Driving Technological Upgrading through Carbon Markets, Turning Green into Gold[1]

Guangdong's Four-Pillar Approach to Corporate Emission Reduction and Low-Carbon Technology Deployment

Abstract: Against the backdrop of the steady expansion of China's unified national carbon market, Guangdong has established an integrated four-pillar regional carbon market system featuring coordinated operation among government authorities, the trading market, enterprises, and green finance. The province stabilizes carbon price signals by dynamically adjusting covered sectors, applying differentiated allowance allocation, and linking the CCER mechanism with the Carbon Inclusive Mechanism, while relying on the Guangzhou Emissions Exchange to connect allowance trading, registration under the Carbon Inclusive Mechanism, and green technology assessment channels. Local regulated enterprises have converted carbon compliance pressure into an impetus for technical retrofits, deploying low-carbon processes such as hydrogen metallurgy and high-efficiency energy-saving furnaces to develop the potential for large-scale emissions reductions. Guangdong has also introduced an innovative online carbon allowance pledge-financing model and explored alignment with carbon market development in the Guangdong-Hong Kong-Macao Greater Bay Area. Practice shows that a tiered carbon incentive system can effectively promote the large-scale application of mature low-carbon technologies, while high-investment frontier low-carbon technologies still require coordinated fiscal and financial support, offering a reference pathway for linking emission reductions and technological innovation in China's regional carbon markets.

Keywords: carbon market, policy support, market trading, corporate innovation, financial coordination

I. Background

By putting a price on greenhouse gas emissions, carbon markets translate emission-reduction targets into tangible cost and revenue signals for enterprises and have become a core market-based policy instrument for addressing climate change and advancing the global low-carbon transition. In recent years, emissions trading systems (ETSs) have been widely established and continue to expand worldwide. As of 2026, 41 ETSs are in operation worldwide, covering approximately 26% of global greenhouse gas emissions, while the jurisdictions in which they operate account for 63% of global GDP. Their role in the climate policies of major economies continues to strengthen. China launched carbon emissions trading pilot programs in seven provinces and cities in 2011, with the regional pilots coming online successively from 2013. Building on experience from these pilots, China launched the national carbon market in 2021 and the national voluntary greenhouse gas emission reduction trading market in 2024. In 2025, the national carbon market was further expanded to cover the steel, cement, and aluminum smelting sectors. Following this expansion, it covers more than 60% of China's carbon emissions, further strengthening the carbon market's role in supporting cost-effective emission reductions and the green and low-carbon transition of key sectors.

[1] Case provided by CCICED Special Policy Study on *Innovation in Green Financial Products and Services to Support Carbon Market Development*

Guangdong Province, as a major manufacturing and export-oriented economy in China, faces the dual pressures of economic growth and carbon emission reduction. Guangdong's carbon emissions trading program began operations in 2013 and explored an auction mechanism for paid allowance allocation. The Guangdong pilot is the most liquid regional carbon market in China and has long served as a market-based testing ground for mature emission-reduction technologies. In recent years, however, as China's national carbon market expanded and the steel and cement sectors were transferred in phases, carbon prices continued to weaken and the market's capacity to incentivize frontier technologies contracted further. Against the dual backdrop of linking with China's national carbon market and deepening paid allowance allocation, Guangdong's carbon market has developed a coordinated four-pillar system integrating government regulation, market trading, corporate practice, and green finance. This dual-track framework, combining a mandatory compliance market with voluntary emission reductions under the Carbon Inclusive Mechanism and coordinating with carbon finance and green technology trading platforms, has guarded against weakening carbon price signals while effectively converting allowance constraints into drivers of corporate emission reduction and low-carbon technological innovation.

II. Key Measures

(1) Government Regulation: Dynamically Improving Coverage, Allowance Allocation, and Compliance Management while Balancing Emission-Reduction Constraints and Market Stability

First, implement differentiated allowance allocation and strengthen carbon cost constraints and market regulation through paid allowance auctions. Guangdong combines free and paid allowance allocation. Based on sector-specific technological characteristics, product structures, and emission-reduction conditions, it applies the benchmarking method, the historical emissions intensity method, and the historical emissions method, and gradually tightens constraints through annual reduction factors and the share of allowances allocated free of charge. On the basis of free allocation, Guangdong was among the earliest regional carbon markets in China to introduce a paid allowance auction mechanism. Paid allowance auctions are organized in light of carbon market conditions and enterprises' allowance surpluses and shortfalls, and enterprises may participate voluntarily according to their compliance needs. By allocating a portion of allowances through market-based auctions and adjusting the supply of paid allowances in response to market conditions, the mechanism helps strengthen enterprises' awareness of the scarcity of carbon emission resources and the principle of paying for their use, while providing a supplementary tool for regulating market supply. The combination of differentiated, gradually tightening allowance allocation and paid allowance auctions reflects differences in emission-reduction conditions across sectors while enabling enterprises to form relatively stable expectations regarding carbon costs.

