challenge for industries with high product variability and complex relationships among energies and raw materials. Enterprises with these characteristics in Guangdong Province are mainly in the steel and petrochemical industries. Petrochemical enterprises have different refining and product structures, and the length of the process chain can be different as well. Steel enterprises make multiple types of products,

with complex operations, such as single processes that generate multiple products. Further, one process may simultaneously use energy and also supply energy to another process in the manufacturing network — inputs and outputs are linked with other processes (e.g., blast-furnace gas, coke-oven gas, converter gas, etc.). There is some uncertainty in monitoring the output and usage of these gases in each process and calculating their corresponding heat value; in addition, it can be difficult to accurately classify corresponding energy/material inputs according to the products generated. This makes it tremendously challenging to reasonably and accurately calculate carbon emissions per unit of product as the basis for industry benchmarking. For this reason, allocations for the petrochemical industry in the Guangdong ETS have been based on the emissions-based grandfathering method. For the steel industry, the benchmarking allocation has gradually been refined from four products to seven products, and the application of the benchmarking method has been further expanded, with more scientific classification of products and processes and greater comparability of enterprises. However, the emissions-based grandfathering method continues to be used to allocate allowances for the rolling and processing of steel products. The next step will be to further study data monitoring and allowance allocation methods for complex industries, gradually expand the application of the benchmarking method, and improve the scientific integrity and fairness of allowance allocation.

4.2 Further enhancement of the data quality assurance system

While encouraging enterprises to measure parameters related to emissions, resulting regulatory costs must be weighed and MRV requirements should be gradually transitioned from pre- and post-operational oversight to oversight during operations. Learning from domestic and international carbon market best practices, the parameters used to calculate carbon emissions mainly include activity data and emission factors. Activity data must be measured by enterprises, while emission factors can generally be used to provide default values and enterprises can choose to employ actual measurement methods.

This is also the case for the Guangdong ETS. For activity data, China has established a relatively mature data quality control system based on legal and technical documents, regulations and systems for calibrating measurement instruments, and inspections and penalties for violations. The Energy Conservation Law was promulgated to address energy data measurement issues. It includes implementing regulations and technical support standards, such as the requirement that key energy-consuming enterprises must be equipped with measuring instruments of specific accuracy (according to technical standards) and with energy management systems for external assessment. The law also establishes provincial, municipal and county-level energy conservation monitoring systems, which require supervised enterprises to comply with energy conservation requirements and regulations as well as mandatory technical standards, etc.

For emission factors, Guangdong encourages actual measurement as a way to better reflect real emissions from enterprises, but this approach can also increase the risk that enterprises make false statements and gain from irregularities. To address this concern, Guangdong has established a relatively complete system for data quality control (pre- and post-operational oversight)

that involves clear methods and rules for actual measurement, third-party verification, expert auditing, and sample review. It has been recommended that the province further complement its operational data quality oversight measures and strengthen its supervision of enterprises' emissions-related data monitoring throughout the year. For example, Guangdong could promote the establishment of management systems in accordance with international standards (such as ISO/IEC 17025, etc.) and improve its documentation of the monitoring process, explore the establishment of an unannounced inspection system for enterprises, conduct sampling and data verification of energy- and carbon-containing materials from time to time during the compliance period, explore the establishment of an online carbon dioxide monitoring system with continuous monitoring of enterprises throughout the year, and compare results from monitoring with results obtained using the calculation method to improve data quality.

4.3 Expanded industry coverage

Expanded industry coverage will not only benefit the Guangdong ETS, it will also help the province meet targets for peak carbon emissions and carbon neutrality. When the Guangdong ETS was first established, it was planned to include industrial sectors such as electric power, cement, iron and steel, ceramics, petrochemicals, textiles, non-ferrous, plastics, papermaking, and transportation and construction. These industries were to be added in batches and phases. At present, six industries, namely electricity, cement, iron and steel, petrochemical, papermaking and civil aviation, have been included in the carbon market, which has been fully operational for more than 8 years. Thus, the basic conditions exist for expanding coverage to further industries. Expanded coverage will help further reduce the overall cost of emissions reductions from covered enterprises, increase the liquidity of the carbon market, reduce carbon leakage, stabilize carbon prices, and thereby enable the province to achieve emission reduction targets at a lower cost. In addition, under President Xi Jinping's proposed goal of "peaking carbon emissions by 2030 and achieving carbon neutrality by 2060," Guangdong, as an economically important province, should strive to be at the forefront of the country. As a policy tool to promote low-cost emissions reductions, the carbon market is helping to achieve Guangdong's carbon goals; expanding its coverage would allow the market to play a greater role in promoting emissions reductions.

A variety of factors need to be considered for the specific industries to be included in the near future; these factors include the volume of emissions, industry trends, management costs, affordability to the enterprise, and the technical difficulty of allowance allocation. **At present, candidates for new industries or sectors to be covered include data centers, ceramics, textiles, transportation and construction, among others.** These industries or sectors are experiencing larger or faster growth in carbon emissions, and also share certain characteristics common to the province.

