Compilation of Typical Cases of China Carbon Market Practitioners

(2026)

The China Carbon Emissions Trading Association
Carbon Emission Registration and Clearing (Wuhan) Co., Ltd.

2026

Contents

Case Category: Market Compliance Practice Cases..... 1

1. Actively Participating in Carbon Market for High Quality Compliance | China Petrochemical Corporation (Sinopec)..... 1

2. Compliance Driven by Institutional Mechanisms — China Huadian Carbon Asset Management Practices | China Huadian Carbon Asset Operation Co., Ltd.....4

3. A Closed-Loop Management System: Setting Norms with Standards, Identifying Gaps through Evaluation, and Driving Improvement via Action Plans | Datang Yangling Thermal Power Co., Ltd..... 7

4. Refined Carbon Asset Compliance and Value Appreciation Practices | Huaneng Qinmei Ruijin Power Generation Co., Ltd..... 12

Case Category: Carbon Asset Management Practice Cases..... 16

1. Longyuan Carbon Asset: Innovating Carbon Asset Management Enabled by Digitized and Intelligent Technologies | Longyuan (Beijing) Carbon Asset Management Technology Co., Ltd..... 16

2. The World's First Carbon-Neutral Energy Commodity Term Contract | PetroChina International Co., Ltd.....19

3. Taking CCER Development as the Engine to Lead a New Paradigm for Realizing the Value of Green Rights | State Power Investment Corporation Comprehensive Smart Energy Co., Ltd. 22

Case Category: Data Quality Management Practice Cases.....25

1. Standards as the Guide, Dual-Track Co-Governance — CQC's Carbon Market Data Quality Management Practice | China Quality Certification Centre Co., Ltd..... 25

2. Improving Carbon Emission Data Quality through "One Enterprise, One Strategy" in Guizhou Province | China Environmental United Certification Center Co., Ltd.....29

Case Category: Green Transition Technology Practice Cases.....33

1. Profound Heritage Empowering Green Renewal — WISCO's Systematic Energy Conservation and Carbon Reduction Practice of "Ultimate Energy Efficiency +

Energy-Carbon Synergy" | Wuhan Iron and Steel Co., Ltd. (WISCO)..... 33

2. Forge Ahead in Green and Low-Carbon Transition, Embark on the Path of Circular Development — Practices of Green and Low-Carbon Transformation of State-Owned Cement Groups under the "Dual Carbon" Goals | Anhui Conch Group Co., Ltd..... 38

3. Ningxia Dam: End-to-End Management and Control Practices for Energy Conservation and Carbon Reduction in Coal-Fired Power | China Energy Investment Corporation..... 41

Case Category: Carbon Market Service Innovation Cases..... 44

1. CITIC Securities Comprehensive Carbon Finance Services | CITIC Securities Company Limited..... 44

2. Computing–Carbon Synergy: Carbon Finance Services for Data Centers' Green and Low-Carbon Transition | China International Capital Corporation Limited (CICC), China Mobile Bay Area (Guangdong) Innovation Research Institute, and the Research Institute of China Mobile Communications Co., Ltd..... 48

3.China Minsheng Bank Carbon Market Settlement and Carbon Finance Innovation| China Minsheng Banking Corp., Ltd..... 51

I. Market Compliance Practice Cases

Actively Participating in Carbon Market for High Quality Compliance

China Petrochemical Corporation (Sinopec)

I. Case Background

Carbon market is a crucial market-based regulatory instrument for achieving China's carbon peaking and neutrality goals ("dual carbon" goals). The national carbon emissions trading system was officially launched in 2021 and has gradually incorporated the power generation, iron&steel, cement, and aluminum smelting sectors.The petrochemical and chemical industry is expected to come under national carbon market control in 2027. Anchoring its vision of building a world-leading clean energy and chemical company, Sinopec has leveraged the specialized platform of Sinopec Carbon Industry Technology Co., Ltd. ("Sinopec Carbon Tech") to establish a carbon trading model characterized by "group-level unified allocation, platform-based professional trading, strict market risk control, and in-depth tapping of value-added benefits." The company has always prioritized timely and full compliance as its foremost political priority, ensuring stable and compliant fulfillment across Sinopec.

II. Key Measures and Innovation Highlights

First, improving institutional standards. Sinopec has issued the *Sinopec Carbon Trading Management Measures*, while Sinopec Carbon Tech has revised the *Detailed Rules for* Implementing *Carbon Trading Management*, stipulating transaction approval rights and operational procedures to achieve standardized and traceable process management for every transaction. Second, strengthening risk control. A multi-department collaborative model integrating finance, risk control, and audit, forming a three-tier defense line of "business operation-risk monitoring-audit supervision" to ensure closed-loop compliant operation of carbon trading. Third, enhancing digital empowerment. Sinopec Carbon Tech has independently developed the "Carbon Resource Pool Value Management System" platform with a built-in standardized economic evaluation model that provides real-time updates on carbon asset inventory, compliance gaps, and potential returns. Guided by a dual model of

"manual analysis + digital empowerment," the platform effectively directs allowance purchase, reallocation, and compliance procedures, reducing Sinopec's overall compliance costs.

III. Case Outcomes

First, continuous full compliance with zero violations for consecutive years. All Sinopec enterprises under carbon market control have achieved a 100% compliance rate with no overdue settlement or irregular trading. In 2024, the 17 enterprises listed in the national carbon market took the lead in completing compliance, with overall timeliness and quality ranking among the top of all central enterprises. Second, remarkable market-based cost reduction. Cumulative carbon trading volume from January 2024 to June 2026 exceeded 10 million tonnes, cutting compliance costs by over RMB 10 million. By innovatively deploying a portfolio of instruments, including allowances, CCER, and local carbon inclusive mechanisms, Sinopec Carbon Tech created a diversified compliance plan, helping Sinopec Yanshan Petrochemical Company save several million yuan in costs, and the company completed compliance for the first time without auction. Sinopec completed the annual compliance for its entire system ahead of schedule in November 2025. Third, breakthroughs in carbon finance innovation. In collaboration with the finance company, the first batch of Dedicated Carbon Finance Loans in the Sinopec system was launched, and the first "carbon allowance financing" business in the national carbon market was conducted, with cumulative loans issued exceeding RMB 10 million, providing financial support for low-carbon transformation. Fourth, the specialized model has been widely recognized by the industry. The company has received the "Outstanding Carbon Asset Management Enterprise" award from China Carbon Emissions Registration and Clearing Co., Ltd., as well as the "National Carbon Market Annual Outstanding Market Service and Management Practice Enterprise" award from the Shanghai Environment and Energy Exchange.

IV. Experience, Insights and Replicable Value

Sinopec has elevated integrated carbon trading management to a strategic initiative at the group level. Through of Sinopec Carbon Tech, the traditional model in which emissions-controlled enterprises independently assessed the carbon market, conducted scattered trading, and coped with compliance pressure alone has been transformed into an integrated operation model of "group-level unified management, Sinopec

Carbon Tech centralized trading, and overall resource allocation." Operational procedures, window-period judgment, and compliance risk control rules have been unified effectively avoiding the risks of overdue or irregular compliance caused by insufficient assessment capacity and non-standard operations. By integrating resources such as allowances and CCER, the company has accurately controlled trading rhythms and released the market-based value of cost reduction and efficiency enhancement. This model upgrades carbon asset management from "decentralized self-operation" to "group-based, professional, digital" providing replicable and scalable practical experience for central enterprises and large groups in carbon asset management and participation in the national carbon market, with important reference significance for industries such as petrochemical and chemical industry that will soon be incorporated into the national carbon market.



Figure: The "Carbon Resource Pool Value Management System" platform of Sinopec Carbon Tech — reflecting the scenario of digital empowerment and group-level coordination.

Compliance Driven by Institutional Mechanisms — China Huadian Carbon Asset Management Practices

China Huadian Carbon Asset Operation Co., Ltd.

I. Case Background

China Huadian Carbon Asset Operation Co., Ltd. (hereinafter referred to as "Huadian Carbon Asset") was established in June 2021 to exercise centralized management over more than 100 key emission entities within China Huadian Co., Ltd., (hereinafter referred to as “Huadian”) its principal responsibilities include carbon asset operation, account management, the trading of carbon emission reduction credit products, the development and maintenance of carbon asset management systems, and carbon asset-related financial services. With the deepening of the national carbon market and the "Dual Carbon" requirements of China Huadian's 15th Five-Year Plan, the scope of Huadian Carbon Asset's mandate has been progressively expanded to encompass consultancy services for green products and zero-carbon scenarios. Through the establishment of a comprehensive carbon management system, China Huadian has achieved institution-driven, systems-based carbon asset operation and management.

II. Key Measures and Innovation Highlights

I. Three-tier control framework with clearly defined responsibilities

A three-tier governance structure has been established, comprising the Group Headquarters, provincial subsidiaries, and facility-level enterprises. The Group Headquarters is responsible for the centralized development of institutional frameworks and performance assessment. Five institutional systems have been put in place, covering emission management, statistical accounting, trading compliance, supervision and assessment, and voluntary emission reduction, spanning the entire carbon management value chain. Provincial subsidiaries review the data and trading plans submitted by their affiliated enterprises, while facility-level enterprises—as the responsible entities within the carbon market—are tasked with implementing accounting, reporting, evidentiary archiving, and compliance surrender.

II. Professional platform for centralized operations

Huadian Carbon Asset undertakes, on a unified basis, the account management, trading execution, compliance surrender, accounting and verification, market analysis, and talent development of more than one hundred enterprises.

First, the company conducts accounting and verification. Full-coverage carbon accounting is carried out each year. Differentiated, facility-specific ("one facility, one strategy") data archives have been established, with allowance parameters reconciled on an item-by-item basis.

Second, the company conducts trading operations. Policy developments are tracked on a routine basis, and market conditions are systematically analyzed. A weekly carbon market bulletin is compiled and disseminated across the group. The trading workflow is governed by a three-stage control mechanism—ex-ante approval, in-process supervision, and ex-post verification.

Third, the company completes compliance surrender. Data accuracy is bilaterally confirmed with facility-level compliance entities, with the principle of "verify one, surrender one" applied throughout the process.

Fourth, the company carries out talent development and capacity building. Leveraging a "training, assessment, and competition" mechanism, the company has cultivated a multi-tiered talent pool comprising senior technicians, technicians, and technical experts.

III. Digital-intelligent system ensuring execution

In 2022, Huadian Carbon Asset independently developed a carbon asset management system, which is the only system recognized by the Ministry of Ecology and Environment as a pilot for interfacing with the National Carbon Market Management Platform. The system aligns approval authorities one-to-one with institutional requirements, enabling the end-to-end online processing of intention matching, trading plans, review and confirmation, and compliance surrender. Blockchain technology is employed to ensure an immutable audit trail at each step. The platform supports automatic data comparison and real-time alerting, with key nodes verified by the system to ensure consistency between records and actual data.

III. Case Outcomes

First, leading data quality. The verification deviation rate stands at 0.01%, with a data accuracy rate exceeding 99% across consecutive compliance cycles, and zero major deviations have been recorded in supervisory verifications conducted by the Ministry of Ecology and Environment.