Second, link the CCER mechanism with the Carbon Inclusive Mechanism to establish market-based reward channels for voluntary emission-reduction and low-carbon innovation projects. Guangdong allows regulated enterprises to use China Certified Emission Reductions (CCERs) and Guangdong Provincial Carbon Inclusion Certified Emission Reductions (PHCERs), in accordance with applicable rules, to offset part of their actual emissions. Project owners of eligible low-carbon technology application and business-model innovation projects may apply for project registration and emission-reduction registration. Following quantification, verification, and registration, the emission reductions become tradable CCERs or PHCERs and can generate revenue through sale. In this way, the compliance demand of regulated enterprises is converted into market demand for voluntary

emission-reduction projects such as renewable energy and forestry carbon sinks, enabling innovative emission-reduction outcomes to receive revenue rewards in addition to allowance allocation.

Third, dynamically adjust the scope of regulation to align with the expansion of China's national carbon market. As China's national carbon market expands, Guangdong has correspondingly adjusted the coverage of its regional market by bringing sectors such as ports and data centers under management, while continuing to manage certain steel and cement enterprises that are not included in the list of key emitting entities under China's national carbon market[2]. In 2025, the Guangdong regional carbon market covered eight sectors, with an inclusion threshold of 10,000 tonnes of CO_2 emissions per year, thereby providing supplementary management for sectors and enterprises not yet covered by China's national carbon market.

Fourth, optimize the management of historical allowances and enterprise surpluses and shortfalls to cushion the supply-demand impact of the expansion of China's national carbon market. Guangdong freezes a portion of the historical allowances allocated free of charge to existing regulated enterprises and unfreezes them as needed for compliance, while converting the historical allowances of enterprises exiting the regional market into special allowances or releasing them in phases. From 2025 onward, enterprises with compliance emissions below 3 million tonnes and those with compliance emissions at or above 3 million tonnes are subject to surplus or shortfall ratio caps of 20% and 15%, respectively, in order to reduce the impact of concentrated releases of accumulated allowances on market supply, demand, and prices.

Fifth, improve emissions verification, compliance supervision, and interdepartmental coordination to ensure the effective enforcement of carbon constraints. Guangdong aligns the level of data used in emissions reporting and verification with that used for allowance allocation, conducts reviews on the basis of enterprise reporting and third-party verification, and promotes the inclusion of the compliance rate and allowance surrender rate of enterprises in the regional market in relevant provincial assessments.

(2) Trading Market Operations: Facilitating Price Formation, Emission-Reduction Revenues, and Technology Commercialization to Support and Incentivize Low-Carbon Innovation

First, introduce diverse market participants and connect primary and secondary markets to facilitate allowance circulation and reasonable price formation. Adequate market liquidity is a prerequisite for the stable transmission of carbon price signals and, in turn, for incentivizing enterprises to pursue low-carbon technological innovation. The Guangzhou Emissions Exchange provides trading services to regulated enterprises, institutional investors, individuals, and owners of voluntary emission-reduction projects. Participation by diverse entities helps improve allowance circulation and market activity. As of mid-2026, cumulative trading in Guangdong allowances totaled approximately 234 million tonnes, with a transaction value of about RMB 6.8 billion. Enterprises may currently participate in paid allowance auctions in the primary market as well as trade in the secondary market. Based on market conditions and forecasts of enterprise allowance surpluses and shortfalls, the exchange prepares analytical reports to inform decisions on whether to organize paid allowance auctions.