- **Data centers are an emerging source of emissions in Guangdong,** with high electricity consumption and large indirect emissions. This industry is expected to grow substantially in the future, generating a volume of emissions that is expected to reach 10 million tons per year—thus, the necessity and urgency of incorporating data centers into the emissions control system is high.

- **Ceramics** is another typical industry in Guangdong Province (the province accounts for about one-fifth of national ceramic production), accounting for about 7% of the province's total carbon emissions. However, the ceramics industry is dominated by small and medium-sized enterprises whose individual emissions are lower than those of incorporated industries—thus management costs for including these enterprises can be relatively high.

- **The textiles industry** is similar to the ceramics industry: it mainly consists of small and medium-sized enterprises, process differences between these enterprises are large and therefore the management costs, allowance allocation, and technical difficulties associated with including these enterprises are relatively high.

- **Transportation and construction** account for almost a quarter of the province's total carbon emissions (the latter mainly refers to emissions caused by energy consumption during the daily operation of buildings after they are built).With emissions growing fast, the inclusion of these sectors will be important for achieving the peak emissions target in Guangdong Province. At the same time, the transportation and construction sectors in Guangdong share strong commonality with these same sectors in Hong Kong and Macao. This will help provide a basis for establishing a carbon trading market that covers the entire Guangdong-Hong Kong-Macao Greater Bay Area. However, individual emissions sources within these sectors are also more fragmented, with each source generating a relatively small volume of emissions and fragmented management, ownership and use rights. These factors usually work against the determination and management of emission control responsibilities.

In general, there are compelling reasons to include these candidate industries and sectors in the carbon market, but because there are still certain challenges the recommended approach would be to steadily push forward, gradually incorporating additional sectors and industries one at a time as the market matures.

5. CO-ORDINATION BETWEEN THE GUANGDONG ETS AND THE NATIONAL ETS

5.1 Inclusion of Guangdong's electricity industry in the national carbon market

A total of 85 enterprises in Guangdong's power industry are expected to be included in the national ETS. According to the division of unit types in the national ETS, the province has 31 enterprises with conventional coal-fired units larger than 300 megawatts (MW), 22 enterprises with conventional coal-fired units 300 MW or smaller, 6 enterprises with non-conventional coal-fired units (such as coal gangue, coal slurry and water-coal slurry units), and 26 enterprises with gas-fired power generation. Among these 85 enterprises, 65 were originally included in the Guangdong carbon trading market. Once the national market is officially launched, these enterprises will withdraw from the Guangdong pilot program and be covered under the unified national trading system for power sector carbon emissions.

When Guangdong's electricity enterprises are incorporated in the national carbon market, the bigger uncertainty factor they will face is the interface between their allowances in the provincial pilot program and their allowances in the national carbon market. Some enterprises have achieved allowance surpluses in the Guangdong ETS by implementing energy saving technology improvements, carbon asset management and other means. However, there is no clear national policy on whether these surplus allowances can continue to be used in the national carbon market after the enterprises are included in the national market. This creates a certain degree of uncertainty concerning future policies. Compared with the larger volume of allowances in the national carbon market, the volume of surplus allowances in the Guangdong pilot market is relatively small. Their impact on the national market can be significantly reduced by means of a phased carry-over, use restrictions (in the form of ratio/use or volume/use limits per compliance period), discounted carry-over, or a combination of the above. Therefore, it is suggested that the national authorities give due consideration to carrying over remaining allocation allowances from the pilot programs to the national program in ways that avoid affecting the smooth operation of the national program and that reduce the impact of remaining allowances from the pilot programs by applying several of the auxiliary measures mentioned above.

5.2 Preparation for the inclusion of industries that are not part of the national carbon market in Guangdong's trading program

Once the national carbon market is operating, Guangdong should further deepen and improve the work of its regional carbon market. In this way the province can continue to pilot approaches that will be useful for the national market and enhance basic carbon trading capacity for all emissions sources. In the area of MRV, for example, Guangdong should actively promote the gradual convergence of its emission reporting requirements for industries that are not included in the national carbon market with national requirements, strengthen the data monitoring capacities of enterprises and further standardize emission reports, verification

personnel, verification agencies, verification processes and other related requirements. In terms of allowance allocation, Guangdong should continue to optimize and improve its allocation methods, extend the benchmark method to cover a greater proportion of emissions sources, further enhance the scientific basis for and fairness of allowance allocations, and accumulate more useful experience for the inclusion of these industries in the national market in the future. In terms of capacity building, Guangdong should continue to conduct training for government departments, enterprises and verification agencies to enhance the ability of all parties to participate in the carbon trading system. The province also plans to assemble talent teams and cultivate professional service organizations related to carbon emissions and carbon asset management. These will provide a useful base for serving Guangdong enterprises when they are eventually included in the national carbon market.

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