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China Carbon Footprint Annual Report (2026)

Foreword

Promoting green and low-carbon development is an essential component of pursuing modernization in which humanity and nature coexist in harmony, and is necessary for building a Beautiful China in all respects and achieving carbon peaking and carbon neutrality. At present, efforts to address climate change and pursue a green and low-carbon transition are increasingly shaping patterns of economic and social development worldwide. Carbon emissions management is likewise extending from the macro level of countries, regions, and sectors to enterprises, products, and supply chains. A product carbon footprint, though seemingly a technical indicator, connects green production, green consumption, green trade, and the restructuring of industrial chains. Work on product carbon footprints provides an important foundation for the comprehensive green transformation of economic and social development.

Achieving China's carbon peaking and carbon neutrality goals requires not only strategic planning and implementation pathways at the national and regional levels, but also practical tools that can be applied at the enterprise, product, and industrial-chain levels. From the raw materials a product uses and the energy it consumes, to how it is produced, transported, used, and recycled, carbon footprint accounting puts green and low-carbon principles into practice throughout the product life cycle. As China's dual control system for total carbon emissions and carbon intensity continues to improve, and as the development of product carbon footprint standards, databases, labeling and certification, information disclosure, and green supply chain systems accelerates, carbon footprint work is gradually moving beyond specialized accounting to provide essential information underpinning green design, enterprise management, market evaluation, and international trade. This concerns not only the building of a Beautiful China, but also the ability of Chinese enterprises to participate in global green competition and to advance global sustainable development. Building a Beautiful China, achieving carbon peaking and carbon neutrality, and contributing through China's green and low-carbon practices to a clean and beautiful world all require solid, transparent, and credible foundational work.

For nearly five years, the team behind the China Products Carbon Footprint Factors Database (CPCD), established under the leadership of the Chinese Academy of Environmental Planning of the Ministry of Ecology and Environment, has worked to build China-specific data capabilities for greenhouse gas emissions over the full product life cycle through a public-interest approach based on openness and sharing. The database is jointly maintained, used, and improved by professionals, volunteer contributors, and a broad community of users. This approach to data development, grounded in openness and sharing, supported by professional volunteer participation, and continually refined as issues are identified through real-world use, represents an important initiative with significant social value in China's carbon footprint

field. Through several years of collaborative development and sustained practice, the platform has brought together approximately 40,000 professional users and has gradually established a mutually reinforcing relationship between data development, professional exchange, knowledge dissemination, and feedback from practice. Building on this foundation, the CPCD team has compiled and published the China Carbon Footprint Annual Report (2026).

Openness does not mean lowering professional standards. On the contrary, public data with lasting value should be able to withstand use, discussion, scrutiny, and correction. The China Carbon Footprint Annual Report (2026) states that a key value of open data lies in its capacity to be "subjected to scrutiny, corrected, and iteratively improved," thereby avoiding "black-box certainty" unsupported by an explanation of data sources and conditions of applicability. I therefore believe that this perspective of the CPCD team deserves recognition. Database development is not simply a matter of accumulating numbers; more importantly, it is a matter of establishing trustworthy, transparent, and traceable data infrastructure, so that data can serve policy-making, enterprise management, and the green transformation of industry.

The publication of the China Carbon Footprint Annual Report (2026) is an important undertaking. This report not only systematically reviews the latest developments in China's carbon footprint policies, standards, methods, databases, certification, supply chains, and international trade rules; more importantly, it grounds its analysis in real-world practice. Firsthand feedback from enterprises and practitioners enables the report to reflect not only "what policies require," but also "what enterprises are actually doing, what they need, and where their difficulties lie." This is an important and noteworthy feature of the annual report.

The field of carbon footprints continues to develop rapidly: standards are being refined, data are being updated, and application contexts are constantly changing. I hope that the China Carbon Footprint Annual Report (2026) will not be a one-off publication but will continue to be produced over the long term. I hope that the CPCD team will continue to uphold its public-interest mission and commitment to openness, sharing, and broad participation; persist in conducting open surveys and engaging directly with practitioners; and continue to produce, improve, and update its work while encouraging exchanges of ideas and sustained discussion. It should attend to international rules and the research frontier, while staying close to the actual needs of Chinese enterprises and focusing more closely on the problems encountered in production facilities, supply chain management, and practical market applications.



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Abstract

CPCD (China Products Carbon Footprint Factors Database) is an open, public-interest professional platform for carbon footprints in China, dedicated to long-term development of localized carbon footprint data, dissemination of professional knowledge, and exchange of industry practices. We continuously focus on a fundamental question: what stage has carbon footprint reached in China? This is reflected not only in how many policies, standards, and databases have been issued, but more importantly in how these rules enter enterprises—why companies undertake carbon footprint work, how they actually do it, how much it costs, what difficulties they encounter, and whether carbon footprints can truly enter procurement, certification, supply chains, international trade, and business decision-making.

China Carbon Footprint Annual Report (2026) aims to provide a systematic record and phased assessment of this rapidly evolving field from three dimensions: institutional, technical, and practical. CPCD continuously tracks changes in domestic and international carbon footprint policies, regulations, standards, databases, certification systems, and international trade rules, providing timely interpretations and commentary; around important policies, technical controversies, and corporate practice issues, it invites authoritative experts in relevant domestic fields for analysis and discussion; at the same time, it maintains ongoing exchanges with enterprises, third-party institutions, and frontline practitioners, bringing data, accounting, certification, and supply chain issues encountered in actual projects back into research and discussion. This report is not a review produced through a single concentrated writing effort, but rather the crystallization and elevation of CPCD's more than one year of continuous tracking, research, and practice.

The report systematically discusses changes in China's carbon footprint institutions, standards, data, certification, and application scenarios from January 2025 to September 2026, and analyzes their impact on Chinese enterprises and industrial chains in light of the evolution of international rules. Its content covers the transformation of carbon footprint from technical accounting to economic rules, the evolution of China's carbon footprint policy system from a 'construction blueprint' to an 'institutional chain', key methodological issues such as system

boundaries, functional units, allocation, biogenic carbon, and attributional approaches, the development of carbon footprint databases and electricity factors, certification, information disclosure, Scope 3, and supply chain chains of custody, as well as the impact of international rules such as CBAM, SBTi, and GHG Protocol on trade, subsidies, and market access. The report particularly emphasizes that a carbon footprint is not a number that exists independently of rules; its true value is shifting from 'calculating a result' to establishing an evidence chain that can be explained, traced, reviewed, and continuously updated.

From July to August 2026, CPCD conducted on-site surveys of 18 enterprises, focusing on understanding the real motivations for enterprises to carry out carbon footprint work, project costs, actual benefits, implementation difficulties, and policy demands. The surveys show that customer and market access requirements, policy assessments, supply chain requirements, and internal management have become the main drivers for enterprises to undertake carbon footprint work, but data acquisition, rule harmonization, international mutual recognition, professional capacity, and return on investment remain common challenges.

During the same period, CPCD also conducted a real-name questionnaire survey among registered users, yielding 370 valid real-name responses, and systematically analyzed the database usage, project costs, application purposes, data challenges, and future needs of actual users such as enterprises, third-party professional institutions, and researchers.

It is precisely this data from enterprise sites and real users that enables this report not only to document where carbon footprint theory and technical methods have developed, and what policies require enterprises to do, but also to further present what enterprises are actually doing, why they are doing it, and what are their questions. This is the most distinctive feature of this report, and it is also the positive contribution that CPCD hopes to engage to the development of China's carbon footprint institutional framework and industrial practice.

Glossary

Abbreviation	Full Name	Explanation
PCF	Product Carbon Footprint	The metric used to measure the total greenhouse gas emissions generated by a product over its life cycle is the central focus of this article.
LCA	Life Cycle Assessment	A method for systematically assessing a product's environmental impact, from raw material extraction, production, and transportation through use to end-of-life disposal.
ISO	International Organization for Standardization	An organization that develops international standards.
ISO 14067	International Organization for Standardization 14067	An accounting standard developed by the International Organization for Standardization (ISO) specifically for "product carbon footprints."
GHG Protocol	Greenhouse Gas Protocol	A greenhouse gas accounting framework jointly initiated and maintained by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD). Due to its flexibility and practicality, it is regarded as the de facto global "standard," particularly for accounting within corporate value chains (Scope 3).
PCR	Product Category Rules	Uniform carbon footprint accounting rules established for a specific product category to ensure that results calculated by different companies are comparable.
PEF	Product Environmental Footprint	A set of uniform methods prescribed by the European Union for calculating the environmental impact of a product throughout its entire life cycle
PEFCR	Product Environmental Footprint Category Rules	PEF calculation guidelines established by the EU for specific products (such as batteries), equivalent to the EU version of PCRs.
EPD	Environmental Product Declaration	A "Product Carbon/Environmental Declaration," similar to a certifiable environmental label.
Cradle-to-Gate	Cradle-to-Gate	A boundary in life cycle assessment that calculates environmental impacts only up to the moment the product leaves the factory, regardless of subsequent developments.
Cradle-to-Grave	Cradle-to-Grave	A boundary in life cycle assessment that calculates all environmental impacts throughout a product's entire life, right up to the moment it is discarded or incinerated.
ALCA	Attributional LCA	Accounting Approach: Calculates how much of the environmental burden a product actually bears under the current supply chain conditions (primarily recording historical and current data).
CLCA	Consequential LCA	Predictive Approach: Calculates what changes would occur globally "if" a decision were made (e.g., recycling)—such as how much virgin material production would be avoided. This logic is commonly used in carbon credit development.
LUC	Land Use Change	A change in land use (such as forest being converted to farmland) typically results in carbon emissions.
dLUC	Direct Land Use Change	If the land use is directly altered (e.g., cutting down trees to plant crops), these emissions must be attributed to the product.

Abbreviation	Full Name	Explanation
iLUC	Indirect Land Use Change	The "butterfly effect": If this land is used to grow cash crops, it displaces food-producing land, forcing the clearing of other areas (such as rainforests) for food cultivation.
CDR	Carbon Dioxide Removal	Removing carbon dioxide from the atmosphere and storing it, such as through Direct Air Capture (DAC) or tree planting
LSR	Land Sector and Removals Standard	Accounting standards in the GHG Protocol specifically for the land sector, used to calculate carbon removals or emissions in agriculture, forestry, and other related fields
Scope 1	Scope 1 Emissions	Direct emissions from sources owned or controlled by the company, such as burning natural gas in its own factories
Scope 2	Scope 2 Emissions	Indirect emissions generated by purchased electricity, heat, or steam
Scope 3	Scope 3 Emissions	All other indirect emissions along the value chain, including those from suppliers, customers, and logistics
SBTi	Science Based Targets initiative	An international organization that helps companies set emission reduction targets aligned with climate science
CNZS	Corporate Net-Zero Standard	The SBTi's core standard document for setting corporate carbon reduction and net-zero targets
AMI	Actions and Market Instruments	A new proposal from the GHG Protocol aiming to separate the accounting of "purchased carbon credits" from "actual emissions reductions" to prevent them from being conflated
REC	Renewable Energy Certificate	A certificate verifying that a specific amount of electricity comes from renewable energy sources; it can be used for market-based accounting of electricity emissions
I-REC	International Renewable Energy Certificate	An internationally recognized green certificate system (primarily used in regions outside Europe, the U.S., and China); multinational corporations often use it to demonstrate the use of green electricity.
Market-based	Market-based method	A declaration of the attributes of the electricity you have purchased, based on certificates or contracts (e.g., GO, REC, PPA)
CoC	Chain of Custody	The process of transferring, monitoring, and controlling inputs and outputs related to supply chain processes
Mass balance	Mass balance	A chain-of-custody model that proportionally allocates sustainable attributes at the system's input and output ends
MRV	Monitoring, Reporting and Verification	A system for the measurement, reporting, and third-party verification of carbon emissions data
PACT	Partnership for Carbon Transparency	A project initiated by the WBCSD, part of the "data exchange school," aimed at addressing the exchange and mutual recognition of carbon data in supply chains.
Ecoinvent	Ecoinvent Database	One of the world's most widely used "underlying databases for carbon emissions data," providing emission factors for various materials and processes
GaBi	GaBi LCA Database / Sphera LCA	A widely used LCA database and software in the industry, helping companies quickly calculate their carbon footprint
CBAM	Carbon Border Adjustment Mechanism	The "carbon tariff" imposed by the EU on imported goods
EU ETS	EU Emissions Trading System	The EU's internal carbon market, where carbon prices are determined through emissions trading.

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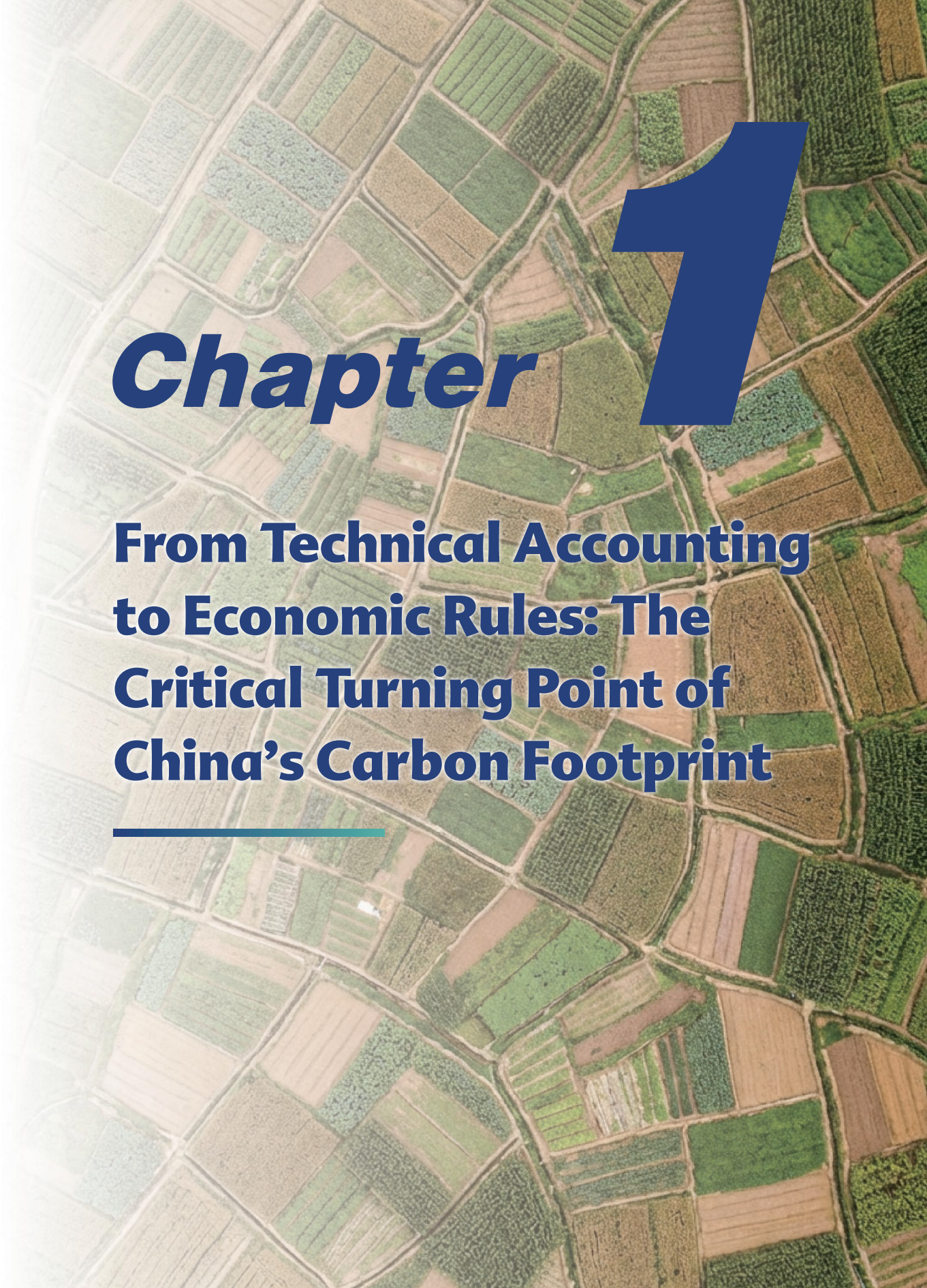
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Chapter 1

From Technical Accounting to Economic Rules: The Critical Turning Point of China's Carbon Footprint

From 2025 to July 2026, China's carbon footprint system made a critical transition from an "overall construction blueprint" to an "institutional chain." Standard development, factor databases, labeling and certification, information disclosure, supply chain management, and key product management are no longer advancing in parallel; instead, they are beginning to form a coherent sequence. The Ecological Environment Code, adopted and published in March 2026, further provides a higher-level legal basis for product carbon footprint accounting, tiered management, labeling and certification, and information disclosure.

Corporate carbon management is shifting from "calculating a number" to "building an evidence chain." What the market truly lacks is not simply lower carbon footprint values, but results supported by clear accounting boundaries, traceable activity data, verifiable supplier information, controlled historical records, and evidence that can withstand independent review. Companies with incomplete data may not immediately lose market access, but they will increasingly face default-value calculations, repeated audits, and customer risk premiums.

China's carbon footprint system has moved beyond the stage of conceptual introduction, but has not yet reached full maturity. Progress in standards, databases, pilot programs, and platform development has been relatively rapid, while cross-system mutual recognition, primary supplier data, SME capabilities, and market returns for low-carbon products remain insufficient. After 2026, the benchmark for evaluating China's carbon footprint system should no longer be "how many product carbon footprint policies have been issued," but rather "how many enterprises use them on an ongoing basis, how much data can be reused, and how much actual emission reduction has been incorporated into procurement and product decision-making."

1.1 International Governance and Changes in Industrial Organization Drive the Rise of Carbon Footprints

The rapid global rise of carbon footprint standards and accounting is not due solely to the increasing urgency of climate change, nor simply to the gradual maturation of accounting standards and databases. The intensifying climate crisis provides the objective backdrop for growing attention to carbon footprints, but the real transformation

of carbon footprints from a specialized accounting method into an important management tool is driven by two deeper structural changes: global climate governance is shifting from reliance mainly on national commitments and compliance toward a parallel model of national governance and supply chain governance; and global industrial organization is shifting from relatively independent competition among enterprises toward value-chain competition centered on chain-leading enterprises. Carbon footprints sit precisely at the intersection of these two changes.

Traditional global climate governance is primarily built on national sovereignty and territorial boundaries. Countries compile national greenhouse gas inventories, set Nationally Determined Contributions (NDCs), and drive emission reductions through domestic laws, administrative plans, and policy instruments. This governance approach covers major emitting sectors such as energy, industry, transportation, buildings, agriculture, and land use, and serves as an irreplaceable foundation for global climate governance. However, it relies heavily on national political will and implementation capacity, making it difficult to establish international enforcement mechanisms with direct binding force comparable to domestic law.

The Paris Agreement illustrates both the strengths and limitations of this governance model. It establishes nationally determined contributions, an enhanced transparency framework, technical expert reviews, and implementation and compliance mechanisms, so it is not entirely without reporting, review, and oversight. However, each country's emission reduction targets are largely self-determined, and the compliance mechanism is facilitative, non-adversarial, and non-punitive. It cannot directly impose economic sanctions or compel a country to raise its reduction targets. The United States notified its withdrawal from the Paris Agreement again in January 2025, with the withdrawal taking effect on January 27, 2026. This more directly demonstrates that an international governance system relying primarily on sovereign-state commitments is vulnerable to domestic political changes.

Another limitation of the sovereign-state framework is the inherent mismatch between territorial emissions boundaries and the globalized production system. A product may be designed in one country, have its raw materials and components produced in several countries, be assembled in another, and ultimately be sold in global markets. National greenhouse gas inventories record

emissions where they occur, which can answer how much a country emits within its territory. However, they cannot fully show how much emissions a product causes across the global supply chain, nor can they adequately address issues such as embodied emissions in imported products, industrial relocation, and carbon leakage.

Global climate governance is therefore forming a dual-track structure in which "horizontal inventories" and "vertical footprints" operate in parallel. Horizontal governance is led by countries and regions, managing emissions from power generation, infrastructure, industrial production, and land use within territorial boundaries. Vertical governance unfolds along the stages of raw materials, components, manufacturing, logistics, use, and waste disposal, tracking emissions within the boundary of products and their value chains. The former provides macro-level goals, legal frameworks, and public-policy constraints, while the latter transmits emission reduction requirements to specific products, enterprises, and transactional relationships. The two are not substitutes for each other, but complementary approaches that work at different scales.

Carbon footprints across industrial chains provide a form of governance with stronger micro-level penetration than inter-state compliance. They do not need to wait for all countries to adopt exactly the same emission reduction policies. Instead, through product standards, market access, procurement contracts, certification systems, information disclosure, green finance, and customer requirements, carbon constraints can be embedded directly into specific transactions. Even if a country has not yet established a strict product carbon footprint system, its export enterprises may still be required to provide carbon data by overseas customers, multinational brands, industry organizations, or importing markets. International climate governance has therefore gained an additional implementation pathway that can bypass differences in national policies and transmit requirements step by step along global value chains.

Industrial-chain governance does not mean that state governance is losing its role. Rather, the focus of governance is extending from sovereign constraints alone to transactional relationships. National rules determine which products need to be accounted for, what data may be used, and what claims may be made public. Chain-leading enterprises then transmit these rules further upstream and downstream through supplier admission, procurement

evaluation, and contractual terms. Third-party certification and verification bodies validate data, while financial institutions and purchasers make financing and trading decisions based on that information. Emission reduction requirements that were originally difficult to enforce directly between countries are therefore being transformed into commercial conditions that can be enforced, verified, and subject to accountability between enterprises.

Changes in the way international industries are organized have further reinforced this trend. Modern industries no longer rely mainly on a single enterprise to complete all production activities independently. Instead, they are composed of complex networks involving raw material suppliers, component suppliers, manufacturers, logistics companies, platform enterprises, and brand owners. The core capabilities of many large enterprises are increasingly reflected less in owning every production stage and more in controlling product design, technical standards, procurement systems, sales channels, and supply chain management.

Chain-leading enterprises have become key governance nodes in modern industrial organization. They typically control orders, standards, technologies, and market access, and can determine the quality, cost, delivery, and environmental requirements that suppliers must meet. Countries emphasize the cultivation of chain-leading enterprises not merely because they are large, but because they can organize and coordinate large numbers of suppliers, allowing their management requirements to spread rapidly through procurement relationships.

Traditional corporate greenhouse gas inventories are not fully suited to this form of industrial organization. A company's own emissions from fuel combustion, industrial processes, and purchased electricity often represent only part of the value-chain emissions it influences. A significant share of emissions may occur in purchased steel, aluminum, chemical materials, batteries, electronic components, transportation services, and the product use phase. For companies mainly responsible for branding, design, and supply chain organization, direct emissions may not be prominent, yet indirect emissions shaped by procurement decisions and product design can affect supply chain emissions far beyond their own operations.

Product carbon footprints are naturally aligned with supply-chain-centered production models. As products move step by step through the supply chain, carbon footprint data can likewise be generated,

aggregated, and transmitted at each stage.

Upstream enterprises provide the carbon footprints of materials and components; midstream enterprises combine this data with their own production emissions; and downstream enterprises further calculate complete product carbon footprints and use the results for design, procurement, certification, and market communication. In this way, carbon footprints become a common data language connecting different enterprises, countries, and production stages.

Carbon footprints also give chain-leading enterprises a concrete lever for managing supply chain emissions. Through product carbon footprints, companies can identify the raw materials, production processes, and suppliers with the highest emission contributions and focus limited management resources on key areas. They can also require key suppliers to provide primary data, develop emission reduction plans, or adopt lower-carbon energy and materials. Supply chain emission reduction targets that were once relatively abstract are therefore being translated into management tasks that can be assigned to specific products and suppliers.

Carbon footprints are therefore not only a carbon-management tool; they are also becoming a tool for industrial restructuring. Once carbon footprints are used for market access, government subsidies, green procurement, financing assessments, and consumer claims, they influence technology pathways, raw material choices, supplier networks, and the distribution of value across the industrial chain. Companies with low-carbon processes, reliable data, and certification capabilities may gain more orders and green premiums, while those unable to provide data, or those relying on default values over the long term, may face higher compliance costs or even exclusion from certain supply chains.

This industrial restructuring effect also means that carbon footprints are no longer value-neutral technical indicators. How accounting boundaries are defined, how emissions are allocated among co-products, to whom upstream emission reductions are attributed, and which databases are accepted can all affect the costs and benefits borne by enterprises. Chain-leading enterprises have the ability to set data requirements, while small and medium-sized suppliers may bear the costs of data collection, verification, and technological upgrading. If the carbon footprint system lacks reasonable data classification, capacity support, and benefit-sharing mechanisms, it may shift excessive green-transition pressure onto weaker actors

in the supply chain.

The rise of carbon footprints is, in essence, driven by the convergence of global climate governance and industrial organization. Climate governance needs to move beyond territorial boundaries and assign emission reduction responsibilities to products and supply chains that flow across borders. Modern industry, in turn, is organized around chain structures, with chain-leading enterprises controlling standards, orders, and data. Carbon footprints can track emissions across the product life cycle and transmit requirements through supply chain relationships, making them a natural tool for connecting climate policy with industrial operations.

In the future, global carbon emissions management will maintain a long-term pattern in which horizontal and vertical approaches develop in parallel. National and regional greenhouse gas inventories will continue to support macro-level accounting, target-setting, and public-policy management, while supply chain carbon footprints will take on micro-level identification, data transmission, market incentives, and cross-border coordination functions. The former answers how much a country or region emits, while the latter answers how many emissions a product carries across the global value chain, and which enterprises, technologies, and trading practices can change those emissions.