Second, exemplary compliance performance. China Huadian has achieved 100% completion of allowance surrender for four consecutive compliance cycles, becoming

the first central state-owned enterprise to attain full compliance in the national carbon market, with zero penalties, zero notifications, and zero violations to date.

Third, significant trading-related economic benefits. The Company has cumulatively traded more than 70 million tonnes of carbon allowances, accounting for around 10% of the total volume transacted on the national carbon market. It has helped enterprises with allowance shortfalls reduce their compliance costs by nearly RMB 500 million, enabled surplus enterprises to generate carbon asset gains exceeding RMB 2 billion, and delivered more than RMB 2.5 billion in operating benefits to the Group.

Fourth, tangible talent development results. To date, 1,651 carbon emission management professionals have been trained, including 409 senior technicians and 46 technicians, with one individual recognized as a National Technical Expert.

IV. Experience, Insights and Replicable Value

As the national carbon market continues to expand, this case offers a replicable model for peer enterprises—regulatory compliance is not a cost, but a source of competitiveness.

First, a professional platform is the cornerstone of centralized management. Centralizing specialized functions within a dedicated platform represents a pragmatic approach for large conglomerates seeking both efficiency and compliance.

Second, institutions and systems must work in tandem. Institutions define the rules, and systems guarantee execution. Only through this dual mechanism can the inherent arbitrariness of human governance be supplanted by the predictability of process-driven operations.

Third, talent development must be anchored in a long-term commitment. Given the strong professional demands of carbon management, sustained investment in capacity building and the cultivation of a robust talent pipeline are essential.



Figure: Huadian's "Low-Carbon Digital-Intelligent Management Platform"

A Closed-Loop Management System: Setting Norms with Standards, Identifying Gaps through Evaluation, and Driving Improvement via Action Plans

Datang Yangling Thermal Power Co., Ltd.

I. Case Background

Datang Yangling Thermal Power Co., Ltd. is a coal-fired power generating enterprise. It was included in the national carbon emissions trading market in 2019, with annual carbon emissions of approximately 3 million tonnes of CO_2.

As the national carbon market moves toward regularized compliance and increasingly stringent verification supervision, the company's original carbon asset management was plagued by fragmented systems, inconsistent procedures, lack of quantitative benchmarks for performance assessment, and absence of a closed-loop rectification mechanism. Carbon management was largely transactional, prioritizing annual compliance over whole-process control — a model that could no longer support the goals of refined carbon asset management, risk prevention and control, and cost reduction with efficiency gains.

To systematically address these management shortcomings, the company adopted a top-level design approach. It formulated the *Work Standards for Standardized Carbon Asset Management* and the *Evaluation Standards for Standardized Carbon Asset Management*, together with the supporting *Work Plan for Improving Carbon Asset Management*. A closed-loop management system featuring "setting norms with standards, identifying gaps through evaluation, and driving improvement via action plans" was put in place, driving carbon asset management to transform from passive compliance into an active, standardized, assessable and refined model, and consolidating the foundation for long-term carbon asset governance.

II. Key Measures and Innovation Highlights

Built on whole-life-cycle carbon asset management and centered on institutional system development, this case establishes a "Standard – Evaluation – Improvement" closed-loop mechanism to advance standardization, quantitative assessment and regularized rectification of carbon asset management.

Improve organizational structure and clarify authority-responsibility boundaries. The company clarifies the responsibilities of the leading carbon management department

as well as production, planning, finance and document management functions of the working departments, and sets up a cross-departmental collaboration mechanism. It defines accountable entities for carbon ledger maintenance, emission accounting, monitoring plans, quota management, compliance risk control, emission reduction project development and other matters, resolving overlapping responsibilities and management gaps to ensure the delivery of all standards and schemes.

Build a two-tier standard system to consolidate the institutional foundation. The *Work Standards for Standardized Carbon Asset Management* unifies operational specifications, document templates and time limits for the full carbon management process, clarifying "what to do and how to do it". The supporting *Evaluation Standards for Standardized Carbon Asset Management* sets quantitative scoring indicators across six dimensions: ledger management, emission accounting, compliance, internal control & risk management, emission reduction management, and capacity building. It forms a quantifiable, self-assessable and auditable benchmark, solving the long-standing sore point that qualitative assessment cannot reliably measure work quality.

Formulate special improvement schemes for closed-loop quality enhancement. Internal self-assessment and diagnosis are conducted against the evaluation standards to sort out management weaknesses and risk inventories. *The Work Plan for Improving Carbon Asset Management* is developed, with rectification measures, responsible departments, completion deadlines and acceptance criteria specified item by item. Regular supervision, review and re-evaluation mechanisms are established, forming a continuous improvement cycle of "evaluation & diagnosis → problem list → rectification & improvement → re-evaluation".

Deliver cost efficiency and risk control through standardized management. Relying on the two sets of management standards, the company achieves rolling quota forecasting and forward-looking compliance strategy research, and identifies in advance risks related to quota gaps, data verification and regulatory compliance. Meanwhile, it standardizes ledger management for energy conservation, carbon reduction and emission reduction projects, and systematically taps emission reduction potential. On the premise of ensuring compliance, it optimizes carbon asset allocation, controls compliance costs, and continuously improves carbon asset value management capabilities.

Innovation Highlight: The company pioneered the three-in-one management model of

"basic operation standards + quantitative evaluation standards + special improvement schemes", transforming carbon asset management from fragmented transactional work into a systematic, standardized, assessable and closed-loop improvement practice.

III. Case Outcomes

The "dual standards + improvement scheme" closed-loop carbon asset management system has delivered remarkable results:

More complete institutional system. The full carbon management process operates under standardized procedures; the standardization of ledger documents and the accuracy of emission accounting self-inspection have been greatly improved; common compliance risks such as missing document items and inconsistent workflows have been eliminated.

Quantitative assessment of carbon management. Based on the evaluation standards, accumulated weaknesses have been identified and rectified in a closed loop; cross-departmental collaboration efficiency has improved significantly; carbon management quality can be compared horizontally and evaluated vertically, solving the problem of "no benchmark for performance".

Enhanced overall carbon asset governance. Dynamic prediction of quota surplus/deficit is realized, compliance pace is optimized, compliance costs are kept under reasonable control, and compliance risks are manageable throughout the whole cycle.

A well-established long-term improvement mechanism. Evaluation drives self-inspection and schemes promote rectification, pushing carbon management to shift from reactive post-event compliance to proactive whole-process control. The company continuously taps energy-saving and carbon-reduction potential, supports cost reduction and efficiency gains, and lays a solid management foundation for long-term, stable participation in the national carbon market.

Optimized quota acquisition. Heat supply meters have been installed for previously uncounted heat supply within the accounting boundary — including steam for denitration systems, urea hydrolysis, and lithium bromide heating air conditioners in office and dormitory buildings — which reasonably expands heat supply accounting and increases quota allocation.

IV. Experience, Insights and Replicable Value

Carbon asset management must not focus solely on annual compliance. Standardized operation benchmarks should be established upfront, and unified work standards applied to regulate the full process, so as to avoid management fragmentation.

A supporting quantitative evaluation mechanism is the key. Scoreable indicators enable objective diagnosis of weaknesses and prevent perfunctory qualitative assessment.

A closed-loop improvement approach should be upheld. Special improvement schemes address problems identified in evaluation, with clear accountabilities, time-bound rectification and re-evaluation verification, to form a long-term governance mechanism.

This "dual standards + improvement scheme" model is highly versatile and replicable for high-energy-consuming, emission-controlled enterprises in power generation, building materials, iron and steel, and other sectors. Enterprises only need to fine-tune evaluation indicators according to their industry's accounting characteristics to build an internal carbon asset assessment and continuous improvement system at low cost. The model provides a practical, replicable management template for emission-controlled enterprises to standardize carbon ledgers, mitigate verification and compliance risks, exercise refined carbon asset control, and achieve cost reduction and efficiency gains. It also sets a good example for advancing the standardization and systematization of carbon management across the industry.

大唐杨凌热电有限公司碳资产规范化管理工作标准（试行）

序 号	项目	管理标准	制度依据	备注
1	体系建设			
1.1	制度编制	1.建立健全内部管理制度与质量保障体系，制定《碳排放管理办法》等专项制度，明确温室气体排放相关计量、检测、核算、报告及交易管理工作的责任部门、岗位职责、工作要求与业务流程； 2.建立内审制度，确保提交的排放报告和支撑材料符合技术规范、内部管理制度和质量保障要求； 3.建立原始凭证和台账记录管理制度，规范排放报告和支撑材料的登记、保存和使用。	《企业温室气体排放核算与报告指南 发电设施》（环办气候函〔2022〕485 号） 《企业温室气体排放核查技术指南 发电设施》（环办气候函〔2022〕485 号）	
1.2	组织机构	1.以正式文件成立公司碳排放管理组织机构，依据指南要求明确职责，并根据公司人员变动、部门职能调整及时动态更新完善； 2.明确建立碳排放管理三级管理网络图，建立碳排放管理任务清单，明确责任分工； 3.按照《核算指南》要求，配备专人专（兼）职负责碳排放日常管理工作，人员必须具有碳排放管理员高级工及以上资质的。	《企业温室气体排放核算与报告指南 发电设施》（环办气候函〔2022〕485 号） 《企业温室气体排放核查技术指南 发电设施》（环办气候函〔2022〕485 号） 《中国大唐集团有限公司碳排放数据管理工作重点要求》（大唐集团生〔2023〕14 号）	
1.3	目标计划	1.对陕西公司下达碳排放强度指标计划进行分解，制定落实方案； 2.利用月度环保或节能工作例会，分析碳排放情况，完善管控措施。	《大唐杨凌热电有限公司碳资产管理提升工作方案》要求	
2	数据质量控制计划			
2.1	组织编制			
2.1.1	责任分工	数据质量控制计划编制工作须严格依照企业碳排放管理制度明确的责任分工组织实施，由设备、运行、燃料、化验、计划等相关部门按职责报送对应资料及相关内容，碳排放管理专职人员对各部门报送资料进行统一收集、梳理与汇总、留存。	《大唐杨凌热电有限公司碳资产管理提升工作方案》要求	
2.1.2	重点关注	1.编制碳排放质控计划前，应先明确核算边界与排放源范围，严格按照指南要求确定应纳入及不应纳入核算的设施，做到应统尽统、不重不漏。对纳入核算边界的相关设施，需在质控计划中逐项明确符合指南规定的数据质量控制措施，重点关注供热量、发电量、燃料消耗量等关键计量表计的定期维护、台账记录与留存管理等； 2.编制碳排放质控计划前，应重点梳理上年度生产工艺、主要设施变动情况及本年度相关政策要求，对可能影响数据质量、数据来源及获取方式的内容，在编制过程中予以补充完善。	《企业温室气体排放核算与报告指南 发电设施》（环办气候函〔2022〕485 号） 《企业温室气体排放核查技术指南 发电设施》（环办气候函〔2022〕485 号）	
2.2	审核发布	1.企业碳排放管理人员作为编制汇总责任人，需对各部门报送的编制内容进行统一收集、梳理和初审，确保各部门内容衔接一致、无冲突遗漏，汇总过程中发现报送内容不完整、不符合要求的，需及时反馈相关部门补充完善； 2.数据质量控制计划编制完成后，需严格执行逐级审核流程，对审核存在的问题整改完成后盖公章每年 12 月 31 日前上传全国碳市场管理信息平台。	《企业温室气体排放核算与报告指南 发电设施》（环办气候函〔2022〕485 号） 《企业温室气体排放核查技术指南 发电设施》（环办气候函〔2022〕485 号）	