[2] https://www.ccn.ac.cn/carbon-market/carbon-emissions-trading/8103.html



Figure 1. Guangzhou Emissions Exchange

(Source: Guangzhou Daily · New Flower City, reposted by the Guangzhou Municipal Ecological Environment Bureau; photo by Li Bo)

Second, undertake the registration and trading of emission reductions under the Carbon Inclusive Mechanism to establish market-based incentive channels for small and medium-sized emission-reduction projects and mature low-carbon technologies. In addition to operating Guangdong's allowance market, the Guangzhou Emissions Exchange also undertakes the registration and trading of emission reductions under the Carbon Inclusive Mechanism at the provincial and Guangzhou municipal levels. Guangdong Provincial Carbon Inclusion Certified Emission Reductions may be used, in accordance with applicable rules, as offsets for compliance in the Guangdong carbon market; voluntary emission reductions under Guangzhou's municipal Carbon Inclusive Mechanism are mainly used for voluntary carbon neutrality by institutions, events, and individuals. Eleven methodologies have been developed to date, covering scenarios such as construction waste recycling, treated effluent reuse, and soil remediation, and the resulting emission reductions may be used for voluntary carbon neutrality and other purposes. Compared with the costlier national CCER mechanism, the Carbon Inclusive Mechanism is more suitable for small and medium-sized emission-reduction entities. However, because this incentive is based on emission reductions that have already been achieved and verified, it is better suited to supporting the application and diffusion of mature technologies.

Third, build a green technology trading platform and explore links among technology screening, emission-reduction assessment, and carbon asset identification to support the commercialization of low-carbon technologies. The Guangzhou Emissions Exchange recently launched a green technology trading platform focusing on regulated sectors, zero-carbon parks, energy performance contracting, and other application scenarios, and assesses the emission-reduction effects and potential carbon assets of relevant technologies. Projects covered by established methodologies and capable of generating emission reductions may be further linked to emission-reduction credit development and trading. Technologies that are not yet eligible for direct development as emission-reduction credits may first undergo preliminary evaluation, with potential carbon assets and future revenues considered as references for subsequent investment and financing assessments. The platform adds carbon emission-reduction assessment services to its existing technology and intellectual property trading infrastructure.

(3) Corporate Practice: Converting Compliance Constraints into Emission-Reduction Actions and Advancing the Application of Frontier Low-Carbon Technologies and Energy-Saving Process Retrofits

Large Petrochemical Enterprise A. Under the constraints imposed by the annual reduction factor in the Guangdong carbon market, the enterprise has cumulatively implemented more than 50 energy-saving technical retrofits, reducing CO_2 emissions by approximately 600,000 tonnes. Its "95+ High-Efficiency Ultra-Clean Industrial Furnace" technology innovation was selected as one of the National Energy Administration's Typical Cases of Energy Conservation and Carbon Reduction in the Oil Refining Industry. Through deep purification of fuel gas and optimization of heat-exchange processes among air, fuel gas, and flue gas, the project increased furnace thermal efficiency to above 95.5%. According to available data, the two upgraded furnaces can save 5,048 tonnes of fuel gas and reduce CO_2 emissions by 11,721 tonnes and nitrogen oxides (NOx) emissions by 4.18 tonnes annually, combining lower energy consumption with higher furnace thermal efficiency. The steam compression upgrading and utilization project, which was also selected, introduced centrifugal steam compressors into the petrochemical industry and adopted a "steam drum + compressor" configuration to replace conventional air cooling, further improving the unit's energy performance while generating significant economic benefits. The steam compression project generated more than RMB 120 million in economic benefits within 19 months of entering operation.[3]



Figure 2. "95+ High-Efficiency Ultra-Clean Industrial Furnace" Technology Upgrade Project
(Source: pub.timedg.com[4])

(4) Green Finance: Improving Carbon Asset Financing and Risk Safeguards to Broaden Funding Channels for Emission Reduction and Innovation in the Real Economy

First, improve carbon asset financing and circulation mechanisms to transform allowances from compliance instruments into financing resources for sustained low-carbon innovation. Since 2014, Guangdong has successively explored carbon allowance mortgage/pledge financing[5], repurchase, custody, and forward transactions. By the end of 2025, it had

[3] https://www.sohu.com/a/848204947_100116740
[4] https://pub.timedg.com/s/2025-01/14/AP67861d40e4b09ef8b576f0a4.html
[5] Carbon allowance pledge financing refers to a financing arrangement in which a holder of carbon allowances uses the allowances it owns as pledged assets or collateral to obtain a loan from a funding provider, with the pledge or

completed a cumulative 272 carbon finance transactions, with financing totaling RMB 488 million. In November 2024, Shanghai Clearing House, the Guangzhou Emissions Exchange, Hua Xia Bank, and other institutions launched online mortgage/pledge financing for Guangdong carbon emission allowances. The process uses end-to-end online applications, digital credit approval, and smart drawdowns to shorten financing application, registration, and approval procedures, providing regulated enterprises with an efficient and convenient financing channel for purchasing carbon allowances and completing allowance surrender and compliance.[6]