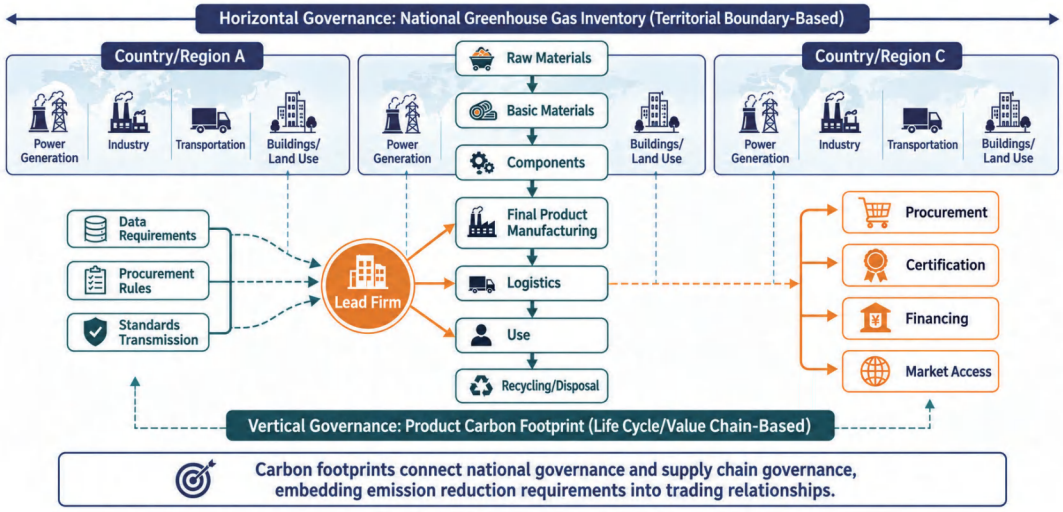


Figure 1 Horizontal Inventories and Vertical Footprints: How Carbon Governance Penetrates Global Supply Chains

For China, this change is particularly significant in practical terms. China has the world's largest and most complete manufacturing system, serves as a crucial

supply base for many international industrial chains, and is also nurturing a growing number of chain-leading enterprises with global influence. Establishing a carbon footprint management system in China is therefore not merely about adding a set of accounting standards or building a database; it is about developing a foundational capability that supports industrial-chain governance, participation in international rule-making, and recognition of the low-carbon value of Chinese manufacturing. Only by truly connecting data, standards, certification, and supply chain management can carbon footprints be transformed from a technical method into an institutional tool for driving green industrial restructuring.

1.2 Carbon footprints are taking on broader economic functions

The core change in the role of carbon footprints lies in their expansion beyond accounting alone. A carbon footprint value is no longer merely environmental information; it may become the basis for comparing products, screening suppliers, determining subsidy eligibility, calculating trade costs, and allocating green benefits. As a result, carbon footprints are beginning to acquire distinct economic attributes.

Accounting remains the most fundamental function of carbon footprints.

Through life-cycle accounting, companies can identify which stages contribute to a product's emissions and determine the relative contributions of energy, materials, transportation, use, and end-of-life treatment. Without this foundation, companies would find it difficult to accurately identify emission reduction priorities or determine whether a technological improvement genuinely reduces emissions, rather than merely shifting them to other parts of the supply chain.

The comparison function further extends carbon footprints into product evaluation. Companies can compare emission changes for the same product across different years, as well as the life-cycle performance of different design options, material alternatives, and technology pathways. Compared with cross-company horizontal comparisons, internal year-on-year or scenario-based comparisons are generally more reliable because accounting boundaries, data sources, and methodological assumptions remain relatively stable. This allows the results to better reflect changes driven by management

and technological improvements.

Management functions make carbon footprints a basis for corporate resource allocation. When a company finds that a certain raw material accounts for most of a product's carbon footprint, it can prioritize material substitution or supplier improvement. When it finds that the use phase is the main source of emissions, it needs to shift attention to energy efficiency, service life, and product design. When electricity sources have a significant impact on results, the company can reassess green electricity procurement, site selection, and production scheduling. At this level, the carbon footprint is no longer merely a result for external display, but an internal tool that supports R&D, procurement, and production decisions.

Access functions are reshaping the binding force of carbon footprints. Whether a product can obtain certification, enter a specific procurement catalogue, receive consumer subsidies, or gain access to a target market may increasingly depend on its carbon footprint and supporting evidence. Companies face not only the question of whether to calculate, but also which rules to apply, whether the data meet the required standards, whether third parties recognize the results, and whether those results can be used in the target market.

The allocation function turns carbon footprints into a tool for adjusting interests. Questions such as whether green premiums should be shared by upstream material companies, component manufacturers, or end-brand owners; whether emission reductions should be attributed to suppliers that adopt technical measures or to chain-leading enterprises that set the requirements; and whether carbon costs should be borne by exporters, producers, or consumers all need to be addressed through carbon data and supply-chain entitlement rules. Once carbon footprints are used to allocate costs and benefits, methodological details directly affect the economic interests of different actors.

Carbon footprints can fulfill these functions because they are quantifiable, decomposable, and transferable.

Companies can allocate a product's total emissions to different raw materials and production processes, and can also pass the carbon footprints of upstream products on to downstream users. What emerges is not an isolated number, but a carbon data chain that continuously accumulates and flows along the industrial chain.

The stronger the economic functions of carbon footprints become, the higher the

requirements for their reliability. Estimates used for internal screening may tolerate a certain degree of uncertainty; results used for product design need stable boundaries and methods; and data used for public claims, certification, and trade compliance must be supported by more complete sources, records, and verification evidence. Different application scenarios should not be subject to exactly the same data thresholds, and a rough estimate should not be repackaged directly as a precise conclusion with legal or commercial effect.

The broad application of carbon footprints also depends on a basic condition: the low-carbon value of products must be recognized by the market. Only when purchasers, investors, consumers, or regulators are willing to make decisions based on this information can corporate emission reduction investments generate economic returns. If carbon footprints only require companies to complete calculations but do not enter procurement, financing, consumption, and trading processes, companies may easily see them as an additional cost. The result would be many reports and certificates, but limited intrinsic motivation for continuous improvement.

The long-term effectiveness of carbon footprint policies depends on advancing technical credibility and market application in parallel. Simply raising accounting requirements may increase the burden on companies; simply granting preferential treatment to low-carbon products may create rent-seeking and unfairness if the underlying data are unreliable. A mature carbon footprint system must answer three questions at the same time: how to calculate, who recognizes the result, and how to use it. Only then can a technical indicator be transformed into a stable economic signal.

1.3 Five structural shifts are reshaping corporate carbon management

The first shift is from voluntary accounting to a tiered institutional system. In the past, companies usually carried out product carbon footprint accounting for brand promotion, customer initiatives, or internal research. In 2025, the general rules for product carbon footprint labeling and certification, the first batch of certification catalogues, and product-specific rules were released in succession. In 2026, the

Ecological Environment Code further confirmed this institutional direction. Carbon footprints are gradually entering national policy, industry management, certification pilots, corporate disclosure, and international trade rules.

Whether companies carry out related work is increasingly determined not only by their own willingness, but also by their industry, position in the supply chain, and the requirements of regulations, policies, and target markets.

Institutionalization does not mean that all companies immediately face the same mandatory obligations. Different policies still vary significantly in their scope of application, legal effect, and pace of implementation. Some systems remain at the pilot stage, some mainly rely on voluntary disclosure or recommended standards, and some apply only to specific products or export markets. Together, however, these rules send a clear signal: carbon footprints are becoming a long-term variable in corporate compliance systems, rather than a short-term project.

The second shift is from individual stages to the full supply chain. In 2026, the Guidelines for Green and Low-Carbon Supply Chain Construction of Central Enterprises (Trial) connected carbon footprints with supplier evaluation, procurement decisions, and information disclosure. SBTi 2.0 also strengthened expectations for companies to drive Scope 3 action and corporate disclosure through procurement, suppliers, and customers.

The shift toward supply chains has significantly increased the complexity of carbon management. Companies can directly control their own production processes, but it is difficult to control the data quality of dozens or even thousands of suppliers. Upstream companies may lack accounting capabilities or may be unwilling to disclose sensitive information related to processes, energy consumption, and costs. Data requirements proposed by chain-leading enterprises may be viewed by small and medium-sized suppliers as an additional burden, and the same supplier may need to report repeatedly under different rules when serving different customers.

The shift toward supply chains has also changed the division of responsibilities within companies. Carbon data is no longer only the responsibility of environmental or sustainability departments. Procurement departments need to incorporate data requirements into contracts and supplier evaluations; production departments need to provide stable records of material and

energy use; R&D departments need to assess how product design affects life-cycle emissions; IT departments need to address data collection and system integration; and finance and audit departments need to focus on data controls and external disclosure risks. Carbon footprints have therefore become a typical cross-departmental management issue.

The third shift is from average estimates to traceable primary data. Since the end of 2025, the product carbon footprint factor database work guidelines and power battery declaration requirements have raised expectations for the sources, time periods, regions, processes, and third-party verification of carbon footprint data. Industry averages remain a starting tool, but companies that want to prove the genuine advantage of a particular supplier, material, or factory must provide primary data from actual production that can be traced back to metering, procurement, and production records.

Traceability does not mean that all raw data must be fully disclosed. Process parameters, procurement relationships, and cost information may involve trade secrets, and databases also need to draw boundaries between transparency and data security. What truly matters is that data can be verified under authorized conditions, and that external users can understand its sources, methods, versions, and scope of application, rather than seeing only a final result that cannot be validated.

The fourth shift is that carbon footprints are moving from environmental disclosure to business decision-making. In the past, companies often prepared carbon footprint reports to complete disclosure or obtain certification, while the accounting results were only weakly connected to procurement, R&D, and investment decisions. Such carbon management can easily remain at the reporting level, neither supporting emission reductions nor creating stable business value.

An operations-oriented approach requires companies to embed carbon footprints into existing management processes. Procurement departments can add carbon-related classifications to existing supplier grading criteria based on emission contribution and commercial importance, and prioritize high-contribution suppliers in data provision and improvement planning. R&D departments can compare different materials, structures, and service lives at the product design stage; production departments can use carbon data to identify energy and material efficiency issues; and management can evaluate emission reduction performance

together with cost, quality, and supply stability.

Carbon footprints can move beyond the dilemma of "filling in numbers for the sake of filling in numbers" only when they are integrated into business decision-making. A one-off calculation may satisfy a temporary reporting requirement, but it does not automatically build organizational capability. A certificate may meet a particular customer requirement, but it cannot replace internal data governance. A polished result that fails to guide technical improvement will also struggle to create lasting value. What companies truly need is to turn the accounting process into a long-term mechanism for identifying problems and improving operations.

The fifth shift is that market competition is moving from competition over results to competition over evidence chains. In the past, companies tended to emphasize that their carbon footprint figures were lower, but when standards, boundaries, factors, and assumptions are inconsistent, simply comparing results may not be scientifically valid. The same product can show significant differences when different service lives, recycling methods, and electricity data are used; differences in geographic location and energy mix may also be mistaken for differences in corporate management capability.

Credible competition focuses more on how results are produced. A lower carbon footprint may not be accepted by purchasers, certification bodies, or overseas regulators if it is not supported by complete data and calculation evidence. Conversely, a temporarily higher result based on authentic data, clear boundaries, and continuous improvement can better demonstrate a company's management capability. What the market needs is not the lowest number, but numbers that can be explained, verified, and continuously improved.

These five shifts are interconnected. Institutional requirements drive companies to collect data along the supply chain; traceable data in turn supports certification, disclosure, and operational applications; and operational applications further generate market demand and prompt companies to improve data quality. As a result, the carbon footprint is gradually evolving from a one-off calculation project into a foundational management tool that connects policy, technology, supply chains, and markets.

1.4 Standard proliferation makes rule selection a new management challenge

The rapid increase in carbon footprint standards reflects accelerating institutional development and growing industry demand, but it also creates new complexity. International general standards, Chinese national standards, industry standards, association standards, product category rules (PCRs, which specify functional units, boundaries, allocation methods, and data requirements for specific product categories), certification implementation rules, and overseas regulatory methodologies now coexist. Different documents may impose different requirements for boundaries, data, allocation, and result presentation. The main challenge for companies is therefore shifting from "having no standards available" to "determining which set of rules should be adopted."

Differences among standards first arise from their intended purposes. General standards primarily define the basic principles of life-cycle accounting.

Industry or product rules refine these principles for specific products, certification rules focus on how results are confirmed by third parties, and regulatory rules may impose stricter limits on data sources, system boundaries, and default parameters to support comparability and enforcement efficiency. These rules are not simply hierarchical, nor can they fully replace one another.

Meeting one standard does not mean that the results can be universally applied across all scenarios. A product carbon footprint completed by a company according to Chinese general standards may not directly satisfy specific EU product regulations; supply chain data provided to customers may not qualify as product carbon footprint certification results; and models used for internal technical comparisons may not be suitable for direct public claims.

Whether carbon footprint results are accepted depends on which rules the intended user recognizes, rather than on which standard the company itself considers most authoritative.

Differences among standards also create significant risks for horizontal product comparisons. Different system boundaries, functional units, background databases, and recycling allocation methods can all change the final results. In the absence of unified product category rules and consistent data requirements, directly ranking carbon

footprints calculated by different companies may mistakenly attribute methodological choices, energy endowments, and data conditions to a company's genuine low-carbon capability, and may also lead companies to misjudge their own carbon management performance.

A carbon footprint value therefore cannot be understood as a natural constant that exists independently of rules. It has a clear scientific basis, but it is always produced under specific boundaries, methods, data, and assumptions. Mature carbon footprint management is not about eliminating all uncertainty, but about making key assumptions explicit, fixing methodologies, keeping uncertainty within an explainable range, and ensuring the necessary conditions for comparability across different periods or products.

The expansion of standards requires companies to establish their own rule-selection mechanisms. Companies should clarify which external rules need to be followed in different scenarios based on product use, customer requirements, certification goals, and export markets. At the same time, they should, as far as possible, establish a unified underlying data system so that the same set of production and supply chain data can be converted and calculated according to different rules. Companies should not collect a completely independent set of data for each external requirement; otherwise, they will remain trapped in repeated reporting and repeated accounting over the long term.

Standard selection is ultimately a business decision. Companies need to consider regulatory effectiveness, customer acceptance, implementation costs, data availability, and future scalability, rather than merely pursuing a greater number of standards or certificates. A truly effective strategy is to meet external requirements while building an internal data and accounting foundation that can accommodate multiple application scenarios.

1.5 Trustworthy carbon data capabilities are becoming a source of corporate competitiveness

As carbon footprints enter procurement, certification, disclosure, and trade, the focus of corporate competition is shifting from "whose number is lowest" to "whose number can be explained, reviewed, and continuously updated." A temporarily higher product

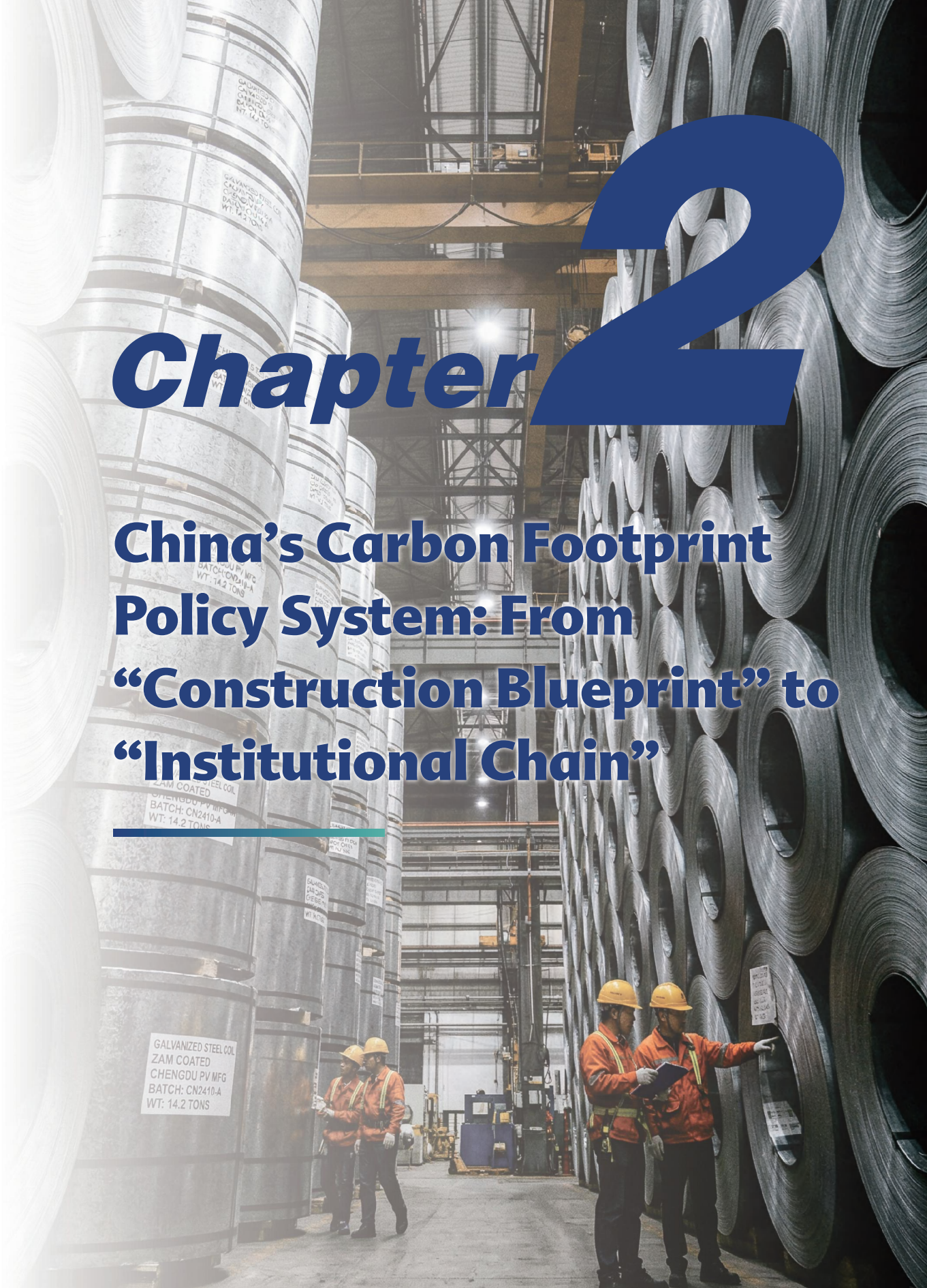
emissions result does not necessarily mean losing market access, but long-term data gaps, unclear boundaries, and untraceable supplier information will cause companies to bear the costs of default values, repeated audits, and customer risk premiums.

These capabilities include at least four aspects: continuously maintaining data on energy, materials, output, and suppliers; enabling key results to be traced back to contracts, invoices, metering records, and production records; encouraging suppliers to provide data in a tiered manner based on emission contribution and supply risk; and retaining versions of factors, models, and rules so that changes in results can be explained as either genuine emission reductions or methodological updates.

Third-party certification can reduce information asymmetry between transacting parties, but it cannot replace a company's own capabilities. A single certificate typically covers only a specific product, facility, period, and set of rules. What can truly be reused are the data records, traceability mechanisms, internal controls, and cross-departmental collaboration established during the certification process.

Therefore, companies do not need to wait until all standards are fully unified before taking action. A more feasible path is to first establish a unified underlying data foundation, and then adjust boundaries and outputs according to the requirements of different customers, certifications, and regulations. Standards will change and tools will be replaced, but complete, authentic, and traceable activity data can be recalculated under different rules. This is the most stable carbon asset a company can build.

Moving from technical accounting to economic rules means that carbon footprints are beginning to influence resource allocation and market relationships; moving from one-off projects to long-term systems means that companies must translate carbon footprints into organizational capabilities. For Chinese companies, the most important task at present is not to wait for all standards to be fully unified or all databases to be fully mature, but to establish a stable data foundation, internal procedures, and supply chain collaboration mechanisms as early as possible under existing conditions. Only in this way can companies gradually shift from passively responding to external rules to actively managing products, supply chains, and future markets.



Chapter 2

China's Carbon Footprint Policy System: From "Construction Blueprint" to "Institutional Chain"

China's carbon footprint policy system is being established through a gradual process of connecting previously fragmented standards, emission factors, certification, disclosure, and application policies. Laws and national plans define its institutional status; overall plans set out development tasks; standards and databases provide the accounting foundation; certification and disclosure mechanisms build credibility; and policies on supply chains, trade, and key products drive practical application. China's carbon footprint management is therefore beginning to move from several parallel policy projects toward an institutional chain with upstream and downstream linkages.

This institutional chain is gradually taking shape. Some systems already have a clear legal basis and implementation rules, while others still operate through recommended standards, voluntary disclosure, or industry pilots. Technical interfaces among different authorities also require continued coordination. To judge whether China's carbon footprint policy system is mature, one should not simply count how many documents have been issued. The more important question is whether these documents collectively answer four practical questions: under which rules companies calculate carbon footprints, what data they use, who verifies or confirms the results, and in which scenarios the confirmed results can be used.

2.1 Laws and National Plans Establish the Institutional Status of Carbon Footprints

The Ecological Environment Code of the People's Republic of China was adopted and promulgated on March 12, 2026, and came into effect on August 15, 2026. Article 1036 of the Code explicitly provides for "carrying out product carbon footprint management, formulating accounting standards and technical specifications, and establishing systems for product carbon footprint accounting, tiered management, labeling and certification, and information disclosure." Product carbon footprints now have a clear legal basis at the national level. They have been elevated from departmental policy tasks to a statutory institutional arrangement and are gradually becoming part of a binding regulatory framework.

This change first stabilizes long-term institutional expectations, rather than immediately imposing the same obligations

on all companies. The Code does not directly specify which products each company must account for, nor does it define system boundaries, emission factors, or certification procedures. Specific requirements still need to be implemented progressively through product catalogues, departmental regulations, mandatory standards, procurement rules, and industry documents.

National planning has further incorporated product carbon footprints into the overall framework of the dual-control system for carbon emissions. The Outline of the 15th Five-Year Plan for National Economic and Social Development of the People's Republic of China places local carbon assessment, industry-level carbon management, corporate carbon management, project carbon evaluation, and product carbon footprints side by side within the policy system. It also calls for rules and standards for product carbon footprint accounting, carbon-emission limit standards for key products, product carbon labeling and certification systems, and international mutual recognition. Product carbon footprints are therefore no longer isolated environmental indicators for products, but institutional tools that connect macro-level carbon goals with micro-level industrial management.

The Beautiful China 15th Five-Year Plan further strengthens the role of carbon footprints in ecological and environmental governance. It links carbon footprints with green production and lifestyles, industrial green transformation, and modernization of the environmental governance system. This shows that the policy objectives of product carbon footprints have moved beyond responding to overseas green trade rules and are beginning to support domestic green production, green consumption, and the broader development of a Beautiful China.

Taken together, laws and plans integrate carbon footprints into the broader carbon-emissions governance system. Granting carbon footprints legal and planning status does not mean that all products will immediately be subject to mandatory carbon accounting. The law provides institutional authorization and direction, while subsequent standards, catalogues, certification rules, and implementation policies determine how the system will operate in practice.

2.2 The Overall Blueprint Establishes a Multi-Departmental Coordination Framework

The overall blueprint for China's carbon footprint policy system took shape in 2024. The Implementation Plan for Establishing a Carbon Footprint Management System set out tasks for standards, factor databases, labeling and certification, application scenarios, and international alignment. These tasks have become the common starting point for the concentrated rollout of carbon footprint policies since 2025, as different modules of the system have gradually been translated into institutional documents and operating mechanisms.

Multi-departmental coordination is a basic feature of China's carbon footprint policy system. Ecological environment authorities are mainly responsible for overall coordination, basic factors, greenhouse gas accounting, and alignment with international climate governance; market regulation authorities are responsible for standardization, certification and accreditation, and labeling systems; development and reform authorities are responsible for the dual-control system for carbon emissions, project carbon evaluation, and energy-consumption accounting; industry and information technology authorities are responsible for industrial product rules and key-sector applications; finance authorities are responsible for sustainability disclosure standards; state-owned assets supervision authorities promote procurement applications through central enterprise supply chains; and commerce authorities incorporate carbon footprints into the green trade support system.

This division of responsibilities is consistent with the cross-cutting nature of carbon footprints, which span environment, industry, energy, trade, and market regulation. Carbon footprint management cannot be completed independently by a single competent authority: accounting methods require standardization management; factor data require input from energy, statistics, and industry authorities; certification requires a conformity-assessment system; supply-chain application requires coordination with procurement and industrial policies; and international recognition also involves trade rules and cross-border data issues. Multi-departmental participation is therefore not institutional duplication, but a result of the cross-sectoral nature of carbon footprints themselves.

China's carbon footprint system is therefore better understood as a combined framework rather than as a single unified regulation covering all issues. National laws and overall plans set the direction; different departments establish specific systems according to their respective responsibilities; and coordination is achieved through standards, data formats, certification recognition, and information exchange. This structure can adapt to China's complex industrial system, but its effective operation depends on clear interfaces among the different systems.