2

Figure 1: *Work Standards for Standardized Carbon Asset Management*

大唐杨凌热电有限公司碳资产规范化管理评价标准（试行）						
序 号	项目	管理评价标准	扣分条款	标准分	实际查评应得分	查评人
1	体系建设			50		
1.1	制度编制	1.建立健全内部管理制度与质量保障体系，制定《碳排放管理办法》等专项制度，明确温室气体排放相关计量、检测、核算、报告及交易管理工作的责任部门、岗位职责、工作要求与业务流程； 2.建立内审制度，确保提交的排放报告和支撑材料符合技术规范。内部管理制度和质量保障要求；	内容不全或未及时修订更新每项扣 5 分；制度缺失本项不得分。	15		
1.2	组织机构	1.以正式文件成立公司碳排放管理组织机构，依据指南要求明确职责，并根据公司人员变动、部门职能调整及时动态更新完善； 2.明确建立碳排放管理三级管理网络图，建立碳排放管理任务清单，明确责任分工； 3.按照《核算指南》要求，配备专人专（兼）职负责碳排放日常管理工作，人员必须具有碳排放管理员高级工及以上资质的。	1.未成立碳排放数据质量管理组织机构，本项不得分； 2.成立碳排放数据质量管理组织机构，但未下发红头文件的，扣 5 分； 3.成立碳排放数据质量管理组织机构，但机构人员未及时更新，扣 5 分； 4.成立碳排放数据质量管理组织机构，但相关人员责任不清晰，扣 5 分。	15		
1.3	目标计划	1.对陕西公司下达碳排放强度指标计划进行分解，制定落实方案； 2.利用月度环保或节能工作例会，分析碳排放情况，完善管控措施。	1.未制定碳排放分解落实方案的，本项不得分； 2.未在月度环保、节能例会上开展碳排放分析的，每次扣 5 分，扣完为止。	20		
2	数据质量控制计划			50		
2.1	组织编制					
2.1.1	责任分工	数据质量控制计划编制工作须严格依照企业碳排放管理制度明确的责任分工组织实施，由设备、运行、燃料、化验、计划等相关部门按职责报送对应资料及相关内容，碳排放管理专职人员对各部门报送资料进行统一收集、梳理与汇总、留存。	1.未按制度责任分工开展质控计划编制工作，职责落实不到位的，扣 5 分； 2.碳排放管理人员未对报送资料进行统一收集、梳理、汇总，导致编制工作滞后或资料缺失的，扣 5 分。	10		

Figure 2: *Evaluation Standards for Standardized Carbon Asset Management*

大唐杨凌热电有限公司碳资产管理
提升工作方案

为深入贯彻落实国家碳达峰碳中和重大战略部署，严格执行全国碳排放权交易市场相关政策法规，全面提升公司系统碳资产管理规范化、精细化、专业化水平，切实解决当前碳资产管理中存在的数据质量管控规范性不高、碳配额管理不精细、碳排放核算不精准等问题，建立健全碳资产管理长效管控体系，结合公司生产经营实际，特制定本专项工作方案。

一、总体要求

以习近平生态文明思想为指导，紧扣国家碳市场建设发展要求及集团公司碳资产管理相关部署，围绕“精准核算、合规管控、优化配置、降本增效”核心目标，坚持“问题导向、标本兼治、依法合规、长效提升”的原则，聚焦碳资产数据质量管控、碳配额与碳核算管理等重点环节，在公司系统开展碳资产管理制度体系完善、能力素质建设、问题排查整治与管理提升等工作，推动碳资产管理与生产经营深度融合，切实降低碳履约成本，有效防范碳市场合规风险，助力公司实现绿色低碳高质量发展。

二、工作目标

1. 健全公司碳资产管理组织机构，提升各级人员碳资产管

Figure 3: *The Work Plan for Improving Carbon Asset Management*

Refined Carbon Asset Compliance and Value Appreciation Practices

Huaneng Qinmei Ruijin Power Generation Co., Ltd.

I. Case Background

Huaneng Qinmei Ruijin Power Generation Co., Ltd. is equipped with 2×350 MW supercritical and 2×1,000 MW ultra-supercritical coal-fired generating units, generating 11 billion kWh annually with CO_2 emissions exceeding 9 million tonnes. It is the only million-kilowatt-level supporting power source in the southern Jiangxi power grid. Relying on the integrated carbon asset coordination mechanism of China Huaneng Group, the company coordinates the entire carbon compliance and trading process. From 2019 to 2024, it has fulfilled its compliance obligations in full and ahead of schedule across multiple consecutive compliance cycles, cumulatively selling 2.77 million tonnes of surplus carbon allowances, and has become a benchmark for multi-unit thermal power enterprises for achieving low-cost, zero-risk carbon asset appreciation.

II. Key Measures and Innovation Highlights

(1) Establishing a multi-unit forecasting system to precisely identify quota surpluses or deficits. Separate calculation models are developed for the 350 MW supercritical and 1,000 MW ultra-supercritical units, respectively, distinguishing three operating modes: base load, deep peak shaving, and peak load. Taking as-fired coal carbon content, lower heating value, coal consumption for power generation, and hourly load curve as core variables, annual emission forecasts are revised on a rolling monthly basis. In response to policy changes such as declining quota benchmarks and tightening peak shaving compensation, sensitivity scenario analysis is added to reserve a 10% buffer. The fuel, operation, environmental protection, finance, and marketing departments are coordinated to consolidate the data foundation.

(2) Deep understanding of quota allocation policies to optimize trading and compliance timing. Drawing on quota allocation and carry-over policies and historical quota balances, position-holding and trading strategies are formulated to manage the pace of quota disposal ahead of the compliance deadline. A "phased and gradient trading" strategy is implemented: at the beginning of the year, the previous year's carbon emissions and carry-over quotas are compiled; carbon price trends on the national market are monitored; buyers are actively engaged; surplus quotas are disposed at right time; annual surplus quotas are carried forward in accordance with

policies, thereby avoiding concentrated selling at year-end.

(3) Establishing a full-process, multi-level risk control system to strictly uphold the bottom line of compliance. Regular full-process self-inspections of carbon compliance are conducted, covering the entire chain of emission accounting, quota ledgers, trading records, and compliance certificates. Doublechecks are conducted against the dishonesty penalty list to ensure data authenticity and accuracy. A dynamic policy tracking and response mechanism is established to monitor quota allocation, quota carry-over, compliance deadlines, and policy updates on market expansion, dynamically adjusting plans to hedge against policy risks.

III. Case Outcomes

First, outstanding emission control. Carbon emissions in each compliance cycle have been controlled within the approved quota, achieving consecutive surpluses. Second, remarkable carbon asset preservation and appreciation. A total of 2.77 million tonnes of surplus allowances have been sold, and 720,000 tonnes of surplus allowances have been carried forward, effectively revitalizing carbon asset stock. Third, elevated data quality management. The "daily monitoring, weekly review, and monthly correction" mechanism operates effectively, with the consistency between annual carbon emission verification data and forecast values reaching over 95%.

IV. Experience, Insights and Replicable Value

Institutional constraints, talent cultivation, and self-inspection supervision are the foundation for ensuring the authenticity and accuracy of carbon accounting data. Refined forecasting by unit type and operating mode is the basis for stable compliance. Advance formulation of compliance and trading plans is the key to carbon asset management and risk prevention.

Focusing on a large thermal power enterprise with mixed large and small units and an annual power generation of 11 billion kWh, this case features innovations in carbon compliance, full-chain technological prevention and control of as-fired coal sampling, preparation and analysis, research on quota allocation and carry-over policies, and rapid compliance. The company has established a standardized compliance management model characterized by credible data, thorough policy understanding, early initiation, effective risk prevention, and secure asset preservation—balancing the dual objectives of increasingly stringent carbon market regulation, power supply assurance, and carbon asset preservation and appreciation. The case offers strong

demonstration value for similar multi-unit thermal power plants and regional branches of large energy enterprises, and can serve as a reference for standardized compliance and carbon quota asset management in the power generation sector of the national carbon market.



Figure 1: Overall view of the plant



Figure 2: Distributed rooftop photovoltaics in the plant area



Figure 3: Centralized control

III. Carbon Asset Management Practice Cases

Longyuan Carbon Asset: Innovating Carbon Asset Management Enabled by Digitized and Intelligent Technologies

Longyuan (Beijing) Carbon Asset Management Technology Co., Ltd.

I. Case Background

Carbon asset management is a challenging task for China Energy Investment Corporation (CHN Energy), which has the largest installed thermal power capacity in China, with more than 170 thermal power enterprises included in China's national carbon emissions trading market. Traditional manual aggregation and ex-post accounting are laborious in ensuring data authenticity, accuracy and completeness, which makes digital enablement essential for refined carbon accounting management. Longyuan (Beijing) Carbon Asset Management Technology Co., Ltd. (hereinafter referred to as "Longyuan Carbon Asset"), the specialized technical service provider for the carbon emissions and carbon trading businesses of CHN Energy, has drawn on more than a decade of professional experience to focus on four core business segments, including carbon emissions, carbon trading, carbon emission reduction, and carbon footprint. It has built a digital carbon inventory management and control system, a carbon asset trading operation platform, a multi-dimensional intelligent computing platform for carbon footprint quantification, and a blockchain-based carbon emissions data preservation system, which together integrate full-process control technologies and applications for thermal power carbon data across collection, storage, calculation, management, and trading. With its technological achievements rated as "internationally advanced", the company has established itself as an industry benchmark for digitized and intelligent carbon management.

II. Key Measures and Innovation Highlights

With "informatization, digitalization, and intelligentization" as its direction, Longyuan Carbon Asset is advancing system development for two core scenarios, involving data management and control and intelligent analysis, as well as intelligent trading and risk prevention and control.

The digitalization of carbon inventory management and control forms a solid foundation for carbon data. The company, Longyuan Carbon Asset, has developed a digital carbon inventory management and control system in house that refines indicators for carbon inventory conducted in thermal power industry. For those enterprises, the system identified the sites that must be inspected, the systems that must be reviewed, the departments that must be visited, and the evidence that must be submitted, along with enhancements to data traceability, on-site management and control, review and verification, and threshold-based early warning. The integration of AI and access to continuous real-time data enables the construction of analysis and verification models for accurate identification of data risks and key emission stages, thereby offering enterprises data support for energy conservation and carbon reduction.

Compliance in trading and risk control safeguard carbon asset security. Longyuan Carbon Asset has independently developed a carbon asset trading operation platform system and strengthened its control framework through both institutional and technological efforts. It has introduced specialized dedicated rules for trading and risk control, separated trading and risk control positions, clarified job responsibilities, and standardized operations across the entire process. The platform follows a three-in-one design that integrates front-end trade execution and compliance, middle-end risk control, and back-end data analysis, enabling intelligent trading operations and automated risk control.