Second, strengthen standards, registration, and default-disposal mechanisms to reduce carbon asset financing risks and enhance the sustainability of financial support for emission-reduction projects in the real economy. Guangdong issued the local standard "Guidelines for the Implementation of Carbon Allowance Mortgage/Pledge Financing," which standardizes participating entities, allowance valuation, loan approval, mortgage/pledge registration, post-lending management, and other procedures.[7] In 2025, the Guangdong High People's Court, the Department of Ecology and Environment of Guangdong Province, and the Guangdong Provincial Branch of the People's Bank of China further clarified that carbon emission allowances may serve as lawful collateral for pledges. They established a "dual-registration" model linking the People's Bank of China's Unified Registration and Publicity System for Financing Backed by Movable Properties with the provincial trading platform, and improved default disposal through real-time allowance freezing, pre-litigation negotiation, and judicial proceedings.[8] The online financing program also introduced securities firms to assist with the trading and disposal of pledged allowances when contractually specified disposal events occur, thereby making carbon assets easier to register, control, and dispose of.

Third, strengthen cooperation among trading institutions in the Greater Bay Area and explore broader carbon market and green finance services. In September 2025, the Guangzhou Emissions Exchange, Shenzhen Green Exchange, Hong Kong Exchanges and Clearing Limited, and Macao International Carbon Emission Exchange signed a Memorandum of Understanding to explore cooperation in carbon markets and green finance, strengthen exchanges of experience and professional capacity building, and lay a foundation for future connections with regional financial institutions, technology projects, and market service resources.[9]

III. Lessons Learned

First, use multi-tiered trading mechanisms to broaden revenue channels for different emission-reduction entities and provide sustained endogenous market incentives for low-carbon technological innovation. In addition to primary-market auctions and secondary-market trading, Guangdong has introduced institutional investors, individuals, and owners of voluntary emission-reduction projects, and uses the Carbon Inclusive Mechanism to connect mandatory compliance with voluntary emission reductions, forming a multi-tiered trading system covering key emitting entities, small and medium-sized emission-reduction projects, and other market participants. The mandatory market primarily serves the compliance needs of key emitting entities, while the Carbon Inclusive Mechanism provides emission-reduction credit development and trading channels for small and medium-sized emission-reduction projects, creating incentives for

security interest released upon repayment of principal and interest at maturity.
[6] https://jrjgj.gz.gov.cn/gzdt/content/post_10017396.html
[7] https://gdee.gd.gov.cn/attachment/0/554/554447/4457504.pdf
[8] https://www.court.gov.cn/zixun/xiangqing/473791.html
[9] https://www.hkex.com.hk/News/News-Release/2025/250923news?sc_lang=zh-hk

different types of emission-reduction entities to participate in the market and obtain emission-reduction revenues.

Second, leverage the technology demonstration role of large compliance entities to drive substantive emission reductions and the application of low-carbon technologies in high-emitting sectors. Large petrochemical enterprise A improves energy efficiency and carries out energy-saving and carbon-reduction retrofits through high-efficiency ultra-clean industrial furnaces and the upgrading and utilization of low-grade steam. Guangdong's practice shows that key emitting entities can translate carbon compliance requirements into market-based incentives for carbon-reduction technical retrofits, promoting the application of mature low-carbon technologies in high-emitting sectors.

Third, advance carbon finance innovation and underlying institutional frameworks in tandem. Guangdong has explored online mortgage/pledge financing and securities-assisted disposal, and has improved carbon asset registration, ownership confirmation, and risk management mechanisms through the mortgage/pledge financing guidelines, dual registration, allowance freezing, and judicial disposal procedures, providing institutional safeguards for carbon asset financing.

Fourth, build a tiered incentive system based on technology maturity. Guangdong's practice shows that current carbon prices and the Carbon Inclusive Mechanism can promote energy substitution, energy-efficiency improvements, process optimization, and the deployment of mature emission-reduction technologies, while working in coordination with instruments such as green finance and fiscal support to provide diversified support for the application of low-carbon technologies.