The basic structure of the carbon footprint policy system can be summarized as three main actors and two types of infrastructure. The government is responsible for setting rules and establishing public institutions; companies are responsible for generating data and implementing emission reductions; and purchasers, investors, and consumers create market feedback through their transaction choices. The standards system defines boundaries, allocation, data quality, and declaration methods, while the basic database provides scalable data and exchange mechanisms. Without any one of these elements, carbon footprints would remain limited to partial accounting and would struggle to develop stable policy and market applications.

China's current policy development has already covered the major modules mentioned above. The Progress Report on the Construction of the Product Carbon Footprint Management System (2026), released by the Ministry of Ecology and Environment, shows concrete progress in standards, factors, databases, certification, local pilots, application scenarios, and international alignment. This indicates that China's carbon footprint development has moved beyond merely proposing concepts and goals and has entered a stage in which institutional modules are being built in parallel and increasingly connected with one another.

2.3 Corporate Accounting and Carbon Markets Strengthen the Data Foundation for Product Carbon Footprints

Product carbon footprint accounting is not an isolated technical exercise. Its data foundation largely comes from a company's day-to-day production, operations, and greenhouse gas management. Corporate-level data—such as energy consumption, fuel use,

raw material inputs, product output, process parameters, and purchased electricity—are both the basis for organizational greenhouse gas accounting and the underlying information needed when product carbon footprints are allocated to specific products and production stages.

Improved corporate accounting standards help reduce the most fundamental data gaps in product carbon footprints. The General Guidelines for Greenhouse Gas Emissions Accounting and Reporting for Industrial Enterprises (GB/T 32150-2025) further standardize the identification, quantification, and reporting requirements for greenhouse gas emissions from industrial companies. For companies conducting product carbon footprint accounting, their practical value does not lie mainly in directly providing product-level accounting results, but in helping them unify activity-data definitions, clarify emission-source boundaries, and strengthen metering and record-keeping so that they can continuously provide stable and traceable on-site data.

A greenhouse gas management system helps turn one-off accounting into continuous data governance. Product carbon footprints often need to be updated regularly. If a company lacks clear data responsibilities, internal review, version management, and exception-handling mechanisms, each accounting cycle may require the data to be collected again, making it difficult to keep results continuous and consistent. By establishing a greenhouse gas management system, companies can embed carbon-data collection into production, energy, procurement, and finance processes, providing a relatively unified data foundation for different products, customers, and certification scenarios.

The most direct contribution of the national carbon market to product carbon footprints is improving on-site data quality in key emitting industries. The carbon market directly links emissions data with quota compliance and economic costs, and sets stricter requirements for fuel consumption, calorific value, carbon content, output, metering equipment, and verification evidence. Better data quality in basic-material sectors such as steel, cement, and electrolytic aluminum can improve the upstream material data on which downstream product carbon footprints rely. The accounting, verification, and evidence-retention capabilities developed through the carbon market can also support product carbon footprint certification. Metering records, emissions ledgers, verification reports, and internal-control documents already established

by key emitting companies can reduce repeated evidence collection for on-site direct emissions in product carbon footprint accounting and improve the credibility of relevant data during third-party verification. For products with long supply chains, the reliability of upstream high-emission material data often has a greater impact on the final result than the calculation methods used in downstream assembly stages.

2.4 The Standards System Shifts from Quantitative Expansion to Coordinated Adoption

China's product carbon footprint standards system has entered a stage of rapid expansion. The Guidelines for the Compilation of Product Carbon Footprint Accounting Standards, released in early 2025, clarify the respective roles of national standards, industry standards, local standards, association standards, and enterprise standards, and set requirements for system boundaries, data quality, allocation methods, and post-implementation evaluation in standard development. The main purpose of this document is not to specify how a particular product should be accounted for, but to define how different types of product rules should be developed and coordinated.

The guidelines for standard development mark a shift in policy focus from "encouraging standard development" to "governing the standards system." In the early stages of carbon footprint work, many industries lacked applicable rules, and association standards were able to fill these gaps quickly. However, as the number of standards increases, the same product may be covered by several rules with similar names but different technical approaches. Duplication and conflict among standards can then weaken market trust. Institutional development must therefore both encourage the supply of standards and control fragmentation.

The recommended lists of association standards serve as an important transitional mechanism for standard adoption. Through technical assessment and recommended lists, government departments identify relatively mature rules so that companies, database developers, and certification bodies can adopt them as a priority. After the third list was released in February 2026, the three lists had cumulatively included 111 association standards. By the end of 2025, China had issued 15 national standards for product

carbon footprint accounting.

Recommendation does not mean mandatory implementation. Inclusion in the recommended list indicates that a standard has received a higher level of policy recognition and application priority, but whether companies must adopt it still depends on specific regulations, certification catalogues, procurement documents, and customer requirements. Conversely, association standards not included in the recommended list are not invalid; however, their acceptance in official certification, public procurement, and international alignment may be lower.

China's standards system is taking shape around a basic structure of "general rules plus product rules." General standards set out the basic principles for life-cycle assessment and product carbon footprint accounting, while specific product standards define functional units, system boundaries, cut-off rules, allocation methods, and data requirements based on industry characteristics. General rules ensure that different products follow a common logic, while product rules improve comparability among similar products.

The challenge facing the standards system has expanded from technical provisions to adoption relationships. Companies not only need to know which standards exist, but also need to judge which standards certification bodies use, which versions customers recognize, whether export regulations impose additional requirements, and whether domestic accounting results can meet overseas requirements. A truly effective standards system cannot stop at issuing documents; it must also establish mechanisms for version management, recommended adoption, dispute resolution, and result conversion.

The number of standards should not be regarded as the sole indicator of system maturity. Product categories are highly complex, and it is neither realistic nor necessary to develop a separate standard for every model and every process. Excessively detailed standards would increase maintenance costs and may even lock in existing technological pathways. A more feasible future direction is to establish stable general modeling rules, product-category rules for major products, and clear mechanisms for data quality, version management, and mutual recognition.

2.5 Carbon Footprint Factors and Database Development Enter an Institutionalized Phase

Product carbon footprint labeling certification addresses whether the carbon footprint of a specific product has been developed in accordance with prescribed rules and whether it can be externally declared using a unified label. In January 2025, the first batch of national pilot programs was announced; in March, the general implementation rules were released; in July, the first batch of 17 product certification catalogues was published; and in September, product-specific implementation rules for those 17 products were released. The certification system has gradually evolved from pilot programs to a more complete framework consisting of catalogues, general rules, and product-specific rules.

In December 2025, seven departments issued the Work Guidelines for Building the Product Carbon Footprint Factor Database, making systematic arrangements for data development, quality evaluation, database architecture, sharing mechanisms, dynamic updates, and security protection. Together with the standard-setting guidelines released earlier, this document signals that China's product carbon footprint data system is moving from fragmented data collection toward institutionalized database development and governance.

In March 2026, the second edition of the National Greenhouse Gas Emission Factor Database was launched, increasing the total number of factors to 576 and further improving support for localized greenhouse gas accounting and product carbon footprint calculation.

First-hand corporate data and commercial databases have thus begun to form a tiered and collaborative structure.

2.6 Labeling, Certification, and Information Disclosure as Credibility Mechanisms

Product carbon footprint labeling certification examines whether the carbon footprint of a specific product has been developed in accordance with prescribed rules and whether it can be externally declared using a unified label. In January 2025, the first batch of national pilot programs was announced; in March, the general

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Product carbon footprint labeling certification converts accounting results into external declarations with clearly defined boundaries. Since 2025, China has successively advanced product carbon footprint labeling certification pilots, certification catalogues, general implementation rules, and the first batch of product-specific implementation rules, covering key products such as lithium batteries, photovoltaics, steel, electronic and electrical appliances, electrolytic aluminum, cement, and wood products. Certification bodies review not only the final figures, but also the accounting boundaries, activity data, emission factors, allocation methods, data quality, internal controls, and evidence records. Certification does not prove that a product is necessarily a "low-carbon product"; rather, it demonstrates that the relevant carbon footprint declaration complies with prescribed requirements within specific rules, time frames, and certification boundaries.

Corporate sustainability disclosure addresses what climate-related information companies should provide to investors and other stakeholders during the reporting period. The "Corporate Sustainability Disclosure Standard No. 1 — Climate (Trial)," issued in December 2025, requires greenhouse gas emissions to be disclosed by Scope 1, Scope 2, and Scope 3. Before the implementation scope and requirements are separately specified, companies may apply the standard voluntarily. This system is not a product carbon footprint accounting system, but it systematically incorporates, for the first time under China's unified national sustainability disclosure standards, both a company's own emissions and its value-chain emissions into the same disclosure framework.

The information disclosure rules of the capital market have further introduced greenhouse gas data into listed-company governance. The China Securities Regulatory Commission (CSRC) has coordinated and guided the Shanghai, Shenzhen, and Beijing stock exchanges in issuing sustainability reporting guidelines for listed companies, and has further issued report preparation guidelines, forming a sustainability

information disclosure rule system for the capital market. Among them, the Shanghai Stock Exchange and the Shenzhen Stock Exchange have imposed mandatory disclosure requirements on companies included in specific indices and on companies listed both domestically and overseas, while the Beijing Stock Exchange generally adopts voluntary disclosure. All relevant rules incorporate climate change response, greenhouse gas emissions, and value chain management into the disclosure framework, and provide definitions and preparation guidelines for Scope 3 emissions.

Scope 3 disclosure is the most important connection point between the information disclosure system and the product carbon footprint system. Scope 1 and Scope 2 emissions mainly come from a company's own fuel combustion, production processes, and purchased energy use, while Scope 3 covers upstream and downstream activities such as purchased goods and services, capital goods, transportation, waste treatment, and the processing, use, and disposal of sold products. To calculate these emissions, companies cannot rely solely on their own on-site data; they must obtain carbon emissions information from the life-cycle processes of raw materials, components, transportation services, and sold products.

Product carbon footprints can provide Scope 3 accounting data that is closer to actual supply chains than monetary estimates or industry averages. When companies lack primary data, they typically estimate Scope 3 emissions using procurement spend, industry average factors, or other secondary data. This approach is suitable for the initial identification of emission scale, but it is difficult to reflect real differences among suppliers. If suppliers can provide product carbon footprints for each tonne of steel, each kilogram of chemicals, each battery, or each component, purchasing companies can combine procurement quantities with the corresponding product carbon footprints to more accurately account for Scope 3 categories such as "purchased goods and services."

The product use and end-of-life stages also require support from life-cycle data. For automobiles, household appliances, industrial equipment, and electronic products, most life-cycle emissions often occur during the use phase after the product is sold. Recycled materials, packaging, and power batteries also require further consideration of recycling, treatment, and disposal processes. Product carbon footprint models can provide technical parameters for the use, end-of-life treatment, and downstream processing

of sold products under Scope 3, enabling corporate disclosures to extend beyond upstream procurement emissions.

Disclosure requirements will, in turn, drive the wider use of product carbon footprints along the supply chain. Listed companies and large enterprises that need to disclose Scope 3 emissions often require major suppliers to provide energy, material, and product carbon footprint data. To maintain customer relationships, suppliers will then make similar requests of their own upstream partners. Carbon footprint data, originally used mainly for product environmental assessment and certification, is therefore becoming essential baseline data for chain-leading enterprises to compile Scope 3 inventories, manage suppliers, and respond to capital markets.

However, product carbon footprints and Scope 3 emissions cannot simply be equated. A product carbon footprint focuses on a specific product and functional unit, typically calculating the unit emissions of a product within a defined life-cycle boundary. Scope 3, by contrast, is centered on the organization and reporting period, aggregating annual indirect emissions across the corporate value chain. Companies cannot directly add together all product carbon footprint values; instead, they need to convert them based on actual procurement volumes, sales volumes, reporting periods, organizational boundaries, and Scope 3 categories, while also addressing issues such as system boundaries, data periods, allocation rules, and double counting.

Certification results also cannot automatically replace corporate Scope 3 disclosures. The two serve different purposes, and Scope 3 covers a broader boundary. A certified product carbon footprint can enhance the credibility of supplier data and reduce the cost for purchasing companies to re-verify individual data points, but a single certificate typically covers only a specific product, production site, data period, and set of accounting rules.

Corporate Scope 3 disclosures also need to consider the completeness of value-chain coverage, the identification of significant categories, the treatment of missing data, internal controls, and assurance requirements at the corporate level.

Labeling certification and information disclosure have thus formed a mutually reinforcing institutional relationship. Certification enhances the credibility of carbon footprint data for individual products, while disclosure systems increase corporate demand for product carbon footprint data. Scope 3 accounting aggregates dispersed

product and supplier data into corporate value-chain emissions, and capital markets and buyers then use this information to evaluate corporate risk, transition capability, and supply chain management performance. Carbon footprint data is therefore no longer just a number on a product label; it is gradually becoming the data foundation for corporate climate disclosure and supply chain governance.

In the next phase, companies need to establish a unified data foundation that can support both product certification and Scope 3 disclosure. Raw material procurement volumes, supplier product carbon footprints, energy use, logistics activities, product sales, and usage parameters should be maintained, as far as possible, under a unified data governance system, and then calculated and reported according to the different boundaries of product certification and corporate disclosure. Only by reusing underlying data while applying differentiated upper-level rules can companies avoid repeatedly collecting the same data for different customers, certification programs, and disclosure requirements.

2.7 Supply Chains, Trade, and Key Products Drive Scenario Implementation

Supply chain policies are becoming the primary channel through which carbon footprint management moves from institutional development to corporate application. The Guidelines for Green and Low-Carbon Supply Chain Construction of Central Enterprises (Trial) require central state-owned enterprises to focus on carbon footprint management for key raw materials, products, and services, and to explore the use of carbon footprint certification results in supplier evaluation, procurement decisions, and information disclosure. Central state-owned enterprises are therefore not only responsible for managing their own carbon emissions, but also serve as key chain leaders that transmit carbon footprint requirements along the supply chain.

Chain-leader procurement can translate policy requirements into commercial conditions. Laws and recommended standards may not directly bind every small and medium-sized enterprise, but when central state-owned enterprises or large manufacturers incorporate carbon data into supplier qualification, bid scoring, and annual

evaluations, upstream companies must provide the corresponding information. The binding force of carbon footprints therefore extends beyond administrative enforcement into orders and supply chain relationships.

Supply chain policies also need to control compliance costs. If large enterprises each design separate data templates, accounting rules, and certification requirements, suppliers will face substantial duplicate reporting and repeated verification. One-time certification, multi-party mutual recognition, unified data formats, and tiered management are important conditions for implementing supply chain carbon footprints at scale. Leading enterprises also need to provide tools, training, and transitional arrangements for small and medium-sized suppliers, so that data costs are not unilaterally shifted onto them.

Green trade policies directly link product carbon footprints with export competitiveness. The Ministry of Commerce's Implementation Opinions on Expanding Green Trade proposes building a public service platform for green trade, accelerating the development of a carbon footprint database for foreign trade products, enhancing the service capabilities of third-party institutions, and formulating carbon footprint accounting standards for key foreign trade products. The policy positioning of this document is not to establish another independent accounting system, but to make use of domestic standards, databases, and service capabilities to reduce the costs for enterprises in responding to overseas green regulations.

The declaration of power battery carbon footprints marks the beginning of closed-loop management for carbon footprints of key products. The Notice on Carrying Out Carbon Footprint Declaration Work for Automotive Power Batteries, issued at the end of 2025, requires relevant power battery products sold in China to undergo accounting, declaration, and third-party verification, and proposes that accounting rules, standard systems, evaluation and certification systems, and industry background data systems be largely established by the end of 2026. This system connects product rules, corporate reporting, industry databases, verification agencies, and data traceability into a single management process.

The institutional significance of power batteries extends beyond a single industry. The power battery industry has a long supply chain, a high degree of internationalization, and a prominent share of emissions from upstream materials. It is also a key product category under the EU Battery Regulation.

Selecting power batteries for declaration can therefore serve as a focused test of whether China's carbon footprint system can handle complex bills of materials, supplier data, green electricity attributes, industry factors, and international mutual recognition.

The accounting system for non-fossil energy electricity consumption has begun to connect energy attributes with carbon footprint data. The Guidelines for Accounting of Non-Fossil Energy Electricity Consumption (Trial) specify methods such as physical recognition, market transaction recognition, and reasonable allocation, require the avoidance of double counting of non-fossil energy electricity attributes, and apply to accounting for 2026 and subsequent years. These guidelines are not a product carbon footprint standard, but they will affect how enterprises prove electricity sources and how electricity data in product carbon footprints aligns with green electricity, green certificates, and non-fossil energy consumption.

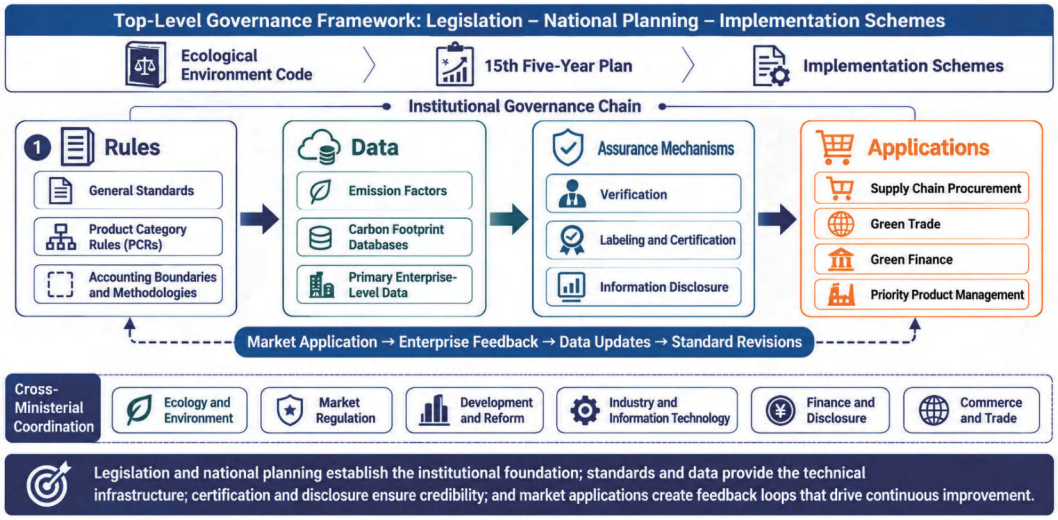
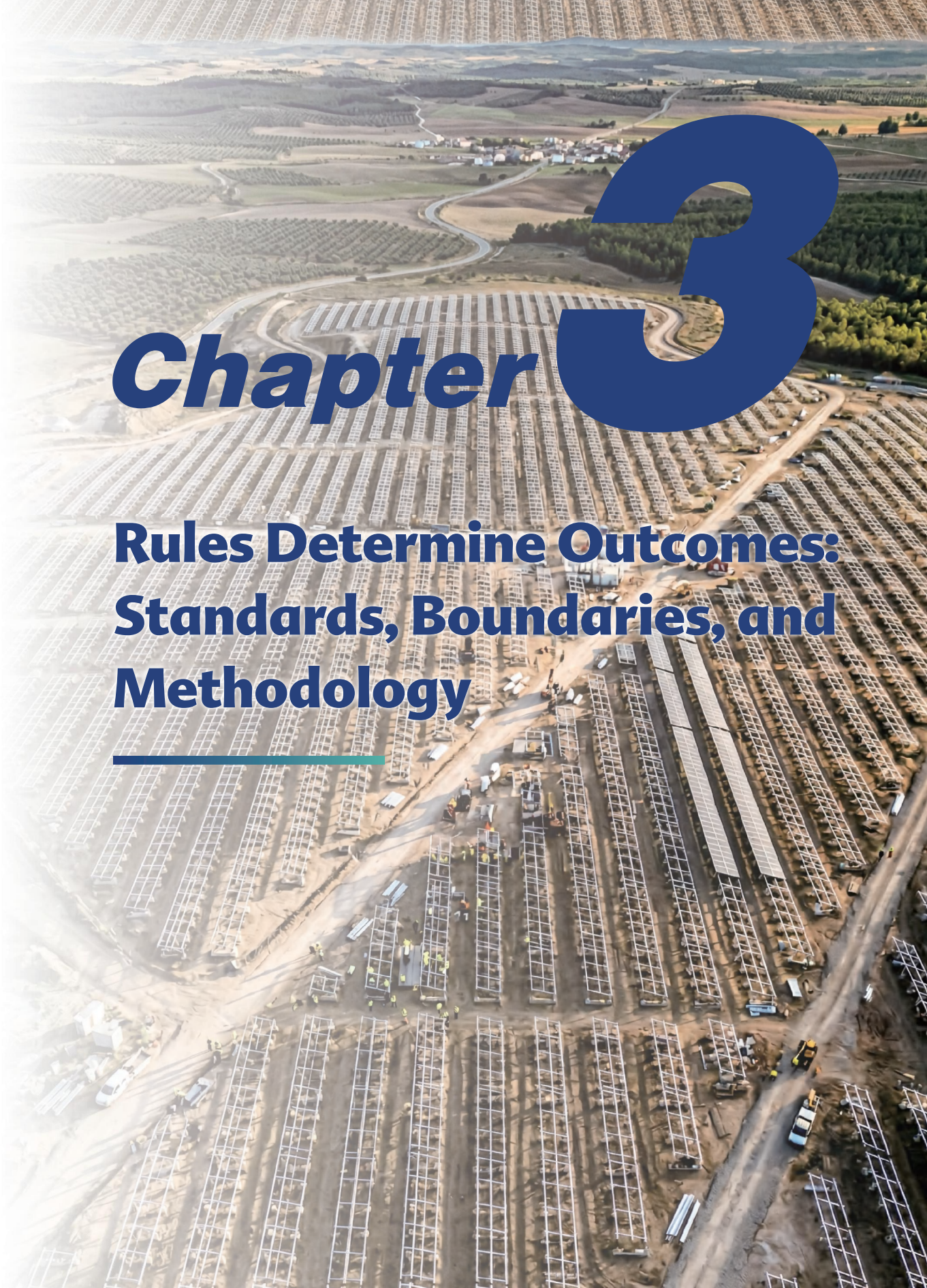


Figure 2 China's carbon footprint institutional chain: rules, data, credibility, and application

Carbon footprint application scenarios are also expanding into government procurement, green finance, and product grading. Official progress reports show that some financial institutions have begun exploring the integration of product carbon footprints with loan interest rates, guarantees, and credit enhancement tools, while industries such as steel, automotive, and electronics are also studying product carbon footprint grading and evaluation. As a result, carbon footprints are shifting from "whether to disclose a number" to "whether this number can influence prices, credit, and

procurement choices."

Application scenarios are the ultimate test of whether the carbon footprint policy system can operate sustainably. Only when enterprises see that product carbon footprints can reduce redundant audits, gain customer recognition, improve financing conditions, or support product R&D will they continue to invest in high-quality data and emission reduction measures. If the system only imposes accounting requirements without generating feedback from procurement, finance, and consumption, carbon footprints are likely to regress into one-off reports.



Chapter 3

Rules Determine Outcomes: Standards, Boundaries, and Methodology

A product carbon footprint may appear to be a quantitative indicator, but in essence it is a result defined by a set of rules. When the same product is assessed using different system boundaries, functional units, service lives, allocation methods, recycling models, and background data, it may produce significantly different carbon footprint results. The physical processes of the product remain unchanged, yet the numbers may vary because the accounting rules differ.

This discrepancy does not mean that carbon footprints lack a scientific basis. Life-cycle assessment is built on objective data on material flows, energy flows, and greenhouse gas emissions, and its fundamental methods have already reached a relatively mature international consensus. The real issue is that product systems in the real world are highly complex, and any accounting exercise must define boundaries, categorize processes, and simplify reality. The role of standards is to specify which processes should be included, which emissions may be cut off, how emissions from co-production should be allocated, and which data can be accepted.

As carbon footprints shift from internal analytical tools to the basis for certification, procurement, subsidies, and market access, methodological differences become even more important. Internal management may allow companies to choose data scopes that are relatively stable and suited to their own needs, but public policy must ensure that different companies are compared under relatively consistent rules. The closer carbon footprints come to interest allocation and market competition, the less standards, boundaries, and data can be treated as mere technical details.

3.1 Global Carbon Footprint Standards Form Different Rule Systems on a Common Technical Foundation

Global product carbon footprint standards share a highly consistent technical foundation.

ISO 14040 and ISO 14044 establish the basic framework for life-cycle assessment, while ISO 14067 and the GHG Protocol Product Standard further apply this framework to climate change impacts. Different systems generally require the same fundamental steps, including goal and scope definition, life-cycle inventory analysis, impact assessment, and interpretation of results.

The main differences among global

standards do not lie in whether they adopt life-cycle thinking, but in their standard-setting bodies, application purposes, and the degree of constraint they impose on specific technical details. Existing systems can be broadly categorized into four types: foundational rules, regulatory rules, application-specific rules, and data-exchange rules. These four categories are not mutually exclusive; rather, they address different issues, such as accounting principles, regulatory compliance, market use, and data circulation.

Foundational rules provide universally applicable accounting principles. The ISO system emphasizes standard-setting procedures, common frameworks, and verification foundations, while the GHG Protocol provides more detailed guidance for corporate and value-chain accounting. Because foundational standards need to apply across a wide range of industries, they typically do not specify complete parameters for each product, leaving many technical choices to practitioners or to subsequent product rules.

Regulatory rules serve specific public-policy purposes. The EU Product Environmental Footprint method and specific regulations in areas such as batteries and fuels not only define general accounting principles, but also further constrain databases, default parameters, system boundaries, recycling formulas, and data quality requirements. These rules emphasize uniform implementation across market participants and offer relatively less flexibility, but they are better suited to product access, subsidy tiering, and regulatory enforcement.