III. Case Outcomes

Data governance capabilities have delivered notable results in regulatory conformity and cost-saving. With technologies such as image and text recognition and Eagle Eye tracking, the system enables all-round control of the carbon inventory, which is characterized by checklists, standardization, regulation, dynamic updates, and professional practices. During 2024 and 2025, digital traceability verification and refined management enabled CHN Energy to reduce verified emissions by 460,000 tonnes and increase allowances by 1.58 million tonnes, with more than RMB 160 million in compliance costs saved. Meanwhile, the technical team of Longyuan Carbon Asset has been recognized by the industry, as reflected in multiple professional honors at the 2024 National Power Industry Carbon Emissions Manager Competition, including first prizes in both the individual and team categories.

The efficient and secure trading of carbon assets has brought comprehensive upgrades to compliance capability. The intelligent trading platform enables automated carbon asset inventory checks and anomaly alerts, and establishes a three-tier risk control system covering pre-event, in-process, and post-event stages, thereby reinforcing carbon compliance defenses. The platform, powered by automation, responds rapidly to trading needs, completing a single listing transaction in less than 2.6 seconds. In 2024, it executed 105 allowance transactions worth RMB 1.89 billion in just five days, and in 2025, its rapid-response capability enabled the Group, CHN Energy, to purchase allowances externally when carbon prices were low, a move expected to save more than RMB 300 million in compliance costs as carbon prices rise.

IV. Experience, Insights and Replicable Value

Group-wide carbon management is best served by a specialized and intensive approach. With numerous emission entities widely dispersed, centralized management through an internal specialized service provider is the optimal path to balancing regulatory adherence and cost control.

Digitalization serves as a core driver of carbon management transformation. End-to-end digital services move beyond the traditional single-service business and enable integration of carbon data collection, accounting, analysis, and trading, advancing fine-grained carbon management.

Intelligent technologies are key to overcoming the challenges that hinder carbon data management and control. Through digital management and control across the entire process, they strengthen data governance with digital and intelligent capabilities, ensuring the authenticity and accuracy of carbon emissions data at the source while substantially reducing regulatory costs.

The World's First Carbon-Neutral Energy Commodity Term Contract

PetroChina International Co., Ltd.

I. Case Background

PetroChina International Co., Ltd. (hereinafter "PCI") is a wholly-owned subsidiary of PetroChina Company Limited and a core global energy trading platform, with a footprint spanning more than 120 countries, annual revenue in excess of RMB 1 trillion, and a substantial presence in carbon asset management and other green, low-carbon businesses. As PetroChina's carbon asset trading center, the Company has been steadfastly implementing the national "dual carbon" strategy. In April 2021, it signed the world's first five-year carbon-neutral LNG term agreement with Shell Eastern Trading Pte Limited, addressing the long-standing pain points of high emissions and difficult quantification inherent in conventional LNG trading and marking a pivotal step toward carbon-neutral energy commodity trading.

II. Key Measures and Innovation Highlights

First, achieving carbon neutrality across the full LNG lifecycle. Total emissions were quantified using the LNG greenhouse gas intensity accounting metrics published by the UK Department for Environment, Food and Rural Affairs (DEFRA). By procuring Verra-verified nature-based carbon credits, the Company offset greenhouse gas emissions along the entire LNG value chain — from exploration, development and transportation through to regasification and combustion at the receiving terminals. Approximately 5 million tonnes of carbon credits were retired cumulatively over the five-year term, establishing a closed-loop framework of "emissions accounting — carbon credit procurement — verification and retirement".

Second, dynamically curating a portfolio of compliant, high-quality carbon sink projects. The Company progressively shifted from passively accepting Shell-designated carbon credits to sourcing premium Verra-certified projects, the majority of which originate from rainforest conservation initiatives across Belt and Road countries, all carrying Climate, Community and Biodiversity (CCB) certification.

Third, opening a new frontier in green finance. PetroChina International (Hong Kong) Corporation Limited, in partnership with Bank of China (Hong Kong), developed an

innovative green transition trade finance framework and, in 2022, completed the natural gas industry's first-ever drawdown under it, materially reducing financing costs.

Fourth, establishing an integrated operating mechanism for carbon-neutral energy commodities that combines international trade, green credit and compliance risk control, thereby ensuring the compliant and robust operation of the carbon-neutral LNG term contract.

III. Case Outcomes

On the energy security front, the world's first carbon-neutral energy commodity term contract has cumulatively delivered approximately 2 million tonnes of full-lifecycle carbon-neutral LNG into China, covering core receiving terminals in Jiangsu, Tangshan and other regions, and serving a diversified customer base spanning city gas distributors, power generation groups and chemical industry parks.

On the green finance front, the Company completed the natural gas industry's first-ever drawdown under a green transition trade finance facility at a more favorable financing rate, forging a new model whereby green attributes unlock financing and financing in turn lowers costs. In recognition of this initiative, PCI received the "Green and Sustainable Finance Award" from the Hong Kong Quality Assurance Agency (HKQAA) in 2022.

On the industry leadership front, the practice was selected as a model case by the China Enterprise Confederation and the China Enterprise Directors Association and featured in the global practices report of the International Group of Liquefied Natural Gas Importers (GIIGNL). It has propelled PetroChina to the top position nationally and into the global top ten in Verra's publicly disclosed carbon credit retirement rankings, and contributed to the upgrade of China National Petroleum Corporation's (CNPC) MSCI ESG rating from BBB to A.

IV. Experience, Insights and Replicable Value

This case presents a "China solution" with broad replicability for the transformation of the traditional energy trading industry under the "dual carbon" goals: first, combining strategic direction with business model innovation, embedding the "dual carbon" strategy across the full energy trading value chain, and converting environmental benefits into assets; second, proactively setting quality standards for carbon credit procurement, establishing a screening mechanism built on

benchmarking and continuous iteration, and elevating carbon credits into strategic assets; third, converging green attributes with financial instruments to unlock low-cost capital via the “green label”; and fourth, maintaining a clear-eyed view of the complexity of the international carbon market, which is shaped by policy, regulatory and geopolitical forces, in order to ensure the commercial viability of the green transition.



Figure 1: Arrival of the first cargo of carbon-neutral LNG of PetroChina International



Figure 2: Storage tanks holding carbon-neutral LNG at the Rudong receiving terminal, Jiangsu

Taking CCER Development as the Engine to Lead a New Paradigm for Realizing the Value of Green Rights

State Power Investment Corporation Comprehensive Smart Energy Co., Ltd.

I. Case Background

State Power Investment Corporation (SPIC) is a globally leading clean energy power generation enterprise, with large-scale clean energy industries and huge potential for carbon asset development. Its specialized carbon asset platform—State Power Investment Corporation Comprehensive Smart Energy Co., Ltd. (abbreviated as "SPICCSE")—undertakes the mission of transforming industrial advantages into a voice in the carbon market and realizing the value of green rights. In 2024, China's national greenhouse gas voluntary emission reduction (CCER) market restarted. In its early stage, methodologies were incomplete, developable projects were limited, and many new energy projects found it difficult to monetize their carbon assets. Facing the difficulty of "carbon rights confirmation", SPICCSE changed from "passively adapting to rules" to "actively participating in rule-making", launching a full-chain breakthrough.

II. Key Measures and Innovation Highlights

First, build a full-chain CCER development system. SPICCSE formed a professional team to systematically tackle processes such as project validation, emission reduction verification, registration, and issuance, resolving problems such as ambiguous standards. In December 2024, taking the lead and coordinating with Shandong Company, it helped the Shandong Peninsula South No. 3 301.6 MW offshore wind power project become the first new project nationwide to complete registration after the CCER market restart; in March 2025, the project became one of the first batch of projects nationwide to obtain issuance, with a first issuance of 1.24 million tonnes of emission reductions. In 2025, in coordination with relevant second-level units, it completed the registration of four offshore wind CCER projects—Jiangsu Dafeng H3, Rudong H7, Guangdong Shenquan I, and Shenquan I (Phase II)—with a total installed capacity of approximately 1.4 GW, forming large-scale, standardized development capacity. At the same time, in coordination with Henan Company, it explored the Group's first CSP CCER project—the Turpan CSP project—completed on-site validation, and expanded development scenarios from offshore wind power to CSP power generation. Second, deeply participate in the top-level design of methodologies,

moving from a "follower" to a "co-builder of rules". Relying on industrial practice, SPICCSE actively participated in the formulation of national CCER methodologies and built a path of "industrial practice feeding back into institutional design." It led or participated in the drafting of multiple methodologies, including "desert, Gobi, and desertified land" new energy bases, offshore photovoltaic power generation, and hydrogen production via water electrolysis powered by renewable energy, and submitted them to the Ministry of Ecology and Environment. Among them, the hydrogen production via water electrolysis powered by renewable energy methodology has been approved and released.

III. Case Outcomes

First, notable results in carbon asset rights confirmation were achieved. In coordination with relevant second-level units, it promoted the completion of registration for five offshore wind CCER projects and achieved the first batch nationwide issuance of 1.24 million tonnes of emission reductions. Based on a CCER price of RMB 80 per tonne, the carbon asset value is estimated at about RMB 100 million. Second, its voice in rule-making was significantly enhanced. It helped SPIC become one of the central energy SOEs most deeply involved in and contributing most prominently to the construction of the CCER methodology system; multiple methodologies opened policy channels for the industry to monetize emission reductions. Third, carbon finance innovation as an enabler. As a professional consultant, it assisted China Power in issuing the country's first CCER carbon emission reduction-linked bond, pioneering the linkage of CCER development volume with bond interest rates and introducing the country's first carbon insurance. The issuance rate was the lowest for central SOE public bonds of the same tenor, 1.3 percentage points lower than the original loan. Fourth, emission reduction benefits and industry demonstration. The five registered projects are theoretically expected to generate about 2.15 million tonnes of CO2 emission reductions annually, with estimated annual CCER sales revenue of about RMB 170 million. The Shandong Peninsula South No. 3 project provides a replicable and scalable path.

IV. Experience, Insights and Replicable Value

This case has formed the "SPIC model" of "industrial practice feeding back into institutional design, standards first empowering asset value." First, turn passivity into initiative. Enterprises should not be satisfied merely with developing projects, but should also devote themselves to industry standards and institutional design, using a

precise grasp of rules to lock in first-mover advantages. Second, open up the full chain. From project development and top-level design to financial monetization, a complete value chain closed loop has been formed; the realization of green rights must be advanced in an integrated manner. Third, data-driven decision-making. Integrate real data and experience from frontline operations into methodology provisions to ensure scientific rigor and operability, and provide support for government decision-making. Looking ahead, SPICCSE will continue to consolidate its full-chain CCER service capabilities, promote the implementation of more new methodologies, and contribute the "SPIC solution" to the national carbon market and the "dual carbon" goals.

III. Data Quality Management Practice Cases

Standards as the Guide, Dual-Track Co-Governance — CQC's Carbon Market Data Quality Management Practice

China Quality Certification Centre Co., Ltd.

I. Case Background

China Quality Certification Centre Co., Ltd. (CQC) is the No. 001 quality service institution established with the approval of the Chinese government. In the field of achieving "dual carbon" goals, CQC is a UNFCCC-authorized Designated Operational Entity (DOE) under the Clean Development Mechanism (CDM). In August 2025, it obtained the qualification as China's first UNFCCC Designated Operational Entity under the Article 6.4 carbon credit mechanism of the Paris Agreement. It is also a verification body and core technical support institution for the national carbon emissions trading market and the national greenhouse gas voluntary emission reduction trading market (CCER). As the largest verification body in the national carbon market, CQC undertakes carbon emission verification and review for key emitting entities in multiple provinces, covering sectors such as power generation, steel, non-ferrous metals, building materials, and chemicals. This case systematically summarizes CQC's systematic practices and standardization experience in carbon emission data quality management.

II. Key Measures and Innovation Highlights

First, build a dual-track standards system of "mandatory + voluntary." In the mandatory market, CQC led and participated in the development of the Guidelines for the Verification of Corporate Greenhouse Gas Emission Reports (Trial) and sector-specific verification technical guidelines for power generation, steel, and other industries, so as to unify verification criteria. It led the drafting of metrological technical specifications such as the Specification for Metrological Testing of Elemental Carbon Content in Coal Used by Power Generation Facilities, and participated in the mandatory national standard General Rules for the Provision and Management of Carbon Measuring Instruments for Key Emitting Entities. In the

voluntary market, it compiled the Guidelines for the Validation and Verification of Voluntary Greenhouse Gas Emission Reduction Projects in 2012 and the Guidelines for the Design and Implementation of Voluntary Greenhouse Gas Emission Reduction Projects in 2023, ensuring that emission reduction calculations are scientific and conservative.

Second, establish a full-chain quality and risk prevention system. CQC formulated dedicated Quality Manual and Management Procedures, forming a closed loop of "pre-event risk assessment—in-process control—post-event report review." Through conflict-of-interest identification, recusal rules, and independent oversight, it ensures that verification is fair, impartial, objective, and independent.

Third, carry out special research and quality improvement focusing on industry pain points. It conducted research on pain points such as coal sample collection, preparation, testing, and storage, as well as heat supply metering, and analyzed technical deviations and management weaknesses.

Fourth, deepen supervision and assistance and unannounced inspections. Entrusted by competent authorities, CQC participated in national carbon market supervision and assistance and unannounced inspections, assisted in identifying data quality issues, and conducted in-depth diagnosis and assistance for enterprises.

Fifth, strengthen capacity building and CCER practice. CQC arranged experts to participate in national carbon market training organized by the Ministry of Ecology and Environment, compiled 100 Questions and Answers on the National Carbon Market, and trained thousands of person-times cumulatively. As one of the first CCER validation and verification bodies, it completed the validation and verification of the first batch of domestic projects.

III. Case Outcomes

Outstanding standard leadership: CQC led and participated in the development of more than 10 key standards, including national carbon market verification technical guidelines, metrological technical specifications, and CCER guidelines, building a rules system covering both mandatory and voluntary markets.

Significant quality control: CQC has consistently led in carbon verification assessments in various provinces, and its verification reports have maintained "zero major quality incidents".

Effective special governance: Achievements in heat supply metering and elemental

carbon measurement of coal were transformed into metrological technical specifications, assisting multiple provincial competent authorities in completing data quality diagnosis and rectification for key emitting entities.

Fruitful capacity building: Through national carbon market training, China-EU train-the-trainer training, unannounced inspections, the Q&A compilation, and supervision and assistance, thousands of person-times have been trained cumulatively.

IV. Experience, Insights and Replicable Value

First, standards first and institutions as safeguards. A unified, detailed, and operable system of standards and specifications is the primary prerequisite for ensuring the authenticity of carbon market data.

Second, strengthen both internal and external governance, and ensure impartiality and independence. Through dedicated quality manuals, risk prevention matrices, and conflict-of-interest avoidance mechanisms, impartiality is translated into executable procedures, providing a quality management model that third-party verification bodies can learn from.

Third, provide front-line services and go deep into the field. Through special metrological research, “one enterprise, one policy” assistance, and multi-level training, data quality management is extended from post-event verification to pre-event prevention and in-process control, which is of universal significance for promoting the improvement of data quality across the entire market.



Figure 1: CQC’s validation exchanges under international carbon mechanisms



Figure 2: CQC’s on-site verification of emission reduction projects

Improving Carbon Emission Data Quality through "One Enterprise, One Strategy" in Guizhou Province

China Environmental United Certification Center Co., Ltd.

I. Case Background

Following the expansion of China's national carbon market from the power generation sector to the iron and steel, cement, and aluminum smelting industries in 2025, the number of key emission enterprises in Guizhou Province increased from 39 to 126. The newly included industries are generally weak in carbon management foundations. In addition, the four industries differ significantly in production processes, accounting methodologies, and data risk points, with notable gaps in enterprise scale and management capacity.

There is an urgent need to complete a comprehensive review and diagnosis of historical data, to develop implementable classified governance tools and a supporting policy system within a limited time frame, so as to ensure data quality and smooth compliance for enterprises covered by the national carbon market from Guizhou Province.

II. Key Measures and Innovation Highlights

1. Carry out province-wide investigation and filing to establish enterprise risk profiles

We reviewed carbon emission reports, verification reports, data quality control plans, and compliance ledgers of 126 enterprises across the four industries in Guizhou Province from 2022 to 2024, with total carbon emissions reaching 155.7 million tonnes in 2024. In line with the principle of "full coverage, stratified random sampling, and targeted focus", we selected 24 enterprises for on-site investigation, covering 4 core industrial cities and prefectures including Guiyang, Zunyi, etc., with representativeness across industries, regions, scales, and risk levels. Meanwhile, we built an information ledger database for the "One Enterprise, One Strategy" initiative, with eight dynamically updated modules to collect full information of enterprises, forming a "unified map" of carbon data risks across the province.

2. Implement stratified and targeted policies with precise application of standardized tools

In response to high-frequency issues in the power generation industry, such as non-standard fuel sampling, preparation and testing, and inconsistency between

ledgers and original records, we standardized the whole-process management of fuel sampling, preparation and testing, as well as the value specifications of accounting parameters. For common issues in newly included industries, such as ineffective implementation of data quality control plans and non-standard data source selection, we compiled industry-specific practical management guidelines. Besides, we systematically developed eight categories of quality management tools, including industry-specific verification work manuals, verification checklists, and auxiliary emission calculation tables, which transform principled accounting guidelines into operational standards that are easy for enterprises to implement and convenient for regulators to enforce. We also implemented gradient assistance based on production capacity: building compliance management demonstrations based on industrial leaders, urging ordinary enterprises to address the shortcomings of metrology calibration, and distributing standardized templates and providing one-to-one guidance for small and medium-sized enterprises.

3. Draw on national experience to build a long-term collaborative mechanism

We systematically sorted out national experience from three types of supervision models: joint verification, multiple reviews, and quality assessment of verification agencies, and integrated them into the local carbon data quality management practices. In addition, a special analysis on quota surplus and deficit of 39 power generation enterprises was conducted in 2024. We identified the total quota deficit of 30 enterprises, and clarified the root causes of divergence: structural quota surpluses at self-provided power plants versus widespread quota deficits at grid-connected main power plants. The findings provided quantitative decision-making basis for provincial quota management and compliance assistance.

III. Case Outcomes

1. Fully identified the baseline of carbon data across the province

Historical three-year data from 126 enterprises have been fully entered into the database for dynamic management. A total of 2,220 non-conformities were classified and graded, forming a stratified risk list and a "unified map" of carbon data quality. Over 70% of data deviations are accurately attributed to enterprise internal management, providing a solid data foundation for differentiated supervision across the province.

2. Accurately identified industry-specific issues

We precisely identified data reporting and accounting parameter selection as the two most prevalent risk categories, and pinpointed core weaknesses such as fuel sampling, preparation and testing in the power generation industry and metrology calibration in newly included industries, driving governance resources to be precisely allocated to weak steps.

3. Widely rolled out governance tools with initial results

Various quality management tools for competent authorities and key emission enterprises have been promoted and applied across the province, effectively unifying industry verification and supervision standards, and improving the standardization of enterprise data reporting.

4. Efficiently translated the research outcomes

The project produced a special policy recommendation report, putting forward policy suggestions from six aspects, including fulfilling enterprises' main responsibilities, improving whole-process supervision, etc., which supported decision-making for Guizhou Province to improve differentiated supervision and normalized process management.

IV. Experience, Insights and Replicable Value

1. "Profiling Prior to Policy-making" is an effective path for precise governance of carbon data.

Based on a comprehensive review of historical data, we first quantitatively identified stratified risks across industries and enterprises, then supported them with differentiated governance measures to avoid "one-size-fits-all" supervision. The methodological system including risk profiling, problem classification and sampling schemes can be directly replicated and applied by other provinces following the expansion of the carbon market.

2. Industry-specific tools plus gradient assistance can effectively adapt to enterprise disparities.

Through standardized toolkits, national accounting requirements are transformed into implementable practical guidelines. Combined with gradient assistance based on enterprise production capacity, limited supervision resources can be precisely allocated to weak links, which offers valuable reference for regions with a large number of newly included industries and a high proportion of small and

medium-sized enterprises.

3. "Dynamic Ledgers + Data Verification + Three-level Joint Review" supports normalized supervision and management.

This framework promotes the extension of data quality supervision from annual centralized verification to monthly routine information submission, enabling early risk identification and timely rectification, which provides a replicable provincial practice sample for the normalized and differentiated dynamic supervision of the national carbon market.

IV. Green Transition Technology Practice Cases

Profound Heritage Empowering Green Renewal — WISCO's Systematic Energy Conservation and Carbon Reduction Practice of "Ultimate Energy Efficiency + Energy-Carbon Synergy"

Wuhan Iron and Steel Co., Ltd. (WISCO)

I. Case Background

Wuhan Iron and Steel Co., Ltd. (hereinafter referred to as "WISCO"), whose construction began in 1955 and production started in 1958, is the first extra-large iron and steel complex built after the founding of the People's Republic of China. It is now a wholly-owned subsidiary of Baoshan Iron & Steel Co., Ltd. under China Baowu Steel Group and a core silicon steel production base in China, with a steel production capacity of 16 million tonnes. Drawing on more than six decades of accumulated expertise, the company possesses a complete industrial system, strong technical capabilities, and mature management experience. In recent years, it has continuously advanced equipment upgrading: five blast furnaces now achieve the 16-million-tonne scale originally requiring six, and five sintering machines have been consolidated and upgraded into three, realizing a systematic "quantity reduction and quality improvement" restructuring. In 2024, the steel industry was formally incorporated into the national carbon emission trading market and welcomed its first compliance year, with allowance management and carbon emission intensity control forming binding constraints. In 2026, the Carbon Peaking and Carbon Neutrality Comprehensive Evaluation and Assessment Measures came into effect, tightening the dual control of total carbon emissions and intensity. Building on its historical heritage and seizing the opportunity of equipment renewal, WISCO has taken ultimate energy efficiency as its driver and energy-carbon synergy as its mainline, systematically implementing energy-saving technical renovations, new energy substitution, and energy-saving digitalization projects from January 2024 to June 2026, charting a path of green and low-carbon transformation for a traditional steel base.