Application-specific rules serve specific industries and market platforms. Environmental Product Declarations (EPDs) typically use Product Category Rules to define the functional unit, accounting boundaries, and disclosure content for similar products. Industries such as chemicals, steel, automotive, and electronics are also gradually establishing industry-specific product carbon footprint guidelines. Their core value lies in translating general standards into operational rules that industries can actually implement.

Data-exchange rules focus on how carbon data is transmitted across supply chains. As corporate Scope 3 accounting and chain-leading procurement requirements expand, completing a single product carbon footprint is no longer sufficient to meet management needs. Companies must also understand how data fields are defined, how quality levels are represented, how emission reduction attributes are assigned, and how upstream and downstream systems exchange

data. Carbon footprint standards are therefore evolving from accounting documents into supply chain data protocols.

Together, these four types of rules form the global carbon footprint system, yet practical application remains highly fragmented. Companies may simultaneously face ISO certification, customer requirements based on the GHG Protocol, EPD Product Category Rules, EU regulatory methodologies, and supply chain data templates. The same batch of production data may need to be recalculated and reported repeatedly under different structures, increasing corporate costs and weakening the comparability of results.

In 2025, ISO and the GHG Protocol announced a strategic partnership in response to this fragmentation of rules. The two parties plan to harmonize greenhouse gas accounting standards at both the organizational and product levels, establishing a more consistent system of terminology, principles, and reporting. This collaboration does not mean that all carbon footprint rules will be replaced by a single standard; regulators and industry organizations will still retain more specific technical requirements based on their own policy objectives. However, the underlying accounting language is moving toward convergence, which can help reduce duplicate accounting efforts for companies.

In the future, global carbon footprint standards are more likely to form a structure of "common foundation plus scenario-specific rules." General standards provide shared terminology and methodological principles, product category rules define industry-specific scopes, regulatory rules specify compliance requirements, and data-exchange rules ensure that results can be transmitted along the supply chain. Companies need to understand the functional boundaries of different standards and should not interpret "international standards" as a one-size-fits-all answer for all scenarios.

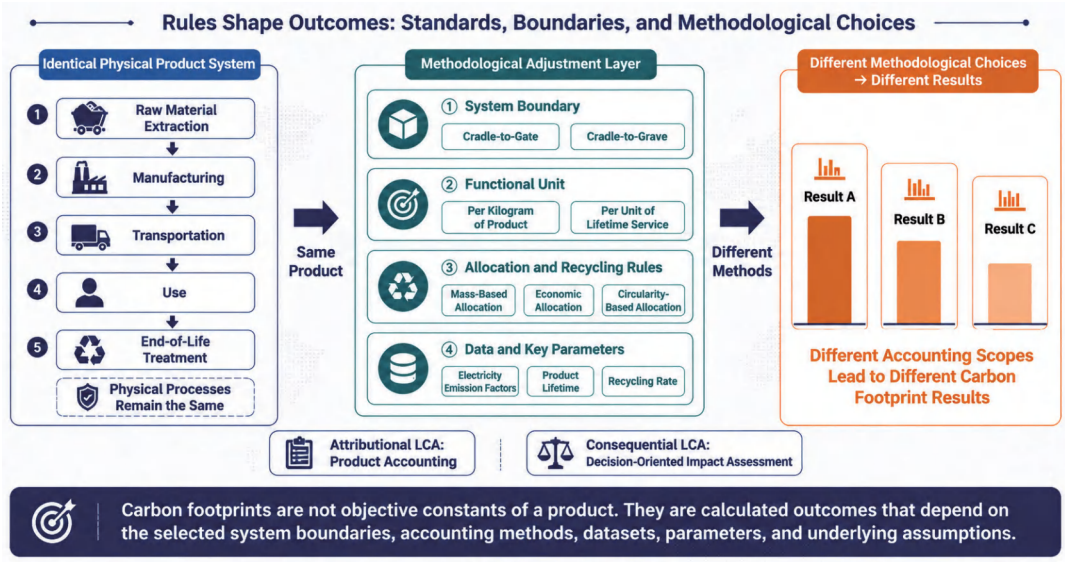


Figure 3 Why the Same Product Can Have Different Carbon Footprints

3.2 General standards must be translated into executable rules through product rules

General standards address consistency in principles, while product rules address comparability of results. ISO 14067 can require product carbon footprints to follow the principles of life-cycle thinking, relevance, completeness, consistency, and transparency, but it cannot predetermine the service life, loss rate, transportation distance, recycling scenario, or allocation method for every product.

The value of product category rules lies in narrowing the choices left open by general standards. Only when similar products use comparable functional units, life-cycle boundaries, data requirements, and calculation methods can they be meaningfully compared. Without unified product rules, companies may all claim to follow the same general standard yet still produce incomparable results because key parameters differ.

Differences in carbon footprint results are often hidden in a few highly sensitive parameters. Two reports may share more than 90% of their methodology and data, yet if vehicle service life, electricity factors, material recycling rates, or co-product allocation methods differ, the final results can

diverge significantly. Consistency in general principles cannot automatically eliminate discrepancies in specific parameters.

The carbon footprint of automobiles is a typical example. The vehicle production stage can be calculated based on materials, components, energy, and manufacturing data, but the use stage also requires assumptions about vehicle lifetime, annual mileage, actual energy consumption, grid changes, and fuel consumption. Different assumptions not only change the total carbon footprint, but may also alter the relative differences among gasoline vehicles, hybrid vehicles, and battery electric vehicles.

Product rules also help regulate market claims. In self-conducted accounting, companies may tend to favor boundaries and parameters that are more advantageous to themselves. This does not necessarily constitute data fraud, but it may lead to methodological selection bias. If different companies each choose the most favorable service life, recycling scenario, and allocation rule, the market will ultimately see a large number of carbon footprint results that are formally compliant but substantively incomparable.

Product rules cannot be subdivided indefinitely. Given the vast number of product models, process routes, and use scenarios, establishing separate rules for every minor difference would make the standards system difficult to maintain and could also lock in existing technologies. A more reasonable approach is to specify basic functional units and key parameters for similar products, while allowing companies to address special scenarios with adequate explanation and sensitivity analysis.

The rapid development of carbon footprint standards for Chinese products reflects growing industry demand for accounting rules, but it also exposes issues of overlapping rules and inconsistent methodologies. For the same product, national standards, industry standards, local standards, and multiple association standards may coexist, making it difficult for companies to determine which set of rules will be recognized by certification bodies, customers, and overseas markets. If the increase in the number of standards is not accompanied by coordination and recognition mechanisms, it may instead increase market uncertainty.

The maturity of a product carbon footprint standards system ultimately depends not on the number of standards, but on whether it can establish a relatively stable basis for comparison. A truly effective product rule should clearly define the

accounting object, functional unit, system boundary, data quality, allocation method, and disclosure requirements, and should allow results to be recalculated by third parties. The value of standards lies not in giving all products lower numbers, but in enabling different entities to participate in evaluation under relatively consistent rules.

3.3 System boundary and functional unit are the fundamental prerequisites for the comparability of carbon footprints.

The system boundary determines what a carbon footprint report actually calculates. A product may adopt a "cradle-to-gate" boundary, covering raw material extraction through the point at which the product leaves the factory, or a "cradle-to-grave" boundary, covering production, use, and end-of-life stages. Fuels and transportation products may also adopt boundaries such as "well-to-wheel," from fuel production to vehicle use. Different boundaries answer different questions, and their results cannot be directly compared side by side.

"Cradle-to-gate" is suitable for transferring intermediate product data between companies. For steel, aluminum, chemical products, battery materials, and components, the final product's use and disposal are usually not yet determined when these materials or components are delivered downstream; therefore, their product carbon footprints are generally calculated up to the point at which they leave the manufacturing enterprise. Downstream companies can then incorporate this data into the life-cycle models of vehicles, buildings, electronic products, or other end products.

"Cradle-to-grave" is more suitable for evaluating the overall climate impact of end products. Automobiles, household appliances, and industrial equipment may consume significant energy during the use phase. If only the manufacturing phase is compared, major differences caused by product energy efficiency and service life may be overlooked. For such products, higher emissions during production can sometimes be offset by lower use-phase emissions, and vice versa. Some products have low manufacturing emissions but, because of their long service lives, generate higher emissions during use, making it even more important for manufacturers to improve product energy efficiency through R&D.

Boundary selection may also result in negative values at certain stages. Biomass

products absorb carbon dioxide from the atmosphere as they grow. If the accounting method records uptake as negative emissions and release as positive emissions, and only calculates emissions up to the factory-gate stage, products such as timber and bio-based materials may show a negative carbon footprint. However, when these products are ultimately incinerated or degraded, the biogenic carbon stored in them may still return to the atmosphere. Therefore, a negative value at the factory-gate stage cannot automatically be equated with negative emissions over the full life cycle.

Cut-off rules determine which small-scale processes may be excluded. Life-cycle chains can be traced almost indefinitely, and it is impractical for companies to collect data on all auxiliary materials, equipment maintenance, and infrastructure. Standards therefore typically allow cut-off criteria to be set based on mass, energy, or environmental contribution. Cut-offs improve accounting efficiency, but if high-emission, low-mass inputs are mistakenly treated as insignificant, they can also systematically underestimate results.

The functional unit determines whether different products provide the same service.

Carbon footprints cannot be compared solely on the basis of emissions per kilogram or per unit of product; it is also necessary to determine whether the products perform the same function. Products with longer service lives, higher load capacities, or better energy efficiency may have a lower carbon footprint under the same service conditions, even if their manufacturing emissions per unit are higher.

Product comparisons must be based on function rather than appearance. When comparing two packaging materials, it is not enough to compare emissions per kilogram of material; the amount of material required to provide the same packaging function, the breakage rate, and the recycling method must also be considered. When comparing different batteries, it is necessary to consider their ability to store or deliver the same amount of electricity, as well as cycle life and degradation. When comparing vehicles, the same mileage, vehicle functions, and usage environment should be considered.

Service life is one of the parameters within the functional unit that can most easily influence results. A product's manufacturing emissions typically occur at the beginning of its life cycle; the longer the service life, the lower the production emissions allocated to each unit of service.

However, if companies lack real scrappage and usage data, service life

can easily become a tool for artificially adjusting results. Product rules should use representative statistical data wherever possible and require companies to explain any deviations from default values.

Temporal boundaries also affect carbon footprint results. The electricity mix, recycling technologies, and energy efficiency all change over time. For products with a use phase lasting more than a decade, consistently applying the electricity factor from the year of production may fail to reflect actual future emissions. On the other hand, directly adopting overly optimistic future grid scenarios may also underestimate the product's true climate impact.

System boundaries and functional units are not merely formal statements in a report; they are the entry point for understanding the results. Any carbon footprint value loses its full meaning once it is detached from the accounting boundary, functional unit, and applicable scenario. When publicly disclosing carbon footprint results, key boundaries and assumptions should be disclosed alongside the results to avoid presenting a conditional result as a universal conclusion.

3.4 Allocation rules determine the carbon responsibility of co-production and recycled materials

Allocation is one of the most controversial methodological issues in product carbon footprint accounting. Real-world production processes often generate multiple products and by-products at the same time, and a factory's energy consumption and emissions cannot be naturally divided among individual products through metering alone. Practitioners must therefore choose a rule for allocating the environmental burden of shared processes to different outputs.

Physical allocation distributes emissions based on mass, energy, volume, or other physical relationships. This method is relatively stable and easy to verify, but the mass or energy share of a product may not reflect its actual role in driving the production process. A small quantity of high-value by-products may receive a very low emissions allocation, thereby showing an exceptionally favorable carbon footprint.

Economic allocation distributes emissions according to the market value of products.

This method reflects the economic purpose of production activities, but it is

vulnerable to price fluctuations. The same product may produce different carbon footprint results at different stages of the price cycle, even when the production process remains completely unchanged, reducing the comparability of results over time.

By-product hydrogen from the chlor-alkali process provides an intuitive example of the impact of allocation rules. When the same batch of by-product hydrogen is allocated by mass, it may receive a very low unit carbon footprint; when it is allocated by economic value, the emissions assigned to it may increase significantly.

Attributional and consequential approaches represent two different ways of thinking about a product's impact. The attributional approach focuses on how emissions occurring within the existing production system should be attributed to a given product, making it suitable for product labels, certifications, and corporate accounting. The consequential approach focuses on whether a product, project, or decision changes emissions across the broader system, making it suitable for policy and scenario analysis. The former is easier to audit and compare, while the latter is closer to the actual climate effect in a counterfactual sense, but relies heavily on assumptions about markets and energy systems. Taking by-product hydrogen from the chlor-alkali process as an example again, if the consequential approach is adopted and the analysis considers what would happen if this by-product hydrogen were not recovered and used, the carbon footprint result could be close to zero. The hydrogen molecules themselves remain unchanged; the change in the carbon footprint comes from how responsibility for emissions is assigned conceptually.

The attributional and consequential methods cannot be mixed arbitrarily within the same product carbon footprint. The attributional method accounts for emissions that actually occur and are attributable to the product, while the consequential method may include avoided emissions from substituted production processes outside the system boundary. If a company calculates its own emissions using the attributional method on the one hand, while selectively incorporating favorable system-substitution benefits on the other, the result may lead to asymmetric emission reduction credits and distorted carbon footprint outcomes.

Circular materials further amplify the allocation challenge. Using recycled aluminum, recycled plastic, or recycled steel can often avoid some virgin resource

extraction and energy-intensive production, but there is no single physical answer to whether this environmental benefit should belong to the previous product that supplied the scrap or to the subsequent product that uses the recycled material. Different accounting methods essentially allocate emission reduction benefits within the circular value chain, and these benefits must not be counted more than once.

The cut-off method typically assigns the burden of recycled materials before they enter the next life cycle to the original product, while assigning emissions from the recycling process and subsequent stages to the new product that uses the recycled materials. This method is simple and transparent, and can provide clear low-carbon benefits to users of recycled materials, making it highly practical for Scope 3 supply chain accounting and corporate procurement accounting.

The closed-loop approximation method places greater emphasis on the continuous circulation of materials across multiple life cycles. It reallocates the burden of virgin material among different products based on material losses and end-of-life treatment. This approach can reflect the overall circular system, but it requires more end-of-life data and is more difficult to calculate and audit.

The Circular Footprint Formula adopted under the EU Environmental Footprint framework further integrates virgin materials, recycled materials, recycling processes, and avoided emissions at end of life into a unified allocation approach. Its essence is not simply to calculate how much energy the recycling process consumes, but to distribute environmental benefits among waste suppliers, recycled material producers, and users through preset coefficients. The selection of parameters in the formula therefore directly affects how much low-carbon value different industrial actors can obtain.

Allocation rules determine how emissions from shared processes enter product accounts; however, how low-carbon attributes continue to be transferred between companies must be addressed through chain-of-custody rules.

3.5 Disaggregated Accounting for Biogenic Carbon, Land Use, and Carbon Removal

On January 30, 2026, the GHG Protocol released its first Land Sector and Removals

Standard, more systematically incorporating agricultural land use, land management, and certain carbon dioxide removal activities into corporate greenhouse gas accounting. The standard brings land traceability, changes in carbon pools, the durability of removals, and the risk of carbon reversal from specialized technical discussions into corporate supply chain management, making simplistic claims such as "biomass is naturally low-carbon" or "planting trees can offset product emissions" harder to sustain. Its release has brought a long-standing question back into the industry spotlight: how should the carbon footprints of biogenic-carbon products and carbon-removal products be understood and accounted for?

Biogenic carbon can be treated in different ways in product carbon footprint accounting. For ease of explanation, this report summarizes two common approaches used in practice as the "0/0 method" and the "+1/-1 method." These labels are informal descriptions used in this report and are not official terms uniformly adopted in international standards.

The "0/0 method" does not include biogenic CO_2 uptake or eventual release in the net total when specific assumptions are met. However, fossil emissions from cultivation, processing, and transportation, as well as other greenhouse gases such as methane and nitrous oxide, must still be accounted for.

The "+1/-1 method" accounts for biogenic carbon according to its actual flow: CO_2 absorbed from the atmosphere during plant growth is recorded as negative emissions, while biogenic carbon re-released into the atmosphere during product combustion, degradation, or disposal is recorded as positive emissions.

When the full life cycle is covered and the amount absorbed is essentially equal to the amount ultimately released, the net results of the two treatment methods may be relatively similar. However, under boundaries such as "cradle-to-gate," which do not include the final disposal stage, the "+1/-1 method" may cause products such as wood and bio-based materials to show negative values at the factory gate because the biogenic carbon stored in the products has not yet been released. This interim negative value indicates that carbon is temporarily stored in the product and cannot be directly interpreted as the product achieving permanent carbon removal or a "carbon-negative" full life cycle.

Carbonated beverages such as cola provide a more intuitive example of carbon mobility. Injecting purified industrial by-

product carbon dioxide into beverages is a form of carbon dioxide utilization, but once the beverage is opened and consumed, the carbon dioxide quickly re-enters the atmosphere. Carbon dioxide temporarily stored in products cannot be regarded as permanent sequestration, nor can a product's carbon footprint simply be reduced by an equivalent amount merely because recycled carbon dioxide was used.

The source of carbon dioxide also affects life-cycle outcomes. Extracting natural geological carbon dioxide introduces carbon that had been sequestered underground over the long term into the current atmospheric cycle. Using industrial by-product carbon dioxide may reduce the need for new extraction and purification, but whether it leads to systemic emission reductions depends on the original treatment of the by-product gas, the energy consumed during capture and purification, and how the related emissions are allocated.

Direct land-use change is an unavoidable source of emissions in the carbon footprint of biomass products. Conversions among forests, grasslands, croplands, and plantations can alter aboveground biomass, belowground biomass, dead organic matter, and soil carbon pools. A biomass material may have relatively low processing emissions, but if its feedstock comes from recent deforestation or high-carbon land conversion, the resulting land carbon loss may completely offset the product's advantages.

Indirect land-use change involves even greater uncertainty. When a crop is diverted to biofuels or biomaterials, existing food demand may drive new cropland expansion elsewhere, potentially leading to remote forest or peatland loss. Such impacts depend on global markets, yields, and substitution relationships, and are often difficult to attribute directly to a specific batch of products. They are therefore better suited to policy and scenario analysis than to inclusion in product carbon footprint totals without explicit explanation.

Land-sector and carbon-removal rules are raising supply chain traceability requirements. Companies that wish to include agricultural management, soil carbon enhancement, or biomass carbon removal in their greenhouse gas inventories must demonstrate a genuine link among the relevant land, carbon sinks, carbon pools, and the products they procure, while continuously monitoring potential carbon reversals. Simply purchasing an offset claim detached from the physical supply chain is increasingly insufficient to support Scope 3 or product-level removal claims.

Biogenic carbon information should be presented as a separate item in carbon footprint reports. Fossil-derived emissions, biogenic non-CO_2 emissions, biogenic carbon uptake, carbon storage in products, direct land-use change, and other additional impacts should be reported separately wherever possible, avoiding the use of a single aggregated net value that masks climate impacts from different sources and across different time scales.

3.6 Attributional and Consequential Methods Serve Different Accounting Purposes

International life-cycle assessment studies generally distinguish between Attributional Life Cycle Assessment (ALCA) and Consequential Life Cycle Assessment (CLCA). This distinction is widely used in academic research and methodological discussions, but it does not mean that all international standards strictly divide life-cycle assessment into two mutually exclusive systems. ISO 14040 and ISO 14044 primarily specify the principles and procedures of life-cycle assessment; the specific modeling approach still depends on the research objective and application context.

The attributional method focuses on how environmental burdens within an existing production system are attributed to a specific product. Based on activities that have already occurred or that are representative of production, it allocates emissions from raw materials, energy, transportation, and production processes to a particular product according to defined system boundaries and allocation rules. It answers the question: "Under a given production system, how much emissions should be attributed to producing one unit of this product?" Corporate product carbon footprints, environmental product declarations, product labels, and most third-party certifications mainly adopt this method.

The consequential method focuses on how emissions across the broader economic or technological system change after a decision is made. It not only tracks the materials and energy used by the current product, but also identifies which marginal supplier would meet additional demand, how the market would change when one product is substituted for another, and whether a measure triggers additional emissions or reductions beyond the system boundary. It answers the question: "Compared with not

implementing this decision, would emissions in the global or relevant system increase or decrease if this decision were implemented?"

The difference between the two methods is essentially a difference in accounting logic. The attributional method is more like an environmental accounting system, focusing on recording emissions that have already occurred in product ledgers according to clear rules. The consequential method is closer to decision-impact assessment, focusing on the construction of counterfactual scenarios to compare system-level emission differences between "taking action" and "not taking action." The former emphasizes attribution, while the latter emphasizes change.

The same activity can produce different results under the two methods. For example, when a company uses by-product hydrogen, the attributional method requires part of the emissions from the upstream co-production process to be allocated to the by-product hydrogen according to established allocation rules. The consequential method would further examine whether, if the company did not use this portion of by-product hydrogen, it would be vented, flared, or replaced by other hydrogen production methods. The attributional method accounts for the emissions borne by the product within the existing system, while the consequential method assesses the emission changes caused by the decision to use by-product hydrogen relative to alternative scenarios.

The attributional method has become the mainstream approach for product carbon footprints mainly because it is easier to standardize and verify. Companies can provide data on raw material procurement, energy consumption, output, and production processes; practitioners can calculate results according to established boundaries and allocation methods; and third parties can review the results based on the same rules. Even when some allocation methods remain controversial, clear and consistent rules allow market participants to conduct accounting, certification, and data exchange within a relatively stable framework.

The institutional function of product carbon footprints also explains why they primarily rely on the attributional approach. Product labeling, supply chain reporting, procurement evaluation, and market access require answers to how much emissions a specific product bears within a defined boundary, rather than a new global market counterfactual model for each batch of products. The attributional approach sacrifices some completeness in capturing system dynamics, but gains the operability, repeatability, and auditability required for

large-scale application.

The dominance of the attributional approach does not mean that the consequential approach is unimportant. The attributional approach is suitable for compiling product accounts, while the consequential approach is suitable for assessing whether emission reduction actions truly change system-wide emissions. Companies can use the attributional approach to compile product carbon footprints and make external claims, while using the consequential approach or scenario analysis to evaluate the actual emission reduction effects of major technology pathways, energy procurement decisions, and supply chain adjustments. The two methods should each answer the questions they are designed for and cannot substitute for one another.

Mixing methods is a risk that must be carefully avoided in practical accounting. If an enterprise collects production emissions using the attributional method but selectively deducts avoided emissions from the consequential method as negative values, it may create asymmetric accounting boundaries. Product carbon footprints should maintain methodological consistency according to established rules. System substitution effects, avoided emissions, and policy impacts may be reported separately as supplementary analyses, but should not be incorporated into product carbon footprint results without clear explanation.

The essence of carbon footprint standards is to compress complex reality into repeatable rules. Standardization primarily serves governability, rather than fully reconstructing the real world. The attributional method provides a relatively stable environmental accounting framework for product carbon footprints, while the consequential method helps decision-makers understand systemic changes beyond those rules.

Mature carbon footprint management must ensure that product accounts are clear and verifiable, while also avoiding a direct equation between emissions changes on paper and real global emission reductions.

3.7 Enterprises should establish stable calculation standards and multi-rule adaptability

The primary task of corporate carbon footprint management is to establish stable internal accounting standards. External standards will continue to be updated,

and different customers and markets will impose different requirements, but the data sources, division of responsibilities, and basic calculation processes used for internal management must remain consistent. Only with relatively stable standards can companies determine whether changes in product carbon footprints result from actual emission reductions or from methodological adjustments.

Maintaining a consistent methodology does not mean refusing updates. Companies should clearly define the system boundaries, functional units, factor versions, allocation methods, and recycling models currently in use, and retain records of all previous versions. After standards are updated, they can recalculate results or conduct variance analysis under both the old and new rules, rather than directly comparing results calculated using new methods with historical data without appropriate context.

Companies need to distinguish between external standards and internal procedures.

External standards define the principles and market requirements that the industry collectively follows, while internal procedures specify who collects activity data, how missing data should be handled, how shared processes should be allocated, which results require review, and how long evidence should be retained. The capability that companies can truly build is a sustainable set of internal data and calculation processes, rather than the mere publication of a standalone corporate standard.

Multi-rule adaptation should be built on a unified underlying data foundation.

Companies do not need to develop separate, disconnected data systems for ISO certification, customer reporting, EU regulations, and internal management. Raw materials, energy, output, logistics, and supplier information should be collected as uniformly as possible, and then adjusted in terms of boundaries, allocation, and result presentation according to different rule requirements.

Sensitivity analysis should become a routine part of accounting for complex products.