II. Key Measures and Innovation Highlights

First, focusing on ultimate energy efficiency and systematically tapping energy-saving and carbon-reduction potential across the entire process. A three-tier advancement mechanism of "process consumption reduction, interface efficiency improvement, and system optimization" was established. Energy-saving technical renovations were rolled out in alignment with the ultimate energy efficiency technology list of the China Iron and Steel Association, with energy efficiency of key processes reaching 100% of industry benchmark levels. A "tight balance" production model was established at the iron-steel interface, with precise "zero emission" regulation of gas, keeping the coke oven gas emission rate at zero. Subcritical gas power generation units were continuously upgraded, increasing self-generated electricity from secondary energy by 71.9% compared with 2021 and raising residual energy recovery per tonne of steel by 31.5%. In December 2024, the company passed the acceptance review and public announcement of the China Iron and Steel Association's "Dual-Carbon Best Practice Energy Efficiency Benchmark Demonstration Enterprise", becoming one of the first nine full-process energy efficiency benchmark demonstration enterprises nationwide.

Second, focusing on green energy and building a diversified substitution pattern of "in-plant photovoltaics + purchased green electricity". The largest rooftop distributed photovoltaic project in a plant area in Central China was built, with an installed capacity of 53.7 MW and annual power generation of about 45 million kWh. Cross-provincial and cross-regional green electricity trading channels were opened; in 2025, cumulative green electricity transactions reached 3.5 billion kWh, making the company the largest industrial green electricity consumer in Hubei Province and one of the first steel bases within the Group to apply green certificates to low-carbon products.

Third, focusing on low-carbon metallurgy and building the capacity to supply green and low-carbon products. An innovative technical route of "blast furnace scrap charging + high scrap ratio in converters + 100% green electricity across the full process" was developed. Automobile sheets, household appliance sheets, and construction steel with 50% full-process carbon reduction have achieved commercial supply, and the company has the capacity for batch supply of products with 30% carbon reduction, providing material support for carbon reduction in downstream industrial and supply chains.

Fourth, focusing on digital-intelligent empowerment and mechanism innovation to build an energy-carbon collaborative management system. The country's first smart carbon data platform was built, integrating three modules—organizational carbon accounting, carbon asset management, and product carbon footprint—enabling full-process carbon footprint traceability across the full product range including silicon steel and automobile sheets, and an online CBAM calculation module was developed. The energy management system has received cumulative investment of RMB 140 million, achieving "daily settlement and daily clearance" of energy data. A four-tier energy management performance evaluation system of "company—plant—branch—team" was innovated, covering 13 secondary units and 707 teams; a simulated operation of "self-bearing of over-consumption and sharing of savings" was implemented, monetizing technical energy savings and carbon reductions at market value and stimulating endogenous motivation for energy conservation and carbon reduction among all employees.

III. Case Outcomes

Energy conservation and carbon reduction indicators improved significantly. In 2025, carbon emission intensity decreased by 8% compared with 2020; in recent years, 61 energy-saving investment projects have been completed with a total investment of RMB 8.239 billion, forming technical energy savings of 605,800 tonnes of standard coal. Renewable energy utilization continued to increase: in-plant photovoltaics reduce carbon emissions by about 35,400 tonnes annually, and purchased green electricity has cumulatively reduced carbon emissions by more than 1.6 million tonnes. Both pollution and carbon emission were reduced and coordinated: in 2025, emissions of sulfur dioxide, nitrogen oxides, and particulate matter decreased by 58%, 60%, and 64% respectively compared with 2021. Compliance and market performance were strong: since the launch of the Hubei carbon market in 2014, the company has maintained a 100% compliance rate; it completed the first allowance settlement of the steel industry in the national carbon market on schedule and has donated China Certified Emission Reductions (CCER) for three consecutive years to support the Wuhan Marathon in achieving carbon neutrality. The company has been awarded titles including "National Green Factory", "National Energy Efficiency Leader", "Dual-Carbon Best Practice Energy Efficiency Benchmark Demonstration Enterprise", "Leading Standardized Enterprise of the Steel Industry", "China Iron and Steel Industry Cleaner Production and Environmentally Friendly Enterprise", and

"National Industrial Tourism Demonstration Base", and was rated a "National 4A Tourist Attraction" in 2025, setting a national demonstration model for the green transformation of traditional steel bases.

IV. Experience, Insights and Replicable Value

First, profound heritage is not a burden of transformation but its foundation. WISCO deeply integrated the management system and technical strength accumulated over more than six decades with continuous equipment renewal, achieving energy efficiency leadership through a systematic "quantity reduction and quality improvement" restructuring. This proves that traditional steel bases, with clear strategy, sustained investment, and scientific methods, can likewise stand at the forefront of the industry's green transformation; its four-in-one path of "top-level design + technological innovation + management reform + market mechanism" is replicable and promotable. Second, mechanism innovation is more fundamental than single-point technology. The four-tier energy performance system, the simulated operation of "self-bearing of over-consumption and sharing of savings", and the smart carbon data platform have transformed energy conservation and carbon reduction from an "external constraint" into "endogenous motivation", providing a practical paradigm for enterprise energy-carbon management in the context of the national carbon market. Third, enterprise transformation and urban development resonate at the same frequency. The energy consumption and carbon emission space freed up by energy conservation and carbon reduction supports high-quality regional development; the combined approach of "photovoltaics + green electricity + low-carbon products + CCER public welfare" amplifies the social demonstration value of central state-owned enterprises, contributing the "WISCO Solution" to the construction of the national carbon market and the green transformation of the steel industry.



Figure 1: Rooftop distributed photovoltaic project in the plant area



Figure 2: Subcritical gas power generation unit

Forge Ahead in Green and Low-Carbon Transition, Embark on the Path of Circular Development — Practices of Green and Low-Carbon Transformation of State-Owned Cement Groups under the "Dual Carbon" Goals

Anhui Conch Group Co., Ltd.

I. Case Background

Against the backdrop of China's vigorous advancement of the strategic goals of carbon peaking and carbon neutrality, Conch Group adheres to the coordinated enhancement of pollution reduction and carbon abatement. Centered on three carbon reduction pathways — carbon reduction at source, carbon reduction in process, and carbon sequestration at the end — the Group has delivered remarkable results in carbon reduction.

II. Key Measures and Innovation Highlights

1. Carbon Reduction at Source

(1) Expanded utilization of alternative fuels. The Group has developed high-proportion alternative fuel systems. In 2018, it constructed its first biomass fuel system at Battambang Conch in Cambodia. In 2020, China's first biomass alternative fuel system in the domestic cement sector was completed at Zongyang Conch. More than 90% of its clinker bases have adopted various alternative fuels, with the calorific value substitution rate reaching 13%.

(2) Continuously increased raw material substitution rate. Industrial solid wastes are used to replace part of raw materials. While realizing the resource utilization of solid wastes, carbon emissions can be offset. For instance, Fusui Conch consumes 260,000 tonnes of such wastes annually, enabling a carbon emission reduction of nearly 100,000 tonnes.

(3) Developed renewable energy projects. The Group has an operational photovoltaic installed capacity of 696 MW, wind power installed capacity of 101.5 MW, customer-side energy storage projects of 76.5 MW/249 MWh, and grid-side energy storage projects of 500 MW/2000 MWh. Clean energy accounts for 14% of total energy consumption. The cumulative power generation/discharge volume stands at nearly 2 billion kWh, cutting CO_2 emissions by almost 640,000 tonnes. Its subsidiary Jining Conch has built China's first low-carbon park in the cement industry with zero

purchased power. Centralized wind power projects at Pingliang Conch and distributed wind power projects across multiple sites have also been put into operation.

2. Carbon Reduction in Process

(1) Increased investment in energy-saving technological innovation (new technologies, new processes, new equipment and new materials). The Group keeps tapping energy-saving potential in clinker production processes. It has developed energy-saving and carbon-reducing products such as melting promoters and combustion promoters, which have been promoted and applied to many external enterprises in the cement industry. The standard coal consumption of clinker production lines has decreased by approximately 10 kg per ton of clinker, and the comprehensive power consumption has dropped by around 10 kWh per ton of clinker.

(2) Pioneered and applied oxygen-enriched combustion technology. Oxygen-enriched combustion technology has been rolled out at Baxu Conch, Linxia Conch and other subsidiaries. The standard coal consumption of the clinker calcination system is reduced by 3–6 kg per ton of clinker. A single production line can cut CO_2 emissions by roughly 20,000 tonnes per year.

(3) Built full-process smart factories. Partnering with leading tech enterprises, the Group integrates the Internet, big data, 5G and AI deeply with cement manufacturing. Take the expert optimization system as an example: for a single clinker production line with an annual capacity of 1.8 million tonnes, the annual benefit from electricity conservation reaches RMB 267,000, and the benefit from coal saving in the calcination system is RMB 1.89 million, bringing a total annual benefit of RMB 2.15 million.

3. Carbon Sequestration at the End

(1) Successfully developed and commissioned the world's first carbon capture system for the cement industry. In 2018, the world's first CO_2 capture demonstration project for the cement sector was completed at Baima Plant. The project won the First Prize of the 2019 Building Materials Science and Technology Progress Award and the First Prize of the 2020 Anhui Provincial Science and Technology Progress Award.

(2) Research and development of green and low-carbon new technologies. The Group co-established the National Key Laboratory of Silicate Science and Advanced Building Materials with Wuhan University of Technology. It has built multiple industry-university-research joint laboratories in partnership with University of

Science and Technology of China and other universities and research institutes, launching more than 30 joint research projects. The pilot test for high-efficiency carbon sequestration carbon fiber board preparation has been completed.

III. Case Outcomes

Total carbon emissions and emission intensity have declined year by year. In 2025, carbon emission intensity and total carbon emissions decreased by 4.65% and 26.15% respectively compared with 2020. The project “Design and Preparation Technology of High-ferrite Anti-corrosive Cementitious Materials and Its Application in Severe Environment Engineering”, in which the Group participated, won the Second Prize of the 2023 National Science and Technology Progress Award.

IV. Experience, Insights and Replicable Value

Conch Group takes green and low-carbon development as its core strategy. It has provided replicable and promotable solutions for the coordinated reduction of pollution and carbon across China’s cement industry. The synergistic improvement of carbon emission reduction effects and economic benefits demonstrates a new paradigm for low-carbon development in the manufacturing sector.

Ningxia Dam: End-to-End Management and Control Practices for Energy Conservation and Carbon Reduction in Coal-Fired Power

China Energy Investment Corporation

I. Case Background

Currently, the “Carbon Peaking and Carbon Neutrality” goals are being advanced in depth. China’s “dual control of energy”, which sets targets for both energy intensity, defined as energy consumption per unit of GDP, and total energy consumption, is shifting to “dual control of carbon emissions,” which places both the total amount and the intensity of carbon emissions under control. The green and low-carbon performance of central state-owned enterprises has been incorporated into mandatory assessments. CHN Energy has issued hard targets for carbon reduction in thermal power, pushing aging units to reduce carbon emission intensity through technological upgrades and refined management. After extended service, units of CHN Energy Ningxia Dam Phase III Power Generation Co., Ltd. are experiencing declining equipment efficiency. Coal consumption, auxiliary power consumption, and carbon intensity all have substantial potential for improvement. The previous coal blending and combustion were imprecise and inefficient, resulting in poor coal quality compatibility with boiler requirements, inefficient auxiliary equipment operation, and weak control over non-power energy consumption. All these factors increased carbon emissions through ineffective energy use. Tasked with ensuring regional power supply, the company is required to meet its carbon reduction targets while maintaining stable power generation. Therefore, the project aims to establish a low-carbon benchmark for thermal power in CHN Energy. It combines Class A maintenance for hardware upgrades with precise coal blending, optimized operations, standardized carbon data management and control, and improved supporting energy-saving policies and systems. These measures are designed to achieve stable generation, carbon reduction, efficiency gains, and revenue growth, producing a replicable and scalable carbon reduction solution for aging units across the industry.

II. Key Measures and Innovation Highlights

As part of the Class A maintenance of Unit 6, deep technical retrofits were carried out across the steam turbine, air-cooled condenser (ACC), boiler, and auxiliary systems. These included modifying the steam turbine through-flow parts to improve work efficiency, optimizing heat exchange and fan systems in the air-cooled

condenser(ACC) and installing monitoring devices to reduce auxiliary power consumption, upgrading the boiler heating surfaces and combustion system to reduce flue gas heat loss and improve pulverized coal burnout, and implementing comprehensive auxiliary equipment improvements, such as leak remediation and flue gas desulfurization (FGD) equipment optimization, to restore design operating conditions.

A closed-loop coal blending and combustion system was established. A dedicated fuel task force was set up to implement a “one unit, one policy” approach and an interlaboratory coal sample comparison, supported by a three-tier directive management system covering monthly coal procurement orders, weekly coal blending orders, and daily co-firing orders. Combustion conditions were dynamically adjusted according to coal quality, while carbon reduction and cost savings were calculated on a monthly basis to continuously optimize the blending scheme.

Refined operation and control measures were implemented. Primary air and pulverized coal parameters were dynamically adjusted to reduce combustion losses. Economic scheduling of auxiliary equipment was carried out, and an energy efficiency early warning system was established to lower auxiliary power consumption. Non-process energy consumption, including heating and soot blowing, was regulated to strictly control ineffective energy use. Key indicators such as carbon intensity and coal consumption were monitored daily, analyzed weekly, and reviewed monthly, with targets decomposed down to work teams to achieve closed-loop rectification.

A plant-wide monitoring system for energy consumption and carbon emissions was established, strictly adhering to carbon accounting standards and a unified accounting methodology. It draws data from the continuous emission monitoring system with full traceability and the accuracy rate exceeding 99.5%, sufficient for carbon verification and performance assessment.

III. Case Outcomes

Environmental Benefits. In the first quarter of 2026, the carbon intensity of power generation fell 12.16% year on year, total carbon emissions dropped by 239,900 tonnes, and 69,000 tonnes of standard coal equivalent were saved. The decline in carbon intensity far exceeds the industry average of 5%–8% for comparable 600 MW subcritical air-cooled units.

Economic Benefits. After the retrofit, the net coal consumption rate of Unit 6 under turbine heat acceptance (THA) conditions decreased by 16.27 g/kWh, directly reducing power generation costs. Precision blended coal combustion made full use of low-cost economic coal types, while optimized operations continuously lowered auxiliary power consumption, achieving synergy among energy conservation, carbon reduction, and efficiency improvement.

Social Benefits. Through the successful fulfillment of regional power supply obligations and an increase in generation without a corresponding increase in carbon emissions, the company provides a practical model for reconciling thermal power supply security with low-carbon transition.

Management Benefits. With the establishment of an end-to-end carbon management system integrating retrofit-driven efficiency gains, source-level carbon control, process optimization, and data management and control, complemented by a strengthened assessment mechanism and a cultivated professional team, the company supports the long-term low-carbon operation of generating units.

IV. Experience, Insights and Replicable Value

Large carbon reduction for aging units does not require major new investment. Class A maintenance retrofits, combined with end-to-end refined management, can significantly lower carbon intensity while balancing energy supply security and green transition, with strong potential for industry-wide replication. During the Class A maintenance outage, the company upgraded main and auxiliary systems, established a closed-loop blended coal combustion system for source-level carbon control, tapped energy-saving potential through operational optimization, and standardized carbon data management for verifiable results. A regular energy-saving performance assessment mechanism was also introduced to establish a carbon management benchmark and a long-term carbon reduction model for thermal power enterprises, while supporting the national Carbon Peaking and Carbon Neutrality goals through down-to-earth measures.

V. Carbon Market Service Innovation Cases

CITIC Securities Comprehensive Carbon Finance Services

CITIC Securities Company Limited

I. Case Background

In August 2025, the General Office of the CPC Central Committee and the General Office of the State Council issued *Opinions on Advancing Green and Low-Carbon Transition and Strengthening the Development of the National Carbon Market*, proposing to prudently encourage financial institutions to explore and develop green financial products and services related to carbon emission allowances and certified emission reductions.

CITIC Securities is the first securities company in China to receive permission from the China Securities Regulatory Commission to conduct carbon trading business. It upholds fundamental principles and breaks new ground, continuously providing comprehensive carbon financial services for emission-controlled and emission-reduction-oriented enterprises.

II. Key Initiatives and Innovation Highlights

1. Innovating Carbon Asset Repurchase Financing Tools to Provide Financial Support for the Low-carbon Transition of Local Enterprises in China.

In December 2014, CITIC Securities completed China's first carbon-asset repurchase financing transaction with a heat supply company. The transaction model involves the company initially selling its carbon assets to the counterparty and then repurchasing an equivalent amount of carbon assets from the counterparty at a predetermined price in the future. This model features controllable risks, flexible terms, and convenient processes, helping high emission enterprises broaden their financing channels and reduce funding costs, thereby supporting their carbon reduction and transformation efforts.

Since 2022, CITIC Securities has closely cooperated with competent carbon market authorities on business research and system development, and has delivered the first or pilot carbon-asset repurchase transactions across pilot carbon markets in Beijing,

Shanghai, Hubei, Tianjin, and Fujian, providing financial support for local enterprises' carbon reduction and transformation, for example:

(1) In April 2024, CITIC Securities concluded China's largest-ever carbon-asset repurchase transaction in the national carbon market with a materials-building group, with a scale of RMB 100 million. This transaction supports the traditional cement enterprise in its transition toward intelligent and green upgrading.

(2) In January 2024, CITIC Securities executed Tianjin's first carbon emission allowance repurchase transaction with a steel enterprise, with a scale of over RMB 25 million, facilitating the enterprise's energy-saving and carbon reduction retrofitting renovations.

2. Innovating Carbon Market Support Instruments to Address Key Pain points of Market Participants.

In December 2023, CITIC Securities, together with a commercial bank and a chemical enterprise, reached a carbon finance cooperation based on carbon asset pledge loans. CITIC Securities pioneered China's first risk mitigation instrument for carbon pledge loans, resolving critical pain points in the collateral disposal process. This innovation helps commercial banks establish a long-term mechanism to confidently extend loans, thereby broadening financing channels for real economy enterprises.

In December 2025, CITIC Securities collaborated with the China Carbon Emissions Registration and Clearing Co., Ltd. to develop and launch the "China Carbon–CITIC Securities National Carbon Market Price Spread Index (CEA–CCER)". As the first professional indicator in China to systematically track the relative price movements of the two core national carbon market assets, this index provides key references for compliance entities and project owners to optimize compliance strategies and trading approaches.

III. Case Outcomes

Since 2023, CITIC Securities' carbon-asset repurchase transactions have provided more than RMB 200 million of low-carbon-transition capital for emission-controlled enterprises in pilot carbon markets, unlocking the value of their carbon assets with a transaction volume exceeding 35 million tonnes, ranking first in the industry.

In terms of emission-reduction benefits, the aforementioned Tianjin-based steel enterprise has deployed proceeds from carbon repurchases for seven energy-saving

and carbon-reduction projects, reducing CO2 emissions by 11,200 tonnes in a year. Meanwhile, the Hubei materials-building group has channeled repurchase proceeds into energy - saving - and - emission - reduction retrofits; its Scope 1 greenhouse-gas emissions per tonne of clinker reached 791.55kg CO2e/t-clinker,h down 0.23% year-on-year.

IV. Experience, Insights and Replicable Value

CITIC Securities leverages carbon-asset repurchases to resolve financing bottlenecks for high-carbon enterprises, translating one-off pioneering innovations into regular product-and-service supply. Its carbon-pledged-loan risk-mitigation instrument directly addresses collateral-disposal pain-points, and its carbon-price-spread index helps emission-controlled and emission-reduction-oriented enterprises optimize trading strategies. It offers replicable and promotable practical experience for thousands of participants in the national carbon market, constituting an effective practice and beneficial model for improving the quality-and-efficiency of financial support for green low-carbon development and serving high-quality economic growth.



Figure 1: CITIC Securities completed China’s largest-ever carbon-asset repurchase transaction in the national carbon market with a cement enterprise

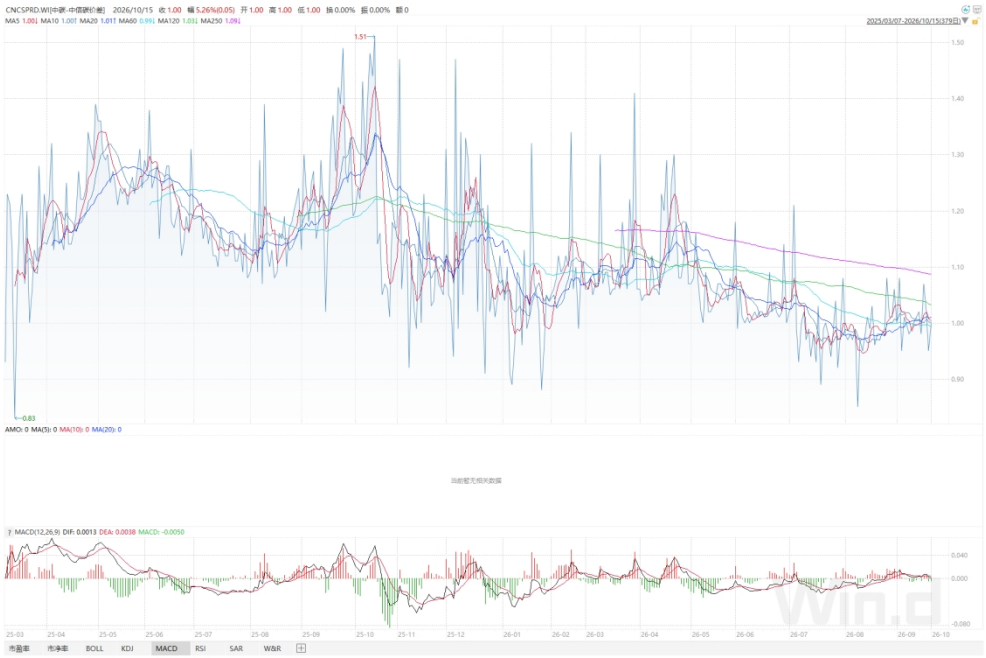


Figure 2: China Carbon–CITIC Securities National Carbon Market Price Spread Index

Computing–Carbon Synergy: Carbon Finance Services for Data Centers' Green and Low-Carbon Transition

China International Capital Corporation Limited (CICC), China Mobile Bay Area (Guangdong) Innovation Research Institute, and the Research Institute of China Mobile Communications Co., Ltd.