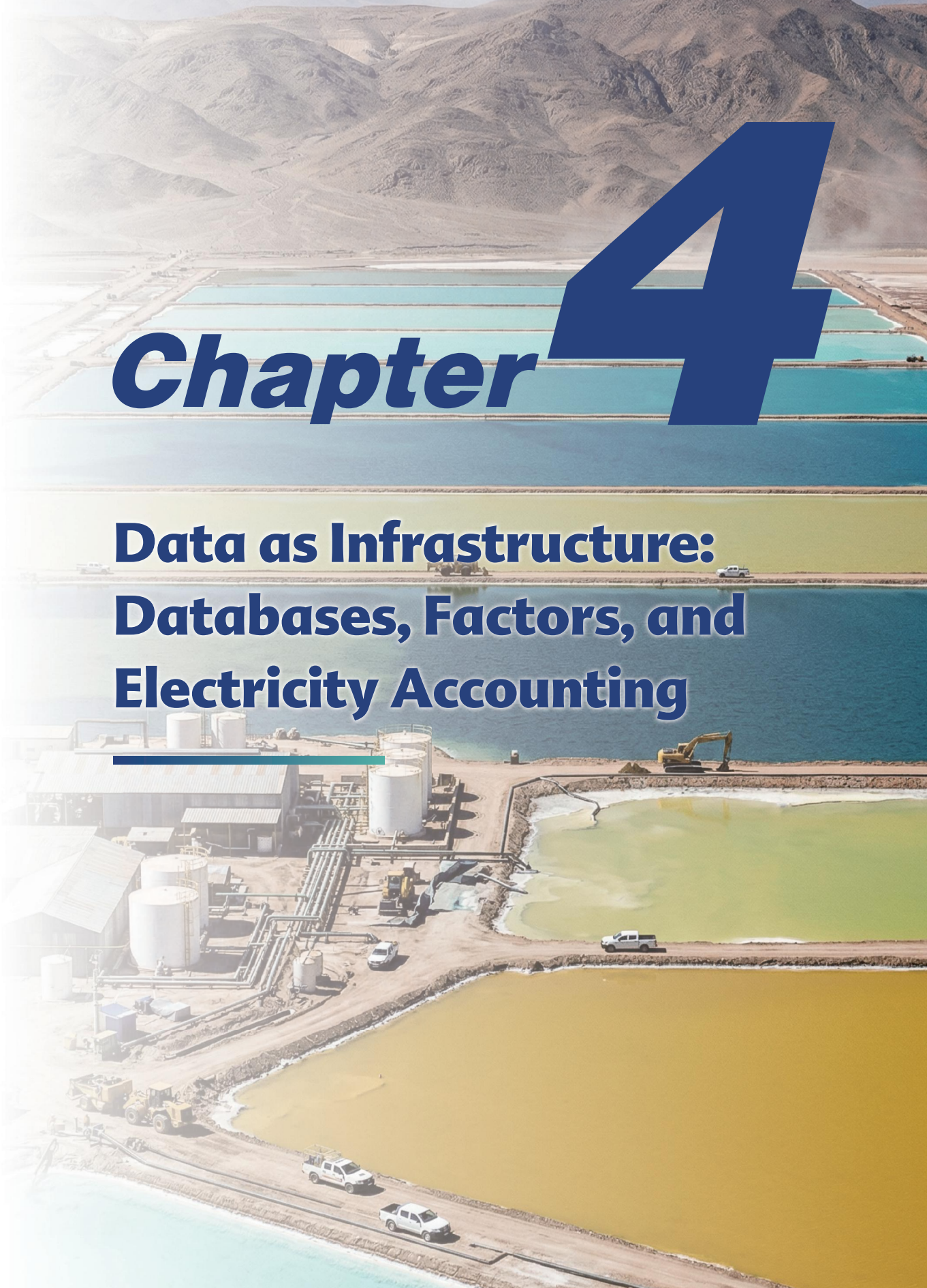
For key variables such as service life, electricity factors, recovery rates, co-product allocation, and future scenarios, companies should not only provide a single result but also assess how reasonable parameter variations may affect the conclusions. A result that is highly sensitive to key parameters should not be used for simple product rankings or rigid reward-and-penalty mechanisms.

Carbon footprint reports should

prioritize interpretability. Companies should clearly explain the accounting object, functional unit, system boundary, data period, major emission sources, allocation methods, and data quality, rather than merely highlighting a single aggregated final number. Itemized disclosure is especially necessary for content that is prone to misunderstanding, such as biogenic carbon, recycled materials, carbon removal, and market-based attributes.

Companies should not treat achieving the lowest possible carbon footprint as the goal of methodology selection. Choosing more favorable boundaries and allocation rules may produce more favorable results in the short term, but it will reduce data credibility in customer audits, certification, and policy compliance. Long-term competitiveness comes from a stable, transparent, and reviewable accounting system, not from one-off numerical optimization.

Rules determine results, but rules do not replace real emission reductions. The role of standards, boundaries, and methodologies is to transform complex life-cycle emissions into information that can be managed and compared. Ultimately, companies still need to reduce physical emissions through energy substitution, material optimization, process improvement, extended product life, and improved recycling efficiency. Only when accounting rules and actual emission reductions are both in place can product carbon footprints truly deliver environmental and commercial value.



Chapter 4

Data as Infrastructure: Databases, Factors, and Electricity Accounting

In product carbon footprint accounting, the most visible element is the final result, while the least visible is the data system that supports it. Standards can define system boundaries, functional units, and allocation principles, but what actually enters the calculation process are enterprise activity data, energy and material emission factors, life-cycle process data, and various technical and market parameters. Without these data, standards remain methodological frameworks only; if the data lack representativeness or traceability, even the most meticulous calculations cannot produce credible results.

Data issues have long been a major challenge for Chinese companies conducting product carbon footprint accounting. A company's own energy and material data are often scattered across production, procurement, finance, and equipment management systems, while stable first-hand data for upstream raw materials remain limited. Publicly available factors often suffer from fragmented sources, inconsistent methodologies, and insufficient localization. Under these circumstances, companies may rely on overseas databases, industry-average data, or scattered research reports to complete their accounting, but the results may not accurately reflect China's energy structure, production processes, or supply chain characteristics.

Since 2025, China's carbon footprint data system has shifted from fragmented factor to infrastructure development. The national greenhouse gas emission factor database continues to expand, an update mechanism for electricity carbon footprint factors has been established, industries such as lithium batteries, automobiles, and building materials are accelerating the development of specialized data, and local public service platforms and domestic databases are also growing rapidly. The focus of data development is shifting from "whether a value can be found" to "where this value comes from, under what conditions it applies, whether it can be verified, and whether it can flow across different systems."

4.1 China's Carbon Footprint Database Is Forming a Layered and Collaborative Structure

China has a wide range of industrial sectors, and its product and technology pathways evolve rapidly, making it difficult for national authorities to continuously

capture real-world data across all subsectors, regions, and companies. A more practical path is to establish a layered system in which national foundational databases, industry-specific professional databases, local databases, corporate data, and commercial databases are interconnected.

The national database serves foundational and cross-cutting functions. Data on electricity, fuels, primary energy, bulk raw materials, general transportation, and waste treatment are repeatedly referenced by a wide range of products and have clear public-good attributes.

When the state organizes the development and public release of such data, it reduces redundant calculations across industries, unifies baseline metrics, and provides an authoritative data foundation for domestic certification, policy management, and public services.

Industry databases serve specialized and refined functions. The production processes for lithium batteries, automobiles, steel, chemicals, building materials, and electronic products differ significantly, and only industry organizations, research institutions, and key companies can fully understand the material structures, process routes, and regional distributions involved. Industry databases can extend beyond national foundational data to cover specialized raw materials, components, and production processes, making the data more closely aligned with actual industrial chains.

Industry data development has gradually shifted from scattered research to large-scale efforts. According to a progress report released by the Ministry of Ecology and Environment, the lithium battery carbon footprint background database updated in 2025 now contains more than 1,200 data entries, covering 28 major production areas across China's lithium battery industry chain. As of May 2026, the automotive life-cycle database had cumulatively developed more than 600 process datasets, and the building materials sector had also established multiple data categories, including cement, glass, lime, ceramics, and manufactured sand.

Local databases and public service platforms support regional adaptation.

The same material may use different energy structures, transportation methods, and production processes in different regions, and local data can compensate for the limitations of national averages in reflecting regional differences. Local platforms can also connect enterprise reporting, product accounting, certification services, and data aggregation, serving as an interface between policy implementation and enterprise

services.

Local platforms should not each build their own closed data systems. Regions can develop distinctive datasets around local competitive industries, but basic coding, metadata, data quality assessment, and exchange formats need to remain compatible. Otherwise, as the number of local databases increases, integrating cross-regional supply chains will become more difficult, and companies will still need to repeatedly match data from different platforms for the same material.

Enterprise data is the layer closest to actual production within the overall system. Public and industry databases mainly provide average or representative data, while the true advantages of a company's specific products ultimately need to be demonstrated through its own energy, material, and supplier data. Industry averages can support accounting at the initial stage, but they cannot identify differences among companies in the same industry in terms of equipment efficiency, energy structure, and process management.

Commercial databases support expanded coverage, continuous updating, and application services. Commercial institutions can invest professional teams to maintain complex process models and provide cross-border data, software interfaces, scenario analysis, and technical support. For processes not yet covered by public databases, or for companies that need to connect with overseas projects, commercial databases still have irreplaceable practical value.

The key to a layered system lies not in determining which type of database has the highest status, but in establishing relationships of mutual use and validation. The state provides foundational data and governance rules, industries supplement specialized processes, localities offer regional adaptation, enterprises contribute first-hand data, and commercial institutions provide coverage and services. Together, these entities form a data supply chain rather than a simple substitution relationship.

4.2 Data quality depends on complete contextual information and the chain of evidence

The reliability of a factor cannot be judged solely by the number of decimal places in its value. Product carbon footprint data must also specify the corresponding product, technology, region, year, system boundary, and data source. Without this

contextual information, the same factor may be fully applicable in one project but lead to serious misjudgment in another.

Temporal representativeness determines whether data reflects current production conditions. Energy structures, process efficiency, and pollution-control technologies are constantly changing. Even if data from ten years ago were considered high quality at the time, they may no longer represent current products. After technological upgrades in energy-intensive industries, continued use of outdated process factors may underestimate or overestimate actual corporate emissions.

Geographic representativeness determines whether data reflects local energy and supply chain conditions. China differs significantly from Europe and North America in terms of energy mix, raw material sources, transportation distances, and equipment efficiency, and regions within China also vary from one another. Directly applying average overseas data to Chinese companies does not necessarily produce higher or lower results, but it is likely to cause results to deviate from the actual production system.

Technological representativeness determines whether factors correspond to companies' actual production processes. The same material can be produced using different raw materials, fuels, and equipment routes. Steel can come from blast furnace–basic oxygen furnace, electric arc furnace, or hydrogen-based metallurgy routes; hydrogen can be produced from coal, natural gas, water electrolysis, or by-product processes; and plastics and chemicals may also follow multiple production pathways. Treating identical product names as identical technological processes is a common mistake in database use.

Completeness determines whether data cover the prescribed life-cycle processes. A value labeled as an "electricity factor" may include only fuel combustion during power generation, or it may also include fuel extraction, equipment manufacturing, transmission and distribution, and line losses. A material factor may be calculated only up to the factory gate, or it may also include transportation or recycling credits. Users must first confirm the boundary before deciding whether the data can be used in the current model.

Traceability determines whether data can serve as external evidence. Databases should retain source materials, calculation methods, data processing procedures, review records, and version changes so that professionals can assess how the data were developed.

Certification and regulation do not require full disclosure of all trade secrets, but they do require an evidence chain that can be verified under authorized conditions.

Uncertainty information helps prevent over-interpretation of data precision. Industry-average factors, sample-based measured data, and company-specific data differ in representativeness and should not be used in the same way. Databases can indicate uncertainty through quality grades, coefficients of variation, sample ranges, and confidence intervals, helping users determine whether the data are suitable for preliminary screening, internal management, or formal certification.

The value of public data does not lie in guaranteeing that every figure is always correct, but in allowing the data to be examined, questioned, and corrected. The China Product Carbon Footprint Database (CPCD) provides an important insight for building a localized database: openness does not mean perfection; it means being open to scrutiny, correction, and iteration. What a database truly needs to avoid is not all uncertainty, but "black-box certainty" that fails to explain its sources and applicable conditions.

4.3 Public databases and commercial databases have different application boundaries

There is no simple hierarchy of superiority between public and commercial databases. Public databases generally offer advantages such as free and open access, strong policy recognition, and stronger localization, but their data coverage, update speed, and software service capabilities may be limited. Commercial databases typically provide broader coverage, mature models, and ongoing technical support, but some data may lack geographic and temporal representativeness, and the underlying processes may not be fully disclosed due to intellectual property protection.

Product carbon footprint labeling certification imposes stricter requirements on the use of commercial databases. The "Knowledge Session on the Pilot Work of Product Carbon Footprint Labeling Certification," issued by the State Administration for Market Regulation in 2025, states that commercial databases should not be directly used for product carbon footprint quantification; instead, priority

should be given to conducting upstream and downstream supply chain surveys or using localized database factors. Only when suitable factors cannot be obtained should appropriate data be selected in accordance with the product-specific implementation rules. What is restricted here is "direct application" without suitability assessment, explanation, or traceability, not the use of commercial databases in all scenarios.

The focus of this requirement is "not using them directly," rather than a blanket rejection of commercial databases. Certification requires determining whether a factor is applicable to a specific company and product, and companies cannot skip verification of the data year, region, process, and boundary merely because they have adopted a well-known international database. Commercial databases can serve as background data sources, but their suitability must be confirmed, and results that cannot be disaggregated or explained should not be directly included in certification materials.

The certification system places greater emphasis on the data formation process than on who owns the database. Whether a factor comes from a public database, a commercial database, or a company's internal data, it is difficult to constitute credible evidence if its source, scope of application, and calculation process cannot be explained. Conversely, commercial data that has undergone suitability analysis, boundary adjustment, and cross-validation can still play a role when it complies with specific rules.

Product carbon footprint certification is shifting from "results-based accounting" to "evidence-based certification."

Commercial databases still have significant value in initial screening and product design.

In the early stages of product R&D, when the final supplier and process route have not yet been determined, companies can use broad-coverage background data to quickly identify high-emission materials and life-cycle hotspots. At this stage, the purpose of accounting is to compare design options, and each factor does not necessarily need to reach the level of primary data required for certification. Commercial databases may also be highly applicable in international projects. Overseas clients, product environmental declaration platforms, and the EU Product Environmental Footprint initiative may specify particular databases or data quality rules. Even if Chinese companies have already used local data to complete domestic certification, they may still need to establish a separate set of calculation results in accordance with international

project requirements. This does not mean that domestic data is invalid; rather, different projects operate under different rules and acceptance systems.

Companies should establish a data selection hierarchy based on application scenarios. For internal hotspot identification, industry averages and commercial background data can be used more extensively. Product design requires better alignment with specific technologies and regions. Supply chain management should gradually transition to primary supplier data, while public disclosure and certification need stronger data traceability, auditability, and regulatory compliance. The data threshold should rise with the external impact of the results.

When companies face multiple domestic and international rule sets at the same time, they do not need to build entirely independent data systems from scratch. Raw material procurement volumes, energy consumption, product output, and supplier data can serve as common underlying data, while background databases, boundaries, and allocation rules can be adjusted according to different project requirements. What truly needs to be established is multi-rule adaptability, rather than multiple fragmented data ledgers isolated from one another.

Public and commercial databases will continue to coexist over the long term.

Public databases are responsible for providing foundational data, policy standards, and fair conditions for use, while commercial databases are responsible for expanding coverage, improving efficiency, and offering professional services. The more important issue is not which type of database will ultimately replace the other, but how to establish data interfaces, quality assessments, and reasonable acceptance rules.

4.4 The electricity factor has become the most critical data in product carbon footprints

Electricity factors are particularly important for the carbon footprints of manufactured products in China. Industries such as steel, non-ferrous metals, chemicals, electronics, batteries, machinery, and data services all rely heavily on electricity. Even minor changes in electricity factors, when amplified by large-scale electricity consumption, can significantly alter a product's carbon footprint. For electrolytic

aluminum, electrolytic hydrogen production, and certain electronic materials, electricity can even determine whether a product remains competitive in low-carbon terms.

The electricity carbon dioxide emission factor and the electricity carbon footprint factor have different meanings. The electricity carbon dioxide emission factor is typically used to account for indirect emissions from electricity use at the corporate or regional level, focusing on carbon dioxide emissions from fossil fuel combustion during power generation. By contrast, the electricity carbon footprint factor adopts a life-cycle approach, incorporating fuel extraction and transportation, power plant construction and operation, the manufacturing of renewable-energy equipment, and other upstream processes, and expresses multiple greenhouse gas impacts in carbon dioxide equivalents.

The two types of factors cannot be used interchangeably simply because they share the same unit. For Scope 2 accounting at the corporate organizational level, it is generally necessary to select either the grid emission factor or market-based data in accordance with the applicable framework. For product carbon footprint accounting, it is more appropriate to adopt an electricity carbon footprint factor that aligns with the life-cycle boundary. Directly applying the carbon dioxide emission factor for electricity to a full life-cycle model may omit upstream emissions from electricity generation; conversely, applying a full life-cycle electricity factor to frameworks that require only direct emissions from generation may also result in boundary inconsistencies.

Renewable electricity is treated quite differently under the two accounting methods. Wind power, solar PV, hydropower, and nuclear power generate virtually no carbon dioxide from fossil fuel combustion during power generation, but equipment manufacturing, engineering construction, fuel supply, and maintenance may still generate life-cycle emissions. Therefore, although they may be treated as having near-zero direct emissions from power generation in certain indirect-emissions accounting, this does not necessarily mean that their product carbon footprint factors are zero.

The successive release of China's electricity carbon footprint factors has improved the localization of product accounting. In 2024, the national average carbon footprint factor for electricity was 0.5777 kg CO_2 e/kWh, and the data released for the same period also provided life-cycle factors for coal-fired power, gas-fired power, hydropower, nuclear power, wind power, solar PV, concentrated solar power, and

biomass power generation.

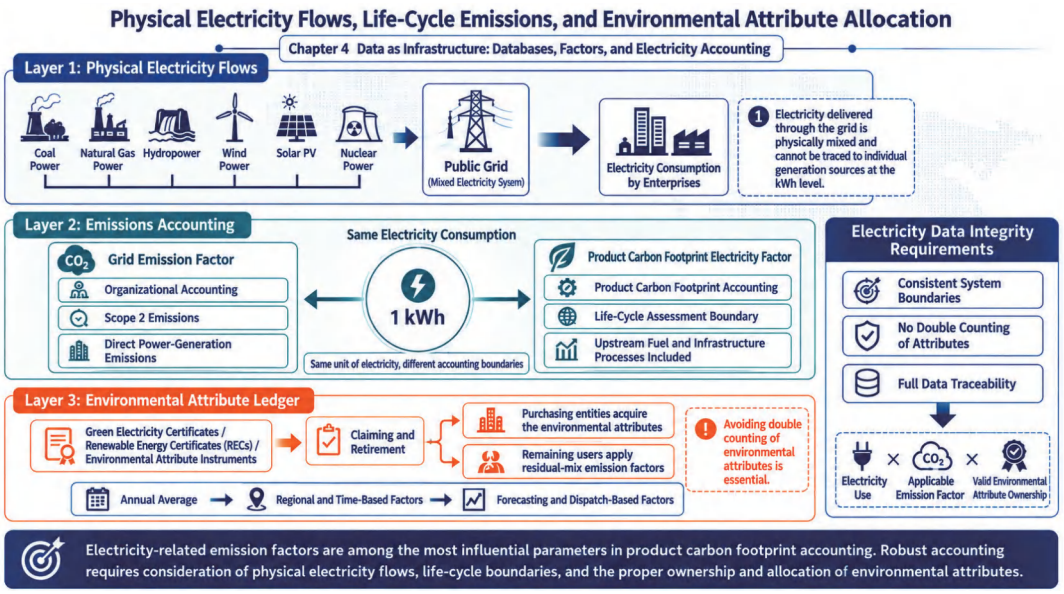


Figure 4 Three layers of carbon accounting for one kilowatt-hour of electricity: physical flow, life-cycle emissions, and green attributes

A decline in the electricity carbon footprint factor can reflect changes in the power supply structure and technology, but it should not be interpreted as meaning that all corporate products automatically achieve a proportional reduction in emissions. Companies differ in their actual electricity sources, regional grid structures, and market-based green electricity procurement, and the share of electricity in total product carbon footprints also varies. Changes in the national average factor serve only as a baseline condition; the carbon footprint of a company's products still needs to be calculated based on specific electricity consumption data.

Updates to electricity factors also affect historical comparability. After companies adopt a new annual factor, product carbon footprints may still decline even if production processes and electricity consumption remain completely unchanged. When externally disclosing emission reduction achievements, companies need to distinguish between changes brought about by overall improvements in the power system and those resulting from their own energy efficiency gains, energy substitution, and production improvements, so as to avoid attributing all emission reductions from the public grid to proactive corporate efforts.

The electricity factor is evolving from a

general parameter into a complex data set.

National averages, regional averages, provincial averages, specific power-generation technologies, market-based green electricity, and corporate self-supplied power each answer different questions. When companies choose an electricity factor, they are no longer simply looking up a number; they are making a methodological judgment involving accounting boundaries, energy attributes, and data representativeness.

4.5 Electricity accounting is shifting from average factors to attribute identification

Traditional electricity accounting primarily relies on average emission factors. After companies obtain electricity from the public grid, they are usually unable to determine which specific power plant each kilowatt-hour comes from, and can therefore only calculate average emissions based on national, regional, or provincial electricity mixes. This method is simple and stable, and is suitable for large-scale statistics and basic accounting, but it struggles to reflect differences arising from companies' green electricity trading, self-built photovoltaic systems, or direct power supply arrangements.

The development of the electricity market has given electricity not only physical-flow attributes, but also environmental attributes that can be traded and transferred. Companies can demonstrate that they have obtained a certain amount of non-fossil energy electricity through self-generation and self-consumption, direct green power supply, electricity trading, green electricity trading, or green certificate trading. As a result, electricity data in product carbon footprints is no longer determined solely by the average grid mix in the region where the company is located, but may also be influenced by the source of electricity and the attribution of its environmental attributes.

The Guidelines for Accounting of Non-Fossil Energy Electricity Consumption (Trial) classify non-fossil energy electricity consumption into physical recognition, transaction recognition, and allocation recognition. Physical recognition relies on actual connections and power flows, transaction recognition is based on electricity, green electricity, or green certificate transactions, and allocation recognition addresses grid electricity from mixed

sources that cannot be identified on a per-kilowatt-hour basis. Although the guidelines themselves are not a product carbon footprint accounting standard, by clarifying the attribution of non-fossil electricity attributes, they provide a foundation for more detailed accounting of indirect electricity emissions and product carbon footprints.

The core of electricity attribute accounting is not to track every electron, but to establish a closed-loop environmental attribute ledger. Physical electricity in the grid always operates as a mix, but green attributes can be allocated to specific entities according to trading contracts and rules. Whether a product carbon footprint can adopt specific green electricity data depends on whether the relevant attributes truly exist, have been retired, and have not been double-counted by other entities.

Attribute trading gives rise to the issue of residual electricity factors, meaning the factors corresponding to the electricity mix left for other users after some users have claimed green attributes. Once a portion of renewable energy attributes is purchased by a company, other users who did not purchase those attributes should, in principle, no longer benefit from the dilution effect of that green electricity on the average grid factor; otherwise, the same low-carbon attribute would be double-counted. A well-designed market system should deduct claimed green attributes from the residual electricity mix and calculate corresponding residual factors for other users.

Time matching is also an important condition for preventing double counting. Green certificates or green electricity attributes should have a reasonable correspondence with the relevant periods of electricity generation and consumption. If a company purchases and retires green certificates generated in earlier years but uses them to adjust the carbon footprint of current products, mismatches may arise between carbon accounts for different years. Electricity accounting is therefore moving from the simple use of average factors toward a more complex era of "attribute disaggregation."

When green electricity data is used in product carbon footprint accounting, the life-cycle boundary must remain consistent. The fact that a company can prove its use of renewable electricity does not mean that the life-cycle emissions of the related electricity are zero.

Product accounting should still consider equipment manufacturing, project construction, and other upstream emissions based on the corresponding power-generation

technology, although the results are typically significantly lower than those of fossil fuel-based electricity.

Average emission factors and attribute-based factors will coexist over the long term.

When reliable information on electricity sources and transaction details is unavailable, the average grid factor remains the most robust baseline data. Companies that can establish complete evidence through contracts, metering, and verification may adopt more targeted electricity data in accordance with applicable rules. The accounting system needs to improve precision while preventing double counting of attributes and excessive data embellishment.

4.6 Time-Segmented and Regional Factors Will Enhance the Management Value of Carbon Footprints

Annual average electricity factors can support reporting and statistics, but they are insufficient to guide companies in making low-carbon decisions at specific times and locations. During periods when wind and solar output is high and electricity load is low, the emission intensity of the same grid may decline significantly; during high-load periods, when coal- and gas-fired power plants provide peak-shaving capacity, emission intensity may rise. Averaging annual electricity emissions across every kilowatt-hour masks these variations.

Spatial differences also have a significant impact. The shares of coal-fired power, gas-fired power, hydropower, wind power, solar power, and nuclear power vary across provinces and regions, as do transmission links and dispatch conditions. Even if companies in two regions produce identical products using the same processes and energy efficiency levels, they may still generate different carbon footprints because of differences in electricity structure.

Time-of-use and regional electricity factors can turn these differences into actionable management information. Data centers can schedule some computing tasks during low-carbon periods, electric vehicles and energy storage systems can optimize charging and discharging plans, and hydrogen production through water electrolysis and other electricity-intensive industries can adjust operations based on electricity prices and carbon intensity. As a result, the carbon footprint is gradually shifting from a post-

hoc statistical tool to a production scheduling tool.

Time-of-use factors need to distinguish between average emissions and marginal emissions. The time-of-use average factor reflects the average emissions of all power generation on the grid during a given period and remains an attributional accounting method. The marginal emission factor, by contrast, analyzes which type of generating unit increases or decreases output when one additional kilowatt-hour of electricity is consumed or reduced, and primarily supports consequential analysis. Both have decision-making value, but they must not be conflated within the same product carbon account.

Predictive factors further shift accounting from "looking back" to "looking forward." Traditional electricity factors are published after the end of the year, allowing companies to account only for emissions that have already occurred. Predictive factors, by contrast, estimate the carbon intensity of electricity over the next few hours or days based on weather, load, power supply plans, and electricity market information, providing lead time for production and energy consumption scheduling.

Prediction results should not directly replace formal accounting data. Predictive factors are used for decision optimization, while actual emissions still need to be calculated afterward based on real power generation and consumption data. Companies can use predicted values to select operating periods and then use actual values to verify emission reduction effects, thereby forming a closed loop of "prediction—scheduling—accounting—verification."

Time-segmented and region-specific accounting imposes higher requirements on data infrastructure. Companies need smart meters and electricity consumption data at finer time scales, the power system needs to provide information on generation mix, regional exchanges, and environmental attributes, and databases need unified time zones, timestamps, and update frequencies. As data granularity increases, calculation results become more precise, but data gaps, system interfaces, and verification costs also rise accordingly.

Time-of-use and regional segmentation are not necessary for all products. For products with a low share of electricity, long production cycles, or limited scheduling flexibility, annual or regional average factors may already meet management needs. For industries with a very high share of electricity, strong operational flexibility, and strict green electricity requirements, higher temporal and spatial resolution offers clear

value. Data refinement should serve actual decision-making needs rather than becoming a new form of administrative burden.

4.7 Data infrastructure needs to undergo an upgrade from computable to credible to usable

The first stage of building China's carbon footprint database is to make data "computable and traceable." This stage requires closing fundamental data gaps so that companies can access commonly used factors for electricity, energy, materials, and transportation, while also clarifying data sources, boundaries, and versions. Insufficient data coverage makes accounting impossible, while untraceable data makes results unacceptable for review.

The second stage is to make data "standardized and credible." Different databases need to adopt relatively consistent classification systems, data formats, quality evaluation methods, and metadata requirements. Key data should be reviewed or verified and aligned with product carbon footprint standards, certification rules, and supply chain requirements. Credibility does not mean that all data must be exactly the same; rather, it means that differences can be identified, explained, and used appropriately.

The third stage is to make data "usable and user-friendly." Databases can truly generate value only when they are embedded in companies' R&D, procurement, production, certification, and disclosure processes. Users need to be able to quickly locate applicable data, compare different technology pathways, understand data limitations, and conveniently import data into accounting software and enterprise management systems.

User orientation is the ultimate test of the product carbon footprint data system. No matter how much data exists or how complete the standards are, if companies cannot find or understand the data, or if the data cannot be accepted by customers and auditors, the database will struggle to achieve sustained use. Carbon footprint data needs to enter actual decision-making through disclosure, labeling, supply chains, and procurement, and user feedback should then drive data updates and institutional improvements.

China's database development must also balance data openness with rights protection. Public foundational data should be shared as openly as possible, while company-specific

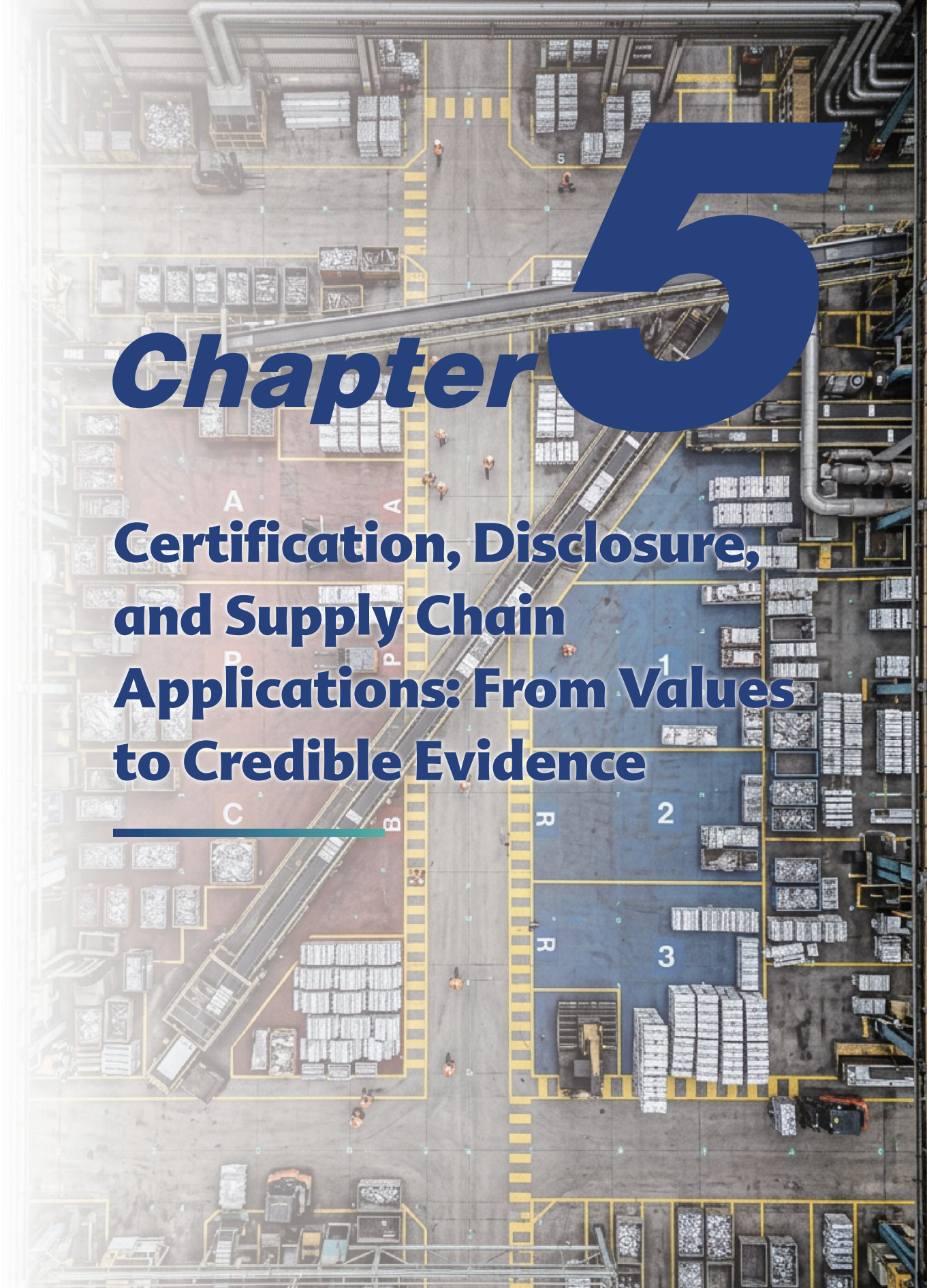
process and supplier data may involve trade secrets and therefore require tiered authorization, anonymization, and trusted computing to control the scope of use. Open sharing does not mean that companies must unconditionally disclose all raw data; rather, it means that data should be verifiable and usable under reasonable permissions.

International mutual recognition ultimately depends on data capability. The international market will not automatically accept a database simply because it carries a "China" or "international" label; instead, it will focus on whether the methodology is transparent, whether the data are representative, whether the process is subject to review, and whether the data can be converted to meet the requirements of target rules. Enhancing the international influence of Chinese data cannot rely solely on expanding the scale of databases; it also requires sustained participation in international standards development, data exchange, and quality evaluation systems.

The maturity of product carbon footprint data infrastructure is not measured by how many values are accumulated in a database, but by whether different stakeholders can conduct accounting, certification, and decision-making based on the same set of fundamental facts. National, industry, local, corporate, and commercial institutions each produce and maintain data; users are able to assess data quality and applicability; and accounting results can be transmitted reliably along the supply chain.

Data is becoming the most valuable long-term asset in product carbon footprint systems.

Standards may be updated, accounting tools may be replaced, and external rules will continue to evolve, but complete, accurate, and traceable activity data can be recalculated under different frameworks. The earlier a company establishes its own data foundation, the better it can reduce redundant costs amid future policy and market changes, while retaining the ability to explain the carbon performance of its



Chapter 5

Certification, Disclosure, and Supply Chain Applications: From Values to Credible Evidence

The technical calculation of a product carbon footprint only becomes meaningful for market transactions and corporate management when it is translated into credible evidence. A company may use internal data and life cycle databases to calculate a product carbon footprint value, but purchasers, certification bodies, investors, and regulators cannot determine whether the result is authentic based on the number alone, nor can they confirm whether the accounting boundaries, data sources, and allocation methods meet the requirements.

Once carbon footprints move from internal analysis into certification, disclosure, procurement, and market access, the institutional focus shifts from 'what the result was' to "how the result was produced, who confirmed it, and what claims it can support."

Credible evidence is not the same as obtaining a certificate. Certification, verification, information disclosure, supply chain traceability, and internal corporate management each serve different functions and together form the credibility mechanism for carbon footprints.

Accounting determines the emissions of a product, verification evaluates whether relevant claims and data comply with regulations, certification confirms under a specific institutional framework that the product and its accounting process meet requirements, and chain of custody determines whether low-carbon attributes can be transmitted along the supply chain. Only by linking these elements can a carbon footprint become operational information that can be relied upon by purchasers and the market.

5.1 The External Value of Carbon Footprints Depends on Evidence, Not Values

There is a clear information asymmetry in the external application of product carbon footprints. Companies know their own production processes, energy use, and data sources best, while external users can only see the final report or declaration. Companies may use real data or rely heavily on industry averages; they may cover the full system boundary or omit upstream stages where data is difficult to obtain; they may strictly follow product rules or choose the most favorable method among several permitted options.

A lower carbon footprint value does not certainly mean higher data quality.

Some companies have advanced production processes and lower actual emissions, but due to insufficient supply chain data, they can only use higher industry average default values; other companies may achieve seemingly lower results by narrowing the system boundary, adopting favorable allocation methods, or selecting less representative data. If the market only compares final values, it is easy to reward companies that are better at choosing methods rather than those that genuinely reduce emissions.

The credibility of a carbon footprint first depends on whether the results can be explained. A credible result should specify the product under assessment, functional unit, system boundary, data period, major emission sources, emission factors, allocation methods, and uncertainties. Users need to know not only how much the product emits, but also which factory, which time period, and which life cycle stages the value applies to.

The credibility of a carbon footprint further depends on whether the results can be verified. Raw material usage should be consistent with procurement records and material balances, energy data should be cross-checked against meters, bills, and production records, and supplier data should be traceable to specific products and accounting boundaries.

External institutions do not necessarily need public access to all trade secrets, but they s hould be able to verify key evidence under authorized conditions.

The level of evidence should match the context of use. For identifying emission hotspots within an enterprise, a greater reliance on averaged data and estimated parameters may be acceptable; for the raw material portion of a product carbon footprint, reasonably documented secondary data can be accepted when suppliers are unable to provide primary data; however, results used for public claims, product certification, green procurement, and regulatory compliance require stricter primary data, internal controls, and third-party evaluation. The greater the external impact, the higher the evidentiary requirements should be.

The essence of a credible carbon footprint mechanism is to reduce the judgment costs for both parties in a transaction. Buyers cannot possibly enter every supplier's factory to verify every data point, nor can investors recalculate the Scope 3 emissions of every company.

Standardized certification, verification, and data traceability systems enable users to form a basic judgment about information

reliability without fully understanding the underlying production processes.

5.2 Product Carbon Footprint Labeling Certification Establishes a Unified and Credible Framework

2025 marks the year when China's product carbon footprint labeling certification transitioned from institutional design to pilot operation. The pilot network announced in January covered 25 provincial-level regions and 57 pilot areas; the general implementation rules were released in March; the first batch of 17 product certification catalogs was published in July; and product-specific implementation rules were issued in September. By the time the official progress report was released in 2026, pilot regions had held 126 promotional and training sessions, selected 73 chain-leading enterprises for real-world data collection, and issued the first batch of certification certificates covering 5 major categories and 7 products.

The numbers are still in their infancy, but the system has moved from "whether rules exist" to a transition phase of "whether the rules can be practically implemented by enterprises and certification bodies."

Product carbon footprint labeling certification is not a simple confirmation of a value submitted by the enterprise itself. Certification bodies are required to conduct a systematic evaluation of the enterprise's data management, accounting process, documentation, personnel capability, and product boundaries in accordance with the general rules and product-specific rules. The accounting report is an important input to certification, but it is not the entire subject of certification.

The basic logic of certification is to trace the entire data chain back from the final result.

Certification bodies need to verify whether the product declared by the enterprise falls within the certification catalog, whether the functional unit and system boundary used in the calculation comply with the product rules, whether the main activity data comes from actual production, whether the background data is appropriate, whether the allocation and cut-off methods are consistent, and whether the calculation results can be recalculated.

On-site auditing is an important step that distinguishes product carbon footprint certification from general report review. Auditors need to assess whether the

written data aligns with actual conditions by considering the factory's production processes, equipment operation, material storage, and metering conditions. If the energy consumption and raw material data submitted by the enterprise clearly do not match its production capacity, procurement quantities, and product output, reliable results cannot be established even if the calculation formulas are correct.

Supply chain data is the most difficult part of certification to control. A company's own production data can be verified through internal records and on-site audits, but upstream material and component data may come from a large number of suppliers. Certification bodies need to assess whether the company has established procedures for supplier data collection and review, whether industry average emission factors are used appropriately, and whether upstream segments with a significant contribution to the carbon footprint have been prioritized for primary data collection.

Post-certification surveillance distinguishes certification from one-off project evaluations. After a company is certified, if there are significant changes in product processes, raw material sources, energy structure, or production locations, the original carbon footprint results may no longer be representative. The certification system needs to confirm through regular surveillance, change management, and re-evaluation that certified products continue to meet certification requirements.

The long-term value of a certification system lies in establishing a unified language of market trust. Carbon footprint reports published by different companies on their own may adopt different formats and levels of assurance, whereas unified label certification reduces the cost of case-by-case assessment by purchasers through prescribed rules, institutional qualifications, and oversight mechanisms. Only when certification is actually accepted in procurement, finance, and consumption scenarios can it transform from a technical system into a market institution.

5.3 Accounting, Verification, Certification, and Declaration Have Different Institutional Implications

Product carbon footprint accounting is a technical process of quantifying emissions. The accounting entity may be the enterprise itself, or it may be a consulting firm or other

technical service provider. As long as the necessary data, standards, and professional capabilities are available, enterprises can in principle complete carbon footprint accounting on their own, without necessarily requiring third-party involvement.

Verification is a process of independently evaluating carbon footprint claims and their supporting evidence. Based on established criteria, verification bodies check whether data contains material misstatements, whether calculations comply with regulations, and whether evidence is sufficient to support the claim, and they form verification conclusions according to the agreed level of assurance. The subject of verification is typically an already formulated greenhouse gas claim.

Certification, by contrast, is a conformity assessment decision made under a specific certification scheme. Product carbon footprint labeling certification requires not only evaluating the carbon footprint value, but also reviewing whether the enterprise meets certification requirements in accordance with the certification catalog, general implementation rules, and specific implementation rules. Certification results are typically presented in the form of certificates and labels, accompanied by post-certification surveillance.

A product carbon footprint claim is a specific expression through which a company communicates information externally. A company may declare the carbon footprint per unit of a product, or explain how much emission reduction has been achieved compared with a baseline product, or state the proportion of a certain type of low-carbon material used. Different claims require different evidence; calculating a carbon footprint value does not automatically entitle a company to make all low-carbon claims.

Product Environmental Declarations (EPD) and carbon footprint labeling certification are not exactly the same. Product Environmental Declarations typically disclose multiple life-cycle environmental impacts according to product category rules, while product carbon footprint labeling certification focuses more on greenhouse gas emissions and is conducted under national pilot programs. Both rely on life-cycle data, but they differ in the content disclosed, the objects evaluated, and the scenarios of use.

The accreditation system further constrains the capabilities of certification and verification bodies. Accreditation bodies evaluate third-party organizations' personnel, management procedures, impartiality, and technical competence to determine whether they are capable of carrying out specific

validation, verification, or certification activities. Being accredited does not mean that an organization can automatically conduct all carbon-related business; its scope of competence still needs to correspond to specific industries, standards, and evaluation activities.

Different third-party services should not be conflated under vague terms such as " international certification" or "carbon certification." Before purchasing services, companies should clarify whether the provider offers carbon footprint calculation, independent verification, product certification, product environmental declarations, or management system certification, and confirm whether the relevant results are accepted by target customers and regulatory authorities. Similar names do not mean the same legal and commercial effect.

5.4 Certification proves rule compliance, not l ow-carbon products

Product carbon footprint certification primarily proves that the results comply with established rules. Certification bodies confirm that enterprises have completed the accounting in accordance with applicable standards and certification rules, and that the data and documentation support the corresponding claims. However, this does not mean that the certified product's carbon footprint is necessarily lower than the industry average, nor does it mean that it holds a low-carbon advantage over all similar products.

Carbon footprint labeling and low-carbon product evaluation follow different logics. The former can be used to express a certified carbon footprint value, while the latter requires setting industry benchmarks, carbon emission limits, or grading standards to determine where a product stands. Without a clear comparative benchmark, certification mainly indicates that "the product has been properly accounted for and has passed certification," rather than "the product has achieved a low-carbon rating."

The scope of certification also has clear boundaries. A certificate typically corresponds to a specific product, manufacturing site, accounting period, and certification rules, and cannot be indefinitely extended to other factories, other products, or all future production batches within an enterprise. Certification of one factory within a corporate group does not directly prove that

the entire supply chain has obtained the same certification.

Certification results cannot be automatically used across different systems. Product carbon footprint certificates obtained under Chinese certification rules may be recognized by domestic customers and procurement projects, but overseas regulations, industry platforms, and multinational enterprises may still require the use of their designated methods, databases, or verification bodies. Certification can enhance data credibility, but it cannot bypass the specific rules of the target market.

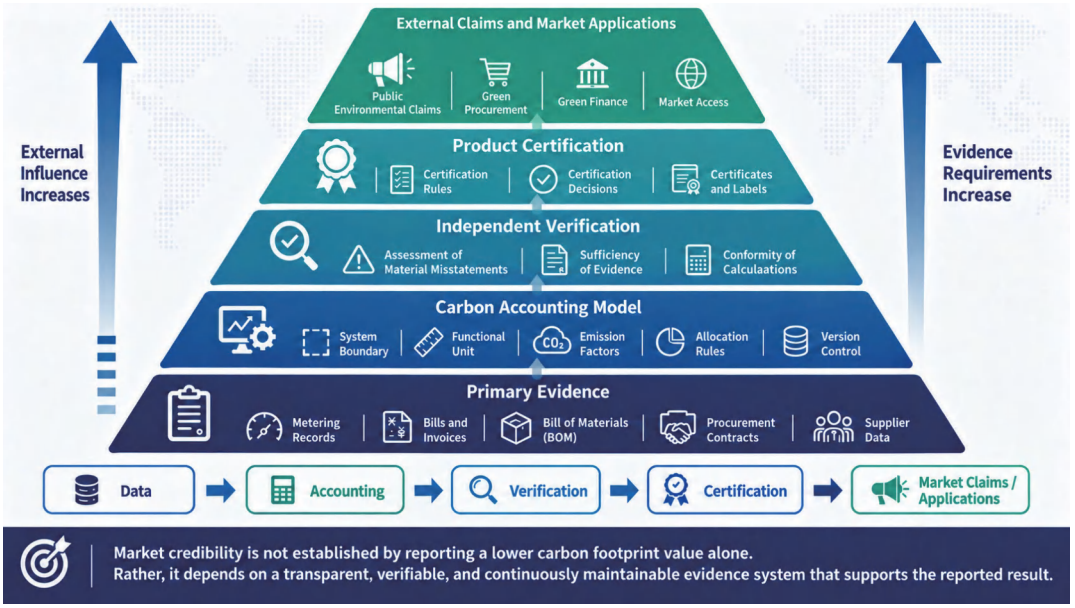


Figure 5 From Values to Market Acceptance: The Carbon Footprint Evidence Pyramid

Product carbon footprints are influenced by background data, model assumptions, and sampling methods, and third-party assessments cannot possibly verify every data point in the supply chain. The role of certification is to keep uncertainty and the risk of material misstatement within reasonable bounds according to established procedures, rather than to claim absolute precision of results. Therefore, the value of certification does not lie in completely eliminating uncertainty.

The true value of certification lies in demonstrating that a company has the capability to consistently produce credible data. A company's ability to continuously maintain product boundaries, activity data, factor versions, and supplier evidence is often more significant in the long term than achieving a lower value in a single

year. What buyers gain from this is not an isolated certificate, but a fundamental trust in the supplier's carbon data management capabilities.

5.5 International Certification is Essentially a Supply Chain Risk Control Tool

The commercial value of international certification primarily stems from buyers' risk management needs. Multinational corporations and international purchasers find it difficult to directly verify the raw material sources, production processes, and environmental attributes of upstream enterprises, so they require third-party certification bodies to inspect the supply chain according to relatively uniform rules, reducing procurement risk through certificates and traceability records.

The core of international certification is not to award honors to enterprises, but to help clients transfer part of their supply chain audit responsibilities. When buyers cannot audit hundreds of suppliers globally on their own, they can require suppliers to obtain designated certifications, with third-party bodies checking whether they meet access conditions.

Certification thus becomes a risk outsourcing mechanism that lowers buyers' investigation costs and compliance exposure.

The integrity of a certification system depends on the extent of supply chain coverage. A single factory's certification only proves that activities within that factory's scope meet the requirements; if upstream raw material sources, transportation, and trading links lack certification or traceability, the credibility of claims about the final product remains limited. Supply chain certification typically requires key links to be continuously included in the system, preventing low-carbon attributes from being interrupted in uncontrolled trading segments.

Enterprises that do not directly export may also bear the costs of international certification. When end brands and exporting companies face overseas regulations, they incorporate data and certification requirements into supplier contracts and pass them upstream to material and component manufacturers.

International green trade rules therefore do not only affect enterprises that clear customs for export, but also enter domestic supplier management through the industrial chain.

International certification cannot replace an enterprise's own risk judgment. Different certification systems have different application targets, accounting boundaries, and market acceptance. Enterprises should not assume that certificates issued by any overseas institution carry equivalent validity simply because customers require "international certification." Enterprises need to confirm whether the certification scheme is explicitly accepted by target customers, regulations, and trading platforms.

The competition between domestic and international certification ultimately comes down to the competition of rule adoption capability. China's establishment of a product carbon footprint certification system is not merely to develop the certification services market, but more importantly to create a credible mechanism that can be widely used by the domestic industrial chain and can be aligned with international rules where conditions permit. The foundation of international mutual recognition is not the name of the certificate, but standard compatibility, institutional competence, data transparency, and oversight systems.

5.6 Scope 3 Disclosure Drives Product Carbon Footprint to Become Supply Chain Data

Corporate Scope 3 disclosure is expanding the scope of use of product carbon footprint data. Scope 3 covers upstream and downstream emissions such as purchased goods and services, capital goods, transportation, product use, and end-of-life treatment. Enterprises cannot complete accounting based solely on their own factory data; they must obtain material, component, and product life cycle information from the supply chain.

Product carbon footprints provide a data interface at the unit-product level for Scope 3 accounting. When suppliers provide the carbon footprint per ton of material, per component, or per product, purchasing companies can calculate upstream emissions from their procurement activities based on actual purchase volumes. Compared to relying solely on procurement spend and industry input-output factors, this approach is better able to reflect differences among specific suppliers and product processes.

Scope 3 accounting, in turn, creates market demand for product carbon footprints.

When listed companies, multinational

corporations, and large supply chain leaders need to improve the quality of their Scope 3 data, they tend to prioritize requesting product carbon footprint data from suppliers with high emissions, high procurement spend, or high risk.

Even suppliers that do not directly face consumers may begin calculating product-level footprints in response to customer disclosure requirements and emission reduction targets.

Scope 3 disclosure does not require all suppliers to immediately provide fully certified data. For the large number of suppliers with relatively low emission contributions, companies can continue using industry average factors; for high-contribution categories such as steel, aluminum, chemicals, batteries, and logistics, the proportion of primary data should be gradually increased. Supply chain data management should be implemented in a tiered manner based on emission contribution and commercial importance.

Scope 3 accounting also requires handling the conversion between annual and product boundaries. Product carbon footprints typically represent emissions per unit product within a specific life cycle boundary, while Scope 3 aggregates a company's value chain emissions over a reporting period. Companies must adjust data based on procurement volume, sales volume, product lifespan, and the reporting period, and cannot simply sum up all product carbon footprint values directly. Once carbon footprint data moves from the product level into corporate disclosure, its applications expand accordingly. The data is not only used to calculate a total, but also to identify emission hotspots across procurement categories and suppliers, supporting supplier evaluation, procurement negotiations, and the allocation of emission reduction targets.

Product carbon footprint thus evolves from a disclosure input into a supply chain management tool.

5.7 Chain of Custody Determines the Transfer of Low-Carbon Attributes and Emission Reduction Benefits

Chain of Custody (CoC) addresses how low-carbon attributes are transferred along with products and transactional relationships. A company may be able to prove that a batch of materials comes from recycled sources, that a portion of its energy has renewable

attributes, or that a supplier has completed emission reductions—but whether these attributes can enter the downstream product carbon footprint depends on whether the supply chain has clear traceability and entitlement rules.