I. Case Background

The rapid advance of artificial intelligence (AI) has driven a surge in demand for compute. As the primary carriers of compute capacity, data centers face mounting pressure on both energy consumption and carbon emissions. The "token economy," epitomized by large AI models and AI agents, has further stoked demand for compute, leaving the industry with a structural tension: compute capacity must expand while carbon emissions must be kept in check. Now that data centers have been designated as key emitting entities under several regional carbon markets in China, they need both actionable guidance to advance green, low-carbon development and professional institutions to manage and trade their carbon assets.

II. Key Measures and Innovation Highlights

1. Standards Development. CICC, together with China Mobile (China Mobile Bay Area (Guangdong) Innovation Research Institute (the "Bay Area Institute") and the Research Institute of China Mobile Communications Co., Ltd. (the "Group Research Institute")) and other leading institutions, developed the group standard Technical Specification for Trusted Assessment of Computing Power Carbon Efficiency in Data Centers. The standard establishes a two-dimensional "compute efficiency–carbon efficiency" metrics framework that directly links compute output to carbon emissions, moving beyond the conventional PUE-only approach.

2. Product Innovation. The Bay Area Institute and the Group Research Institute developed three core technologies and built a digital platform for managing compute carbon efficiency and carbon emissions in data centers. The edge compute-carbon control terminal captures key parameters in real time, including IT equipment power draw, total power consumption, and server load. The energy-carbon operations platform integrates real-time energy monitoring, multi-dimensional energy consumption aggregation, and carbon emission accounting, enabling rapid traceability of anomalous energy use. Drawing on historical energy consumption data and

compute load trends, the energy-carbon forecasting algorithm projects power consumption and carbon emissions with high accuracy and flags carbon allowance shortfalls in advance.

3. Customer Empowerment. The three parties jointly launched the industry's first "computing-carbon synergy" carbon finance service model. Compute carbon efficiency assessment and carbon market capacity building are embedded into investment decisions: data centers apply compute carbon efficiency and carbon trading data to decisions on energy-efficiency retrofits, green power procurement, and carbon allowance reserves, elevating carbon management from "end-of-pipe compliance" to "value creation." The Bay Area Institute forecasts annual carbon emissions and allowance surpluses or shortfalls, while CICC draws on industry research and market analysis to prepare carbon allowance trading and compliance plans in advance, reducing market risk and compliance costs.

III. Case Outcomes

The standard fills an industry gap. The group standard Technical Specification for Trusted Assessment of Computing Power Carbon Efficiency in Data Centers has been officially released and piloted at scale at data centers in Guangdong, Shanghai, and Shaanxi, covering more than 20,000 servers, and has been endorsed by academicians and experts of the Chinese Academy of Sciences. In April 2026, the corresponding national standard was formally approved for development.

Applying the standard improves compute carbon efficiency. Based on pilot data, the framework can save a single data center an average of 2.33 million kWh of electricity and 1,328 tonnes of carbon emissions per year — a leading level in the industry.

"Computing-Carbon Synergy" sets an industry benchmark. The tri-party cooperation establishes a full-chain service mechanism that runs from forecasting energy consumption and carbon emissions, to identifying allowance shortfalls, to well-timed trading, to optimizing compliance costs. This has helped China Mobile Guangdong establish a model of green transition coupled with compliance cost optimization, and offers a replicable financial-empowerment pathway for emission-controlled enterprises.

IV. Experience, Insights and Replicable Value

Green transition can be anchored in research and standards development. Embed compute carbon efficiency into the KPI system for green data center development,

build a quantifiable and traceable management framework, and define transition pathways by tier and by phase.

Digital solutions can empower energy and carbon management. Build a solid data foundation on edge compute-carbon control terminals and the energy-carbon operations platform, and use energy-carbon forecasting algorithms to anticipate allowance shortfalls, closing the loop from data acquisition to decision support.

Carbon trading with technical forecasting safeguards carbon compliance. Arrange trading strategies and compliance plans in advance to reduce exposure to carbon market volatility and optimize compliance costs.

This model offers a reference for other key emitting industries and is well worth replicating.

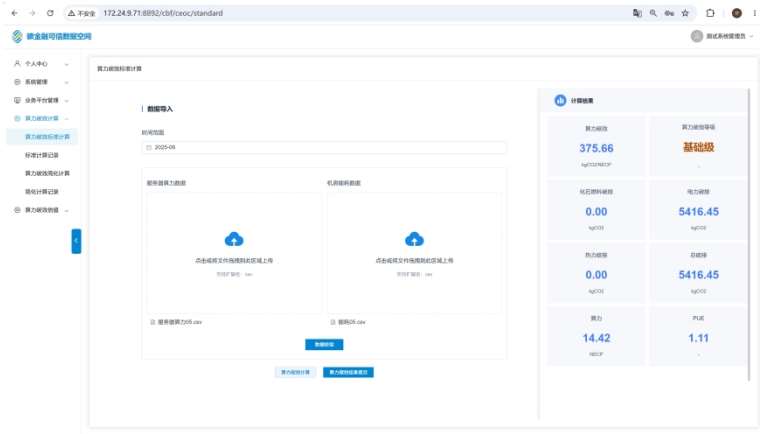


Figure 1: Carbon finance trusted data space platform



Figure 2: Carbon compliance data center

China Minsheng Bank Carbon Market Settlement and Carbon Finance Innovation

China Minsheng Bank

I. Context and challenges

China Minsheng Bank (the Bank) supports the operation of China's national emissions trading system (ETS) through settlement services and carbon finance. It was among the first settlement banks to connect to the National Carbon Emissions Registration System in the market's early stages and provides trade settlement services to more than 2,000 entities covered by the ETS. The Bank has also received an MSCI ESG Rating of AAA for three consecutive years (2024–2026).

Developing a new carbon market presents shared challenges. Settlement infrastructure must meet demanding technical standards and requires complex operations and maintenance. Market participants need stronger capabilities to manage carbon assets, while supporting policies and risk management tools continue to evolve.

II. Approach and innovation

1. Strategy and governance

Green finance and transition finance are integral to the Bank's strategy. Guided by the objectives of the Paris Agreement and the United Nations Sustainable Development Goals, the Bank has strengthened governance and expanded its financial products to support the low-carbon transition of carbon-intensive industries.

2. Settlement services and financing instruments

Solution 1 Market Express settlement platform

Market Express is a fintech settlement platform developed by the Bank for carbon markets and exchanges trading environmental rights and interests. It integrates ledger management, transfers of funds into and out of trading accounts, funds clearing and allocation, and account enquiries and reconciliation. The platform is designed to provide scalable, efficient, secure and cost-effective settlement services.

- **Scalability:** The platform combines a modular "microkernel + plug-in" architecture, DevOps practices and the Tesla framework. It connects to nearly 230 exchanges and supports more than 2,000 member entities in sectors initially covered by the national ETS and those added through subsequent expansions. It also supports transfers into and out of trading accounts through more than 200

banks.

- **Efficiency:** Sub-ledgers can be opened online and used immediately. Funds are credited on the same day (T+0) during trading hours, helping participants manage their cash flow.
- **Security:** The platform uses layered controls, including vulnerability scanning, penetration testing, web application firewalls and intrusion detection systems. The Bank reports no settlement execution errors or data security incidents during market operating hours.
- **Cost efficiency:** A specialist team provides timely operational support, helping participants reduce transaction costs and administrative workloads.

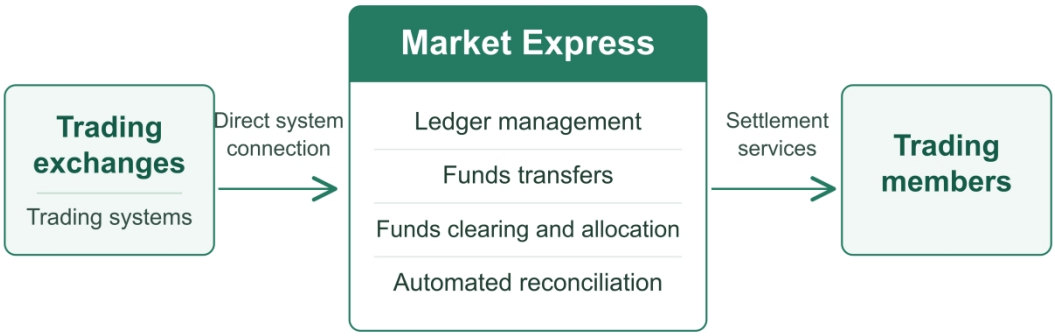


Figure 1. Market Express settlement services

Solution 2 Carbon finance instruments

(1) Financing secured by emission allowances

The Bank provides financing secured by surplus emission allowances held by carbon market participants in the National Carbon Emissions Registration System. The approach is designed to unlock the financing value of carbon assets while managing the associated compliance risks.

(2) Sustainability-linked loans

The Bank provides fixed-asset loans for production-line upgrades aimed at improving energy efficiency and reducing carbon emissions at regulated companies in carbon-intensive sectors. Loan interest rates are linked to borrowers' predefined sustainability performance targets for reducing carbon emissions intensity. This creates a financial incentive for borrowers to improve their performance against agreed transition targets.

III. Results

By combining settlement services with carbon finance, the Bank supports the operation of China's national ETS, the world's largest by covered emissions, and helps participants manage funds and access financing.

- **Settlement services:** The Bank reports that Market Express provides trade settlement services to more than 70 per cent of the entities covered by China's national ETS. The platform has supported the smooth completion of the market's compliance cycles over four consecutive years.
- **Transition finance:** The Bank continues to provide financing secured by emission allowances to companies in carbon-intensive sectors undergoing a low-carbon transition. It also uses sustainability-linked loans to link borrowing costs to carbon emissions intensity targets, extending its role from providing finance to supporting companies' low-carbon transition.

IV. Lessons for other carbon markets

This experience illustrates how settlement banks can combine financial infrastructure, lending and advisory expertise to support companies' low-carbon transition. An integrated approach can connect project development, cash management and collaboration across industrial value chains. Financing instruments can help lower transition costs and translate emissions reductions into measurable economic benefits, while advisory services can support policy interpretation, emissions reduction planning and risk management. Adapted to local market rules, legal frameworks and institutional capacity, the approach may offer useful lessons for emerging economies developing carbon markets and carbon pricing mechanisms. Its potential contribution to a just transition would also depend on measures that address the needs of affected workers and communities.



Figure 2. Launch of Minsheng Bank's "Carbon e-Credit" product in Beijing on 25 April 2022