Low-carbon attributes are intangible benefits that are susceptible to double claiming. The same supplier emission reduction may be reported by the supplier in its own reduction report, counted by the chain-leading company as a Scope 3 decrease, and promoted by the end customer as a product-level reduction. Without clear rules for transfer and use, all parties may possess relevant data, yet none can prove the exclusivity of its claim.

A chain of custody is essentially a property registration and transfer mechanism for carbon attributes. It determines whether raw materials and products can be mixed in the supply chain, how attributes are allocated, which records must be kept, and ultimately what claims a company can make. At its core, it is a "rule for transferring carbon reduction property rights." Without a chain of custody, supply chain emission reductions could become an unverifiable mess.

The identity preservation model offers the strongest physical traceability. Raw materials remain segregated throughout the entire process—from source, production, and transportation to the final product—allowing traceability to specific producers and batches. Companies can make the most specific claims about origin and carbon footprint, but independent storage, dedicated production lines, and batch management significantly increase costs.

The physical segregation model allows mixing among qualified raw materials of the same type, but does not permit mixing with non-compliant conventional materials. Companies can no longer identify the specific source of each batch of raw materials, yet they can still demonstrate that the final product is made entirely from compliant low-carbon or recycled materials.

Controlled blending and mass balance models allow eligible raw materials to be mixed with conventional raw materials within certain limits. Enterprises demonstrate the conservation of total low-carbon attributes through input and output ledgers, and allocate attributes to some or all products according to the rules. This type of model reduces the cost of physical segregation and is more suitable for bulk raw materials and continuous production, but product claims must strictly comply with the corresponding allocation rules.

The ledger and declaration model allows

environmental attributes to be separated from specific physical products to a greater extent. Enterprises may acquire certain environ mental attributes by purchasing certificates or supporting related projects, yet they may not be able to prove that their products actually used the corresponding raw materials. This model can expand the scope of financial support, but it should generally not be conflated with product carbon footprint claims that have physical traceability.

The more flexible the chain of custody model, the lower the supply chain management cost for enterprises, but the weaker the product specificity of the claim. In complex manufacturing, it is impossible to implement identity preservation or strict segregation for thousands of materials. Enterprises need to select appropriate models based on product value, customer requirements, and emission reduction contributions. Core products and high-premium materials can adopt stricter traceability, while bulk commodity materials may rely more on mass balance.

The choice of chain of custody directly changes how product carbon footprints are expressed. Under identity preservation and segregation models, enterprises can directly link low-carbon material data to specific products; under the mass balance model, enterprises may only be able to claim average low-carbon attributes for the company, factory, or product portfolio; under the book and claim model, enterprises are better suited to demonstrate support for external emission reductions rather than easily reducing the physical carbon footprint of specific products.

Chain of custody is the key to transforming supply chain emission reduction from technical achievements into commercial benefits. Upstream enterprises willing to invest in low-carbon technologies often expect to gain orders or green premiums; downstream enterprises paying additional costs hope to reflect the corresponding benefits in product carbon footprints and customer claims. Clear rules for rights allocation can reduce double counting and provide a basis for allocating emission reduction costs and benefits between upstream and downstream parties.

5.8 Chain-leader procurement brings carbon footprint into supplier evaluation

Chain-leader enterprises are becoming the main drivers of product carbon footprint application. Large enterprises control product design, orders, procurement standards, and market access, enabling them to embed carbon footprint requirements into supplier admission, bid scoring, contract terms, and annual performance evaluation. As a result, carbon footprint has shifted from a voluntary corporate accounting initiative to a supply chain trading condition.

The requirements for green and low-carbon supply chain construction by central state-owned enterprises have reinforced this trend. Relevant guidelines incorporate supplier classification and grading, green product evaluation, green procurement, green production, green logistics, and product carbon footprint into an operable evaluation system, moving beyond principle-level advocacy. This effectively provides central state-owned enterprises with a green and low-carbon operational framework that can be directly embedded into procurement and supplier management. Integrating carbon footprint into procurement begins with identifying the suppliers that truly matter. Companies do not need to require all suppliers to complete certification immediately; instead, they should categorize suppliers based on procurement spend, product emission contribution, substitution difficulty, and supply risk. High-emission raw materials and core components should prioritize providing primary data, while low-impact materials can temporarily use industry average factors.

Supplier evaluation should not only compare absolute carbon footprint values.

Differences in region, technology route, and product specifications among suppliers mean that simply ranking by numerical values may be unfair. A more robust evaluation system should also consider data quality, management capability, emission reduction trends, industry benchmarks, and improvement plans.

Chain-leading enterprises need to avoid imposing conflicting data requirements on suppliers. If different large companies each design their own accounting boundaries, templates, and certification rules, the same supplier may need to perform duplicate calculations for multiple customers. Unified data fields, standardized acceptance, and mutual recognition of certification results

are the foundation for supply chain carbon management to operate at scale.

Supplier carbon footprint data should gradually be incorporated into procurement contracts. Contracts can specify the scope of data provision, update frequency, confidentiality responsibilities, third-party verification requirements, and mechanisms for notifying material changes, transforming carbon data from ad hoc questionnaires into stable transactional information. Corresponding liabilities should also be established for false data, duplicate claims, and failure to fulfill emission reduction commitments.

Chain-leading enterprises also bear the responsibility for supplier capacity building. A large number of small and medium-sized enterprises lack life cycle assessment personnel and software systems. If chain-leading enterprises only set requirements without providing templates, tools, and training, suppliers may only be able to purchase one-off consulting services and fail to develop sustained data capabilities. Supply chain carbon management should not be simply understood as shifting compliance costs upstream.

Green premiums and long-term orders are important incentives for driving supplier emissions reductions. Only when upstream companies expect that low-carbon investments will lead to procurement preferences, price compensation, or stable orders will they be motivated to provide high-quality data and undertake technological upgrades. If leading companies require suppliers to bear all emission reduction costs without adjusting their procurement decisions, carbon footprints may ultimately degenerate into a mere form-filling exercise.



Chapter 6

International Trade: How Carbon Footprints Reshape Trade, Subsidies, and Market Access

The ongoing changes in global carbon footprint rules are not simply the addition of a few standards or regulations; rather, product carbon emission information is beginning to enter critical stages of market operations. It is thus more easily converted into procurement conditions, subsidy thresholds, consumer claims, and cross-border costs.

Different international rules apply carbon footprints in different ways. ISO and the GHG Protocol primarily provide accounting language; initiatives such as SBTi translate carbon data into corporate targets and supply chain requirements; EU consumer protection rules constrain what product claims companies can make; UK electric vehicle subsidies condition fiscal support on climate performance; and the EU Carbon Border Adjustment Mechanism directly converts embedded product emissions into cross-border economic costs.

These rules also do not carry the same legal force. EU regulations can directly create compliance obligations, while EU directives require transposition into national law by member states; ISO standards and the GHG Protocol are, in principle, voluntary technical rules; SBTi is not a government body, but it may exert de facto market pressure through investment, procurement, subsidies, and customer evaluations. Companies need to distinguish between legal rules, certification rules, and market rules, and should not loosely refer to all international requirements as "international standards."

The common direction of global rule restructuring has become fairly clear. Rules are raising requirements for primary data in supply chains, placing greater emphasis on the geographic and temporal attributes of data, restricting the use of external carbon credits to embellish product performance, and directly linking accounting results to market interests. Product carbon footprints are shifting from technical indicators that describe environmental impacts to institutionalized information that participates in global industrial competition.

6.1 Global rules shift from voluntary disclosure to multi-level market constraints

Product carbon footprints were initially used primarily for voluntary environmental disclosure. Companies conducted life cycle assessments typically to identify environmental hotspots, publish product environmental declarations, or respond to

customer inquiries. The accounting results themselves rarely directly determined whether a product could receive subsidies, enter the market, or incur additional costs, and companies retained considerable latitude in choosing accounting boundaries and data precision.

The current international rules are forming a multi-layered structure composed of technical standards, industry initiatives, market contracts, and public regulations. Technical standards specify how to calculate, industry initiatives specify what targets companies should set, chain-leading enterprises transmit data requirements to suppliers through procurement contracts, and governments determine how the results are used through trade, subsidies, labeling, and consumer protection systems. As a result, product carbon footprints no longer function through a single system but are constrained by the overlapping effects of multiple rules.

The overlapping of rules expands the scope of influence of carbon footprints. A company may not be directly subject to EU regulations, yet still need to provide product data to EU customers; it may not have voluntarily joined the SBTi, yet be required to set emission reduction plans due to the Scope 3 targets of downstream companies; it may not directly apply for government subsidies, yet need to provide battery and material data to vehicle manufacturers that receive subsidies. International rules extend upstream through chain-leading enterprises and end markets, bringing a large number of companies not directly regulated into the carbon footprint system.

This constraint is primarily transmitted along the supply chain rather than being applied evenly across all enterprises. Companies at the nodes of end-brand products, key raw materials, and international trade are the first to feel the pressure, which then spreads to a broader range of small and medium-sized enterprises through procurement and supplier management. The coverage of carbon footprint rules is therefore typically determined not by the number of enterprises nominally subject to the regulation, but by the scale of the supply chains controlled by the relevant companies.

International rules simultaneously exhibit a pattern of "convergence at the foundation, divergence at the upper level." While consensus is growing around the basic principles of life cycle accounting, the types of greenhouse gases, and data quality requirements, different countries and industries will still design specific methodologies based on their industrial policies, trade interests, and energy

conditions. Companies cannot assume that because baseline standards are converging, a single carbon footprint result will automatically satisfy all international programs.

International competition in product carbon footprints ultimately comes down not to the names of standards, but to the capacity for data acceptance. Rule-makers can require companies to use designated product category rules, default values, and verification procedures, and they can also reject foreign data of unknown origin or insufficient representativeness. Whether a company can explain its data sources, production processes, and supply chain relationships matters more than formally declaring the adoption of a particular international standard.

The international changes during the observation period show a clear time sequence: in September 2025, ISO and the GHG Protocol announced a strategic partnership; in October, the GHG Protocol launched the Scope 2 revision consultation; in January 2026, the GHG Protocol released the Land Sector and Removals Standard; in March, the GHG Protocol published the first-phase white paper on "Actions and Market Instruments"; in April, ISO 19870-1:2026 further translated hydrogen's "color classification" into accountable production-stage greenhouse gas intensity; in June, the SBTi officially released the Corporate Net-Zero Standard 2.0. The common direction is: the underlying accounting language is moving toward harmonization, while specific market rules are becoming more detailed, more evidence-focused, and more directly impactful on economic interests.

6.2 ISO and GHG Protocol Coordinate to Drive Convergence of Underlying Accounting Language

ISO and the GHG Protocol are the two most influential systems for corporate greenhouse gas accounting worldwide. ISO is based on international standard-setting procedures and has developed a series of standards covering organizational accounting, project quantification, product carbon footprints, and third-party verification; the GHG Protocol, on the other hand, starts from corporate disclosure practices and value chain management, establishing accounting frameworks for Scope 1, Scope 2, and Scope 3 emissions.

The two systems have long maintained

a high degree of compatibility, though they are not entirely identical. ISO standards place greater emphasis on principles, procedures, and third-party conformity assessment, while the GHG Protocol provides a more operational framework for emission scopes, supply chain categories, and corporate reporting. In practice, companies often adopt both: using the GHG Protocol to organize data and disclosure structures, and ISO standards for product accounting or third-party verification.

The strategic cooperation between the two sides reflects the practical need of global companies to reduce duplicate accounting. This change should not be interpreted as one institution merging with another, but rather as the two mainstream global accounting languages beginning to actively coordinate. The goal is to reduce unnecessary differences in terminology, boundaries, and technical requirements, enabling companies to conduct multiple accounting and reporting processes based on relatively unified underlying data.

The convergence of accounting languages facilitates the transmission of product carbon footprints along the supply chain. When upstream companies use ISO 14067 to account for their products, and midstream and downstream companies calculate Scope 3 emissions in accordance with the GHG Protocol, if the life cycle boundaries, data quality, and allocation principles of the two can be better aligned, supplier product data can more easily enter corporate value chain inventories.

Coordination does not mean that only one set of rules will remain globally. The EU Battery Regulation, Product Environmental Footprint, and Carbon Border Adjustment Mechanism will still specify particular boundaries, parameters, and databases based on regulatory objectives, and industry organizations will also retain product category rules. ISO and the GHG Protocol mainly coordinate underlying principles and cannot replace the regulatory methodologies established by governments and industries for specific applications.

Enterprises should leverage this trend to establish a unified data foundation rather than waiting for all standards to be fully aligned. Energy, materials, products, and supplier data can be managed centrally, with accounting boundaries and output formats adjusted according to different standards. Standard harmonization can reduce conversion costs, but it will not solve the problems of missing raw data and supply chain traceability for enterprises.

6.3 Scope 2 revision raises temporal and spatial requirements for green electricity claims

The GHG Protocol is revising its Scope 2 accounting rules. As of July 2026, the new rules have not yet taken effect. The current Scope 2 guidance remains the version published in 2015; the 2025 public consultation document proposed hourly matching, deliverability, and stricter quality requirements for market instruments, with further consultations to follow. The final new standard is planned for release in 2027. Enterprises should neither treat the consultation draft as a current mandatory requirement nor ignore the clear direction it signals.

In the past, the market-based method for Scope 2 primarily relied on matching annual electricity consumption with annual green electricity certificates. As long as a company purchased and retired a sufficient number of eligible energy attribute certificates within the same year, it could count the corresponding electricity under the market-based method. While this annual matching approach is highly operable, it cannot confirm whether the renewable energy generation occurred in the same time period and within the same deliverable electricity region as the company's actual consumption.

The hourly matching requirement in the 2025 public consultation document further breaks down annual electricity volumes into hourly increments. Companies must demonstrate that the electricity used in a given hour matches the attributes of low-carbon electricity generated in the same hour, rather than using certificates from midday solar generation to cover nighttime consumption. The deliverability requirement emphasizes that generation and consumption should be located in areas with reasonable transmission and distribution connectivity, preventing companies from purchasing attributes from distant power sources that physically cannot serve their electricity load.

This change will directly affect the electricity data in product carbon footprints. Scope 2 and product carbon footprints are not the same accounting system, but the contracts, certificates, metering, and time-series data that companies use to substantiate green electricity sources often also serve as evidence for applying specific electricity carbon footprint factors in product carbon footprints. As the quality requirements for Scope 2 market instruments are tightened, the practice of simply treating electricity as

zero-emission in product carbon footprints will also face more rigorous scrutiny.

The main challenges facing Chinese enterprises are data granularity and power market interfaces. Currently, many companies still manage electricity consumption based on monthly or annual bills, and some green electricity and green certificates are also primarily retired on an annual total basis. In the future, if international customers require hourly matching and deliverability, companies will need to obtain metering data at finer time scales and be able to explain the relationships between generation facilities, trading contracts, and electricity consumption locations.

Hourly matching will not immediately become a universal obligation for all enterprises.

Companies with relatively low electricity consumption or limited flexible dispatch capabilities may still use annual averages and annual market instruments in the short term; however, energy-intensive industries such as data centers, electrolytic hydrogen production, and products targeting stringent international markets are more likely to face refined requirements first. Companies should build capabilities in stages based on the contribution of electricity to their product carbon footprint and the rules of their target markets.

6.4 SBTi Shifts from Target Validation to a Corporate Transition Action Framework

The Science Based Targets initiative (SBTi) is expanding from a target-setting tool into a corporate transformation management framework. SBTi released version 2.0 of the Corporate Net-Zero Standard on June 11, 2026, but publication does not mean companies can directly submit targets for validation under the new version in 2026. According to SBTi's transition arrangements, version 2.0 can be used for target setting starting February 1, 2027, while companies setting, updating, or renewing targets in 2026 should still use version 1.3.1.

The core change in the new standard is that it no longer stops at "setting a scientific target." Companies are now required to have targets approved by the highest governance body, develop transition plans aligned with business strategy, set and update targets on a five-year cycle, continuously disclose implementation progress, and undergo evaluation at the end of each cycle. Carbon

targets shift from a one-time validation to a closed loop of commitment, planning, execution, reporting, and reassessment. The five-year rolling cycle raises the cost of delaying targets. Companies need to use more recent data to determine the target base year and set targets for the next cycle along the net-zero pathway; if emission reductions in the previous cycle are insufficient, the subsequent cycle must bear a steeper reduction trajectory. This mechanism acts as a "ratchet effect": emission reduction obligations do not disappear when companies delay, but are compressed into a shorter remaining timeframe.

Scope 3 rules place greater emphasis on supply chain action. The new version allows companies to drive value chain transformation through approaches such as absolute emission reduction, supplier and customer collaboration, low-carbon procurement ratios, and consistency in product use and end-of-life, depending on applicable conditions.

Companies are still required to account for material Scope 3 emissions, but the evaluation no longer focuses solely on whether a total volume has declined; it also examines whether companies leverage procurement, products, and market influence to drive transformation among upstream and downstream stakeholders.

Product carbon footprint is a critical data foundation for implementing Scope 3 actions.

To increase the procurement ratio of low-carbon steel, low-carbon aluminum, and low-carbon transportation services, companies must first establish emissions data that can distinguish between product carbon footprints and supplier-level emissions; for new energy vehicle manufacturers, evaluating the consistency of new energy vehicles, energy-efficient equipment, and circular products during the use phase requires support from product life cycle models. Without product-level data, Scope 3 targets can easily remain at the level of procurement spend and industry averages.

The new SBTi also proposes clearer directions for improving the quality of electricity emission factors under Scope 2. The standard introduces deliverable area requirements and raises expectations for hourly matching information from large electricity consumers, echoing the GHG Protocol's Scope 2 revision. SBTi is not a Scope 2 accounting standard, but it will accelerate the entry of granular electricity data into supply chains through target validation and corporate assessment.

SBTi's market influence is not the

authority of international law. It has no power to directly require Chinese companies to adjust their technology pathways, nor can it replace national laws and industry regulations. Its influence stems from adoption by large enterprises, investor assessments, customer procurement, and references in public policy—a de facto constraint formed through market acceptance.

"Science-based" does not mean that all rules have only one unique technical answer. Global temperature targets and carbon budgets have a scientific basis, but how emission reduction tasks are allocated among countries, industries, and companies, which technologies can be counted, and which supply chain actions can be recognized still involve model choices and value judgments. Companies need to understand both the market value of SBTi and make independent judgments on its pathway assumptions, regional applicability, and implementation costs.

6.5 Carbon footprint is becoming a condition for the allocation of industrial subsidies and public funds

Green industry subsidies are shifting from simply rewarding end-use technologies to scrutinizing the carbon footprint of products and their production processes.

Traditional electric vehicle subsidies mainly focused on whether vehicles achieved zero tailpipe emissions, driving range, and price conditions, but new policies are beginning to further examine the climate transition performance of vehicle assembly, battery production, and manufacturing enterprises.

The UK launched an electric vehicle subsidy scheme in 2025, determining vehicle eligibility and subsidy tiers based on sustainability criteria. Applicant vehicles must not only meet basic conditions such as zero tailpipe emissions, range, and price, but manufacturers must also hold verified science-based carbon targets or achieve a specified automotive industry transition rating; the carbon emissions from vehicle assembly sites and battery cell production sites must also fall below corresponding thresholds.

This policy connects three different levels of climate information. Vehicle tailpipe indicators reflect direct emissions during the use phase, production site emissions reflect the energy and process standards of the

manufacturing stage, and SBTi or transition ratings reflect the company's overall emission reduction governance capability. Subsidies no longer only reward products that "do not emit during use," but instead begin to examine the manufacturing system behind the product.

Once carbon footprints enter subsidy rules, a significant supply chain transmission effect emerges. Whether a vehicle manufacturer can obtain subsidies depends not only on its own assembly plants but may also be influenced by battery cell production sites and upstream energy structures. Battery companies, material suppliers, and production bases thus become part of the eligibility for end-user subsidies, even though subsidy funds are not directly paid to these upstream enterprises.

Subsidy rules also affect industrial layout. Companies may prioritize producing models for specific markets in factories with a higher share of low-carbon electricity, reselect battery suppliers, or require upstream companies to provide more complete manufacturing data.

The product carbon footprint is therefore not only a measure of a product's environmental performance, but may also influence factory siting, supplier structure, and international capacity allocation.

The UK case shows that non-mandatory corporate initiatives can gain new binding force through fiscal policy. As mentioned earlier, SBTi itself is not a law, but once the government makes verified science-based carbon targets a condition for subsidy eligibility, it transforms from a voluntary corporate commitment into a de facto threshold for the allocation of public funds. This phenomenon of "NGO standards entering public policy" deserves continued attention from Chinese export companies.



Figure 6 From voluntary standards to economic constraints: the transmission ladder of international carbon rules

6.6 CBAM enters its official phase, and carbon data begins to directly impact export costs

The EU Carbon Border Adjustment Mechanism (CBAM) enters its formal implementation phase in 2026. It requires EU importers or indirect customs representatives to declare the embedded emissions of relevant goods and purchase and surrender CBAM certificates in accordance with the rules; those who can prove that carbon prices have actually been paid during the production process may apply for a deduction as stipulated.

The simplified revision in 2025 sets a uniform mass threshold of 50 tonnes per importer per year, but this does not change the fundamental direction that high-emission goods such as steel, aluminum, cement, fertilizers, hydrogen, and electricity must provide credible e missions data.

CBAM is not the same accounting methodology as the general product carbon footprint. A product carbon footprint typically evaluates product emissions based on life-cycle boundaries, while CBAM calculates the cross-border carbon cost to be borne based on the goods, production processes, precursor materials, direct and indirect emissions specified in the regulation, and the EU carbon market benchmark. Companies

cannot directly use an ISO 14067 report as the CBAM declaration result, but the energy, output, raw material, and supplier data within it can serve as a common foundation.

In the definitive period, what Chinese companies should most be wary of is not " mastering the formula," but whether upstream data can be obtained. Even if downstream processing companies have very low emissions themselves, they may be forced to use EU default values if they cannot obtain verified actual data for precursor materials such as steel and aluminum. For most products such as steel, aluminum, cement, and hydrogen, the default values will be subject to surcharges of 10%, 20%, and 30% after 2026, 2027, and 2028, respectively; thus, default values are not a free convenience tool, but rather a cost pressure that forces companies to provide actual data.

This rule shifts pressure from customs declarants to the domestic supply chain. Exporters need to trace material and process data upstream, EU importers will embed data and verification responsibilities into procurement terms, and material companies that primarily serve the domestic market but support export supply chains will also be required to provide information. Therefore, the actual coverage of CBAM should not be determined solely by " who directly exports," but rather by identifying relationships along customer and precursor material chains.

For companies, the most effective preparation is not filling out forms on a shipment-by-shipment basis, but rather building four long-term capabilities: identifying whether products and precursors fall within the regulatory scope; tiering high-emission suppliers; stipulating data, verification, confidentiality, and change responsibilities in contracts; and simultaneously assessing cost differences between actual values and default values. CBAM is transforming product competition into competition over "product plus data plus evidence chain."

6.7 Carbon Credits and Product Carbon Footprints

In October 2025, the Article 6.4 mechanism under The Paris Agreement adopted its first new methodology, setting out rules for calculating emission reductions from landfill gas combustion or utilization projects. This indicates that the international carbon credit mechanism is moving from institutional development to the operation of

specific projects. However, a carbon credit certifies that a project has achieved verified emission reductions or removals relative to a baseline scenario; it does not mean that a specific product purchased by the buyer has reduced an equivalent amount of emissions over its physical life cycle.

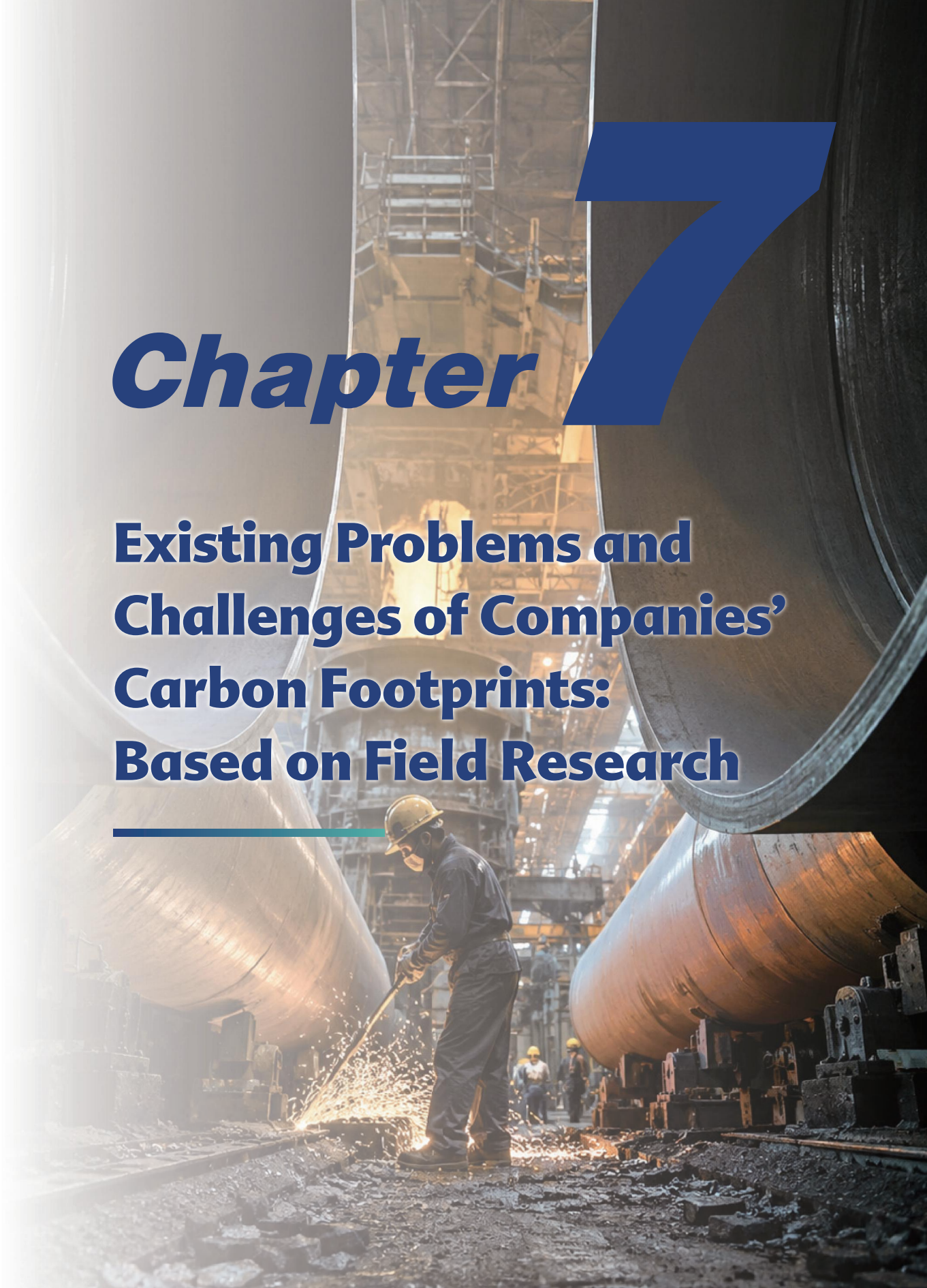
In March 2026, the GHG Protocol released the first-phase white paper on "Actions and Market Instruments" (AMI), proposing to separate physical greenhouse gas inventories, market-based inventories,

and sub-reports on the impact of corporate actions. The direction it signals is "making corporate actions visible," rather than allowing arbitrary netting of numbers of different natures.

EU consumer protection rules are also tightening product climate claims. Claims that a product is "climate neutral," "carbon neutral," or has a "positive climate effect" based on external carbon offsets in the value chain are increasingly difficult to support legally.

Companies may still disclose the purchase of carbon credits, support for climate projects, or contributions to avoided emissions, but these should be expressed separately from the product's own life-cycle carbon footprint, actual emission reductions in the supply chain, and carbon removal.

A product carbon footprint report should distinguish at least four accounts: product life cycle emissions, actual emission reductions within the value chain, verified external carbon credits, and other avoided emissions or social contributions. All four types of information may be valuable, but only by reporting them in separate accounts can we avoid packaging "f unding emission reductions elsewhere" as "this product's emission is zero."



Chapter 7

Existing Problems and Challenges of Companies' Carbon Footprints: Based on Field Research

From July to August 2026, CPCD conducted an on-site enterprise survey on the actual practices of product carbon footprint work, covering a total of 18 companies. The survey focused on five questions, including why companies undertake carbon footprint work, the average cost of a product carbon footprint, the main benefits after completing the carbon footprint, the difficulties encountered during implementation and how they were resolved, as well as companies' experiences with and suggestions for current policies and market requirements. The survey aimed to understand how carbon footprints are used in companies' actual operations, and also to bring together feedback from different companies to present the consensus already formed in the industry and the divergences that still exist.

The 18 companies span fields such as biotechnology and bioengineering, industrial equipment, wire and cable, wind power, green fuels, industrial materials, cement, mining, and carbon services. These include both export-oriented enterprises and those whose primary application scenarios are domestic sales, bidding, and government assessment. It should be noted that the 18 companies surveyed differ in scale, export profile, and carbon management foundation. Most of the participating companies have already been exposed to or have carried out carbon footprint accounting, certification, and related data management work. Therefore, this article mainly reflects the experiences and perceptions of these companies in current product carbon footprint management.

7.1 The reason of calculating carbon footprints

The reasons why the surveyed companies undertake carbon footprint calculation mainly fall into three categories of demand: market demand, policy and assessment requirements, and internal carbon management. The same company is often influenced by multiple factors simultaneously, though the weight of each factor varies.

Enterprises typically align carbon footprint efforts with specific operational tasks.

Export-oriented companies measure it in the context of customer procurement and market access; companies participating in green factory or corporate ratings are more concerned with whether their assessment materials meet requirements; and enterprises

that have already implemented internal carbon management tend to discuss energy consumption, product design, and emission reduction measures. The same question of "why do it" corresponds to different operational tasks for different companies. CVC Certification & Testing Co., Ltd. observed from the certification service side that relatively few chain-leading enterprises proactively conduct carbon footprint accounting based on their own responsibilities, while it is more common for them to do so due to downstream supply chain requirements and bidding demands.

1. ECA HealthCare Inc.The company hopes to "meet international customer and export market requirements, enhance product competitiveness," while also understanding the carbon emissions across the full product lifecycle to provide a basis for energy conservation, carbon reduction, and green development. The response of Jinhua Li Jia Yua n Biological Engineering Co., Ltd was more direct: the enterprise must not only satisfy customer requirements but also wishes to understand its own carbon emission situation and formulate emission reduction measures accordingly.

TSI Group has carried out carbon footprint work for many consecutive years, aiming to respond to customer concerns on the one hand, and hoping to compare carbon emission data of products derived from shrimp and crab shells versus fermentation sources on the other. Danfoss cites customer demand for transparency in low-carbon product information, international regulations, and market requirements as the main reasons. Atlas Copco Group also mentions identifying emission reduction opportunities, supporting customer goals, improving product design, and meeting external requirements.

The feedback from Goldwind and TBEA is closer to specific market access scenarios. Goldwind noted that the French market requires wind turbine manufacturers to submit lifecycle emission commitments and supporting documents, and some European power companies have also listed Life Cycle Assessment (LCA) and Environmental Product Declarations (EPD) as mandatory conditions for bidding. TBEA stated that in qualification admission, bidding procurement, and factory audit processes, the product carbon footprint has become a mandatory item, and in some projects, "having a certificate may not earn extra points, but lacking one directly disqualifies a company from shortlisting." People's Cable Group also regards green barriers in international trade, as well as the requirements for green supply

chains in sectors such as State Grid and new energy, as important reasons for continuously conducting carbon footprint accounting and certification. Donchamp's acrylic sheet products target the European market. Although the products are not yet within the scope of the EU Carbon Border Adjustment Mechanism (CBAM), downstream customers have begun to require carbon footprint and Environmental Product Declaration (EPD) information, and such materials directly affect whether the company can continue to participate in procurement. The Guangzhou Emissions Exchange has also observed that international climate rules such as CBAM are gradually making carbon footprint accounting and certification a compliance requirement for Guangdong foreign trade enterprises to enter certain overseas markets.

Policy and assessment requirements appeared with high frequency in surveys of building materials, mining, and equipment manufacturing enterprises. Henan Energy Group Heavy Equipment Co., Ltd. referred to this as a "hard requirement for applying for green factories," noting that carbon footprint quantitative data is the core supporting material for national-level green factory evaluation, and the company also hopes to use this to clarify emissions during raw material acquisition, transportation, and production processes. Jiande Hongshi Cement stated that the enterprise's A-level rating assessment is currently the biggest driver for conducting carbon footprint assessments and technology reserves. Jiande Hailuo Cement expressed it as, "Driven by the 'dual carbon' goal policy, the company must conduct carbon footprint work." Zhejiang AL Mine stated that within the industry,there is not yet a driving force for proactively conducting carbon footprint work, because "carbon footprint reports cannot yet be converted into profit benefit", currently, relevant assessment and accounting are mainly carried out based on government requirements and energy consumption indicator assessments.

2. Some enterprises hope to conduct carbon emission baseline surveys and optimize carbon e mission management. Jiaozuo Railway Cable hopes to.Understanding greenhouse gas emissions throughout the product lifecycle, while reducing carbon emissions, also "improves internal operational efficiency and saves costs" for enterprises. Hangzhou Jinlin Carbon Sequestration Technology links carbon footprint assessment with negative carbon technology quantification, CCER project methodologies, and carbon emissions trading. Beijing Zhongke Lvran, from the perspective of the green fuel industry

services, points out that the industry faces three challenges: "difficulty in certification, difficulty in trading, and difficulty in carbon asset development." Without credible carbon footprint data, it is impossible to support data traceability, certification, green rights development, and trading. Enterprises believe that carbon footprint accounting is not an "optional item" but a "mandatory question" for future green fuels.

These responses indicate that corporate carbon footprint work usually has a clear business starting point. The importance of customer access, policy assessment, and internal management varies, which also affects the depth of subsequent investment. To understand a company's carbon footprint actions, one must first look at the customers, markets, and assessment scenarios it faces.

7.2 What is the average cost of a product carbon footprint?

The cost figures reported by companies vary considerably. Some refer to the price of a single product's assessment or certification, some to an annual service fee, and others bundle carbon footprint work with carbon inventory, international sustainability certification, green mine evaluation, or factory life cycle assessment projects. Therefore, while these figures reflect companies' actual expenditures, they cannot be directly used as horizontal price comparisons for similar products.

Many companies could not provide a standalone price for a single product in their responses, as carbon footprint work is often procured together with other certifications, annual carbon services, green evaluation projects, or multiple products. As a result, most companies provided the total expenditure under a contract, but not necessarily the specific cost of an individual product.

Based on corporate responses, product complexity, accounting boundaries, supply chain tiers, data accessibility, third-party certification requirements, and international market acceptance requirements all influence costs. TBEA provided two significantly different quotations for domestic conventional projects and projects under the Électricité de France S.A. procurement system. Goldwind's product fees range from 30,000 to 600,000 RMB, reflecting the impact of product complexity on product carbon footprint pricing. Although Danfoss did not specify exact prices, it clearly noted

that costs are relatively lower when existing LCA database support is available and product structures are simpler, while costs increase when multiple suppliers, complex materials, and global supply chains are involved. The service practices of CVC Certification & Testing Co., Ltd. show that the cost for carbon footprint accounting and certification of a single product typically ranges from approximately 8,000 to 20,000 RMB; Guangzhou Emissions Exchange, however, believes that there is currently no unified range for single-product costs, as they are influenced not only by product complexity but also by supply chain length, data foundation, and certification standards.

Bundled procurement is another common scenario. Jinhua Li Jia Yuan tends to bundle carbon footprint assessment with carbon inventory and other certification projects, as these projects require similar basic information. "Quoting several projects together and arranging similar on-site audit schedules" makes it easier for both companies and certification bodies to plan. ECA HealthCare Inc also bundles carbon footprint with ISCC and other

projects when consulting third-party agencies, with a total quote of 40,000 to 50,000 RMB, making it impossible to determine the amount attributable solely to carbon footprint accounting. The costs for Jiande Hongshi Cement and Hangzhou Jinlin Carbon Sequestration Technology also include other projects or services, making it difficult to break down the price into a per-product carbon footprint cost.

Other companies have already begun conducting their own accounting. For example, Goldwind independently completed its carbon footprint accounting and obtained corresponding government subsidies. Zhejiang AL Mine has also started having its technical staff perform the accounting in-house to reduce corporate accounting costs.

Beijing Zhongke Lvran provided a detailed cost breakdown reference for traditional third-party accounting and verification, in which data collection costs account for approximately 40%, third-party verification and auditing approximately 30%, and report preparation and personnel training approximately 30%. Their feedback shows that the price of digital platform accounting is lower than services that include international certification, with the latter also covering audit fees, official system fees, and consulting service fees.

Donchamp's cost breakdown for the EPD project also shows that EPD-related expenditures mainly consist of three components: accounting consulting, EPD

certification, and platform registration. Since not obtaining certification could pose a risk of customer attrition, and this cost accounts for a relatively small share of the company's overall management expenses, the company chose to bundle and complete the relevant projects together.

This survey may find it difficult to aggregate an "average price" applicable to all enterprises. Whether quotes are comparable mainly depends on whether the accounting boundaries, product complexity, data requirements, and certification purposes are similar. When enterprises see the total price, they also need to distinguish whether it includes accounting, consulting, auditing, platform registration, or long-term data maintenance.

7.3 After conducting a carbon footprint assessment, what are the main benefits?

The benefits mentioned in the enterprise survey mainly fall into several areas: market access, customer recognition, internal energy conservation and consumption reduction, and brand qualifications. Feedback varies considerably among enterprises as to whether the benefits can be directly translated into orders, bonuses, or cost reductions.

The benefits of product carbon footprints vary significantly among the surveyed enterprises. Goldwind and People's Cable were able to share actual rewards, orders, qualifications, and cost-reduction measures, while ECA HealthCare Inc and TSI Group placed more emphasis on customer recognition and market competitivenes s; Jiande Hongshi Cement and Zhejiang AL Mine explicitly stated that they have not yet seen benefits or that the benefits remain unclear. Based on the responses, the level of enterprise investment and application scenarios differ, leading to varying judgments on the benefits.

Market demand is the most direct experience for many manufacturing companies. TBEA regards product carbon footprint as a market access compliance tool, with direct benefits including maintaining supplier qualifications, securing bidding eligibility, and improving supplier ratings. Jiaozuo Railway Cable summarized it as "internally tapping potential to reduce costs, externally leveraging carbon footprint to gain shortlisting." ECA HealthCare Inc believes that carbon footprint work can enhance customer recognition, meet green

procurement requirements, and boost export competitiveness. TSI Group also lists meeting customer needs and improving product market competitiveness as primary benefits. Danfoss considers "improving product carbon emission transparency" as the greatest benefit, and carbon footprint data also strengthens customer trust and supports customers in achieving their own sustainable development goals. Atlas Copco mentioned benefits including identifying emission hotspots, optimizing products and sustainability performance, enhancing customer engagement and differentiation, and proactively addressing regulatory requirements. CVC Certification & Testing Co., Ltd. observed from the certification side that the practical role of carbon footprint certificates is mainly to help companies enter or remain o n downstream customers' supplier lists, and to support applications for green factories, zero-carbon factories, and ESG ratings.

After completing EPD and Global Recycled Standard (GRS) certifications, Donchamp primarily uses them to meet European market and international customer requirements for environmental information and recycled materials. However, they also noted that the cost of recycled raw materials required by customers may be higher than virgin materials, yet the green premium has not been fully reflected.

Goldwind also provided more specific economic benefits. After completing the carbon footprint accounting on its own, the company no longer needs to involve consulting agencies, saving on consulting fees for future carbon footprint projects. By using the Zhongguancun association standard that it led the development of to complete the carbon footprint accounting and certification of wind turbine products, it also received a cash reward of 200,000 RMB from Beijing Economic-Technological Development Area in 2025. Products that have completed LCA reports or carbon footprint certification have also gained recognition from international customers, with order volumes increasing year by year.

1. Some companies summarized the most significant benefits as a "green brand basic" and "cost reduction and efficiency improvement." People's Cable believes that carbon footprint quantitative management has provided support for qualifications such as Henan Province's " zero-carbon" factory demonstration enterprise, Henan Province's digital energy and carbon management center, "national-level green factory," and "national industrial product green design demonstration

enterprise." It has also helped the company participate in bidding for large enterprises such as State Grid and PetroChina, and expand into more than 40 countries.

Export business. In terms of internal management, the enterprise optimizes energy dispatch based on accounting results and implements residual pressure from air compressors.

Utilizing and self-building distributed photovoltaic systems to improve energy efficiency has achieved " substantial cost reduction and efficiency improvement."

Some surveyed enterprises also mentioned indirect benefits in management, emission reduction, and the opening of carbon credits. Jinhua Li Jia Yuan stated that carbon footprint accounting "not only met customer requirements but also gained customer recognition," while enhancing the efficiency of corporate carbon management. Henan Energy Group Heavy Equipment Co., Ltd. summarized the benefits as " adding points to applications and improving review pass rates," and improved energy utilization efficiency and reduced energy costs by optimizing energy consumption structures, establishing a long-term management foundation for subsequent low-carbon product certification. Jiande Hailuo Cement emphasized that "carbon footprint-related business should ultimately serve carbon trading," and at the current stage, it is used to guide energy conservation and emission reduction, ultra-low emissions, and production efficiency.

Improvement. Hangzhou Jinlin Carbon Sequestration Technology mentioned that carbon footprint can quantify the potential for energy conservation and consumption reduction, and can be used in green mining and government-related evaluations, allowing enterprises to obtain bonuses and service conveniences.

Beijing Zhongke Lvran, starting from the perspective of green fuel service scenarios, identifies four types of benefits, including meeting international compliance requirements, supporting green credit and carbon asset development, enhancing product market recognition, and enabling the same set of data to continuously serve certification, trading, and green rights development. In its research, it shared that the goal should be to "turn invisible green value into visible business value," and to make a one-time data construction effort serve multiple business scenarios over the long term. The Guangzhou Emissions Exchange further provided a case of carbon footprint entering green finance scenarios: in 2025, Guangzhou facilitated the first "transition finance + carbon footprint"

dual-certification loan in Guangdong Province, using product carbon footprint as a key performance indicator.

The loan interest rate is linked to the company's emission reduction performance, allowing carbon footprint data to directly influence financing costs.

Some enterprises also shared their views: carbon footprint work has not yet shown cl ear returns. Jiande Hongshi Cement stated that carbon footprint accounting can quantify the e mission reductions from converting mining trucks to electric power and other mitigation measures, but "currently, conducting carbon footprints has not generated revenue." Zhejiang AL Mine responded that "the specific returns are not yet clear at this stage." Hangzhou Jinlin believes that most enterprises' carbon footprint reports have not yet been used for carbon emissions trading, and the application of carbon footprints remains very limited.

The different responses from enterprises regarding returns reflect the varying stages of value realization. Some returns have already materialized in orders, incentives, and energy costs, while others still manifest as customer recognition, qualification maintenance, and management readiness. Whether the indirect benefits obtained by some enterprises can be steadily converted into orders, prices, or cost improvements in subsequent operations still needs to be assessed based on longer-term practice.

7.4 What difficulties were encountered during the carbon footprint calculation and management process? How were they resolved?

When companies talked about their difficulties, the responses mainly involved data measurement, historical records, scattered components, supplier confidentiality, and cross-departmental coordination. Once carbon footprint accounting is implemented within a company, departments such as procurement, R&D, production, energy, and logistics must jointly provide data. If any step lacks records, it can increase the workload of subsequent accounting and verification. Therefore, the issues raised by most surveyed companies can be summarized as data-related problems across different dimensions.

1. First, supply chain data was the most frequently mentioned issue among surveyed companies. When TSI Group was collecting upstream data, some suppliers were reluctant to provide information due to

concerns about disclosing business secrets. After signing confidentiality agreements with suppliers, the company had them "provide basic data within a defined scope," including information required for accounting such as energy consumption and product output. ECA HealthCare Inc also encountered difficulties in

obtaining supply chain data, heavy data collection workloads, and inconsistencies in understanding accounting standards, which hindered "upstream basic data collection." The company addressed these issues by strengthening communication with suppliers, establishing internal data management mechanisms, and completing accounting with the support of third-party organizations and database emission factors.

Beijing Zhongke Lvran additionally mentioned that for green fuel products, data involves multiple stages such as raw material planting or collection, transportation, processing and conversion, and storage and logistics. Smallholder farmers and small collection stations often lack the capacity to record carbon emission data, and some suppliers are unwilling to disclose sensitive data. Their solution is to conduct continuous monitoring and evidence preservation as an independent third party, automatically collect key data through interfaces or IoT devices, and sign confidentiality agreements with enterprises. The company also emphasized that "data security is our bottom line," and all data is strictly used in accordance with the agreement.

Atlas Copco, on the other hand, improves data recording capabilities through communication and training with core suppliers; when primary data is truly unavailable, it uses industry average data combined with sensitivity analysis to control uncertainty. In Donchamp's product carbon footprint, the MMA raw material production stage accounts for approximately 80% to 90%, while the company's own production stage accounts for a relatively low proportion. The calculation results are highly dependent on upstream raw material data, and the company has limited direct control over this portion of emissions. The Guangzhou Emissions Exchange also observed that accounting enterprises generally find it relatively easy to obtain their own production data, but difficult to obtain accurate factors for upstream raw material production and basic energy consumption stages.

2. Issues regarding professional talent, accounting standards, and databases also recurred during the research. The difficulty faced by Henan Energy Group Heavy Equipment Co., Ltd. is

the "lack of professional accounting talent," and the solution is to collaborate with third-party professional institutions to conduct accounting training and unify accounting boundaries and methods. Jiande Hongshi Cement has appointed a dedicated carbon management officer, but still believes that this work must be carried out by technical personnel who understand policy rules and possess relevant professional knowledge. Jiande Hailuo Cement has established a carbon accounting department, yet the company is puzzled by the fact that "the results calculated by the company's carbon accounting department differ from those of third parties," and it is difficult to find suitable standards and databases for verification, which also reflects the professional requirements of current product carbon footprint accounting. The problems encountered by Hangzhou Jinlin Carbon Sequestration Technology include unclear project full-process and full-lifecycle definitions, incomplete ledger data, and difficulties in source-sink identification, emission inventory establishment, and scientific calculation. Its approach is to conduct assessments based on the basic principles and methods of relevant international and national standards.

The challenges Danfoss encountered include inconsistent data quality across different regions and suppliers, as well as differences in standards and calculation methods. The company began establishing unified data collection processes, strengthening cooperation with suppliers, adopting ISO 14067 and LCA-related standards, and managing data with internal digital tools. Atlas Copco has developed unified accounting boundary rules by product category, based on ISO 14067, GHG Protocol and Product Category Rules (PCR), unified internal calculation tools, while also strengthening internal training, with the group headquarters coordinating accounting work across different regions.

3. The internal data foundation and certification readiness of enterprises remain highly insufficient. Jiaozuo Railway Cable faces challenges with basic data

Due to incomplete data, raw material consumption and waste data scattered across different departments, and some missing historical data, enterprises currently rely on energy management systems and smart meters to fill measurement gaps, with departments submitting forms monthly. Zhejiang AL Mine finds it difficult to obtain process-level ledger data when refining sub-processes, and plans to consciously record data according to process characteristics in

the future. TBEA mentioned that in multi-product co-production, energy consumption data lacks measurement methods or reasonable allocation rules, relying only on empirical estimates; some components are measured by piece, while emission factors are calculated by weight, requiring extensive conversion work for complex products. To obtain more reasonable raw material data, it is necessary to trace upstream or even further upstream suppliers, which is not practically feasible for enterprises.

Goldwind describes cross-departmental, cross-stage, and cross-regional data collection as "a difficult and time-consuming task," currently relying on professional technicians and suppliers to jointly confirm the production, processing, assembly, and maintenance processes of products and raw materials.

During certification, CVC Certification & Testing Co., Ltd. also found that some companies have incomplete Bill of Materials (BOM) data, lacking specific weight information, which requires disassembling products and weighing each component to fill in the gaps. Some companies have insufficient granularity in energy metering, and when multiple products share energy sources, allocation can only be done based on physical or non-physical parameters. At the same time, the number of companies meeting the requirements for product carbon footprint assurance capability remains limited, and internal systems, data recording, and division of responsibilities have not yet formed a stable mechanism.

Certification bodies often need to first guide and assist companies in building foundational capabilities before conducting certification activities.

4. Companies also raised other issues that urgently need to be addressed. Goldwind Science & Technology reported that the green electricity used in production cannot be traced, the carbon reduction effect cannot be confirmed, and the product carbon footprint calculation can only use the average electricity carbon footprint factor. Zhongke Lvran mentioned that from carbon footprint accounting to green rights development, and even to listing for trading, multiple professional stages and different institutions are involved, making the process lengthy and the monetization channels less smooth. The company currently provides support by connecting data collection, evidence storage, and trading services, but it also believes that the specific integration pathways between carbon footprint data and mechanisms such as CCER need to be further clarified in the future.

The difficulties enterprises are currently encountering indicate that carbon footprint accounting will become part of their existing data and management processes. Completing a report does not mean the data issues are resolved; they will still face ongoing data acquisition and level monitoring, boundary consistency, and supplier collaboration in the future. The maturity of carbon footprint work also reflects the actual level of an enterprise's foundational data governance and supply chain collaboration.

7.5 What is your experience with the current carbon footprint policies or requirements? What problems or suggestions do you have?

Most enterprises have affirmed the current direction of carbon footprint policies, but they also mentioned specific issues in implementation. Inconsistent standards, incomplete databases, a lack of mutual recognition among departments, and high costs for small and medium-sized enterprises all emerge in the actual process of enterprises preparing data, undergoing audits, and responding to customer requirements.

Some companies recognize or accept the policy direction, but feedback on implementation is relatively concentrated. ECA HealthCare Inc generally recognizes the current policy; People's Cable Group believes the policy direction is clear and has played a leading role in corporate green transformation; Jiande Hongshi Cement stated that the existing policy is acceptable. Henan Energy Group Heavy Equipment Co., Ltd. experienced and felt that carbon footprint is "gradually shifting from voluntary work to quasi-mandatory requirements." Jiaozuo Railway Cable stated that the policy direction has been supported, but "specific implementation is still unclear, standards are inconsistent, requirements are scattered, and there is a lack of detailed local guidance," with companies mainly relying on customers.

driven initiatives, third-party guidance, and self-exploration.

1. Inconsistent standards and methodologies are a frequently reported issue. TSI Group stated that different customers adopt

different standards—some require ISO 14067, while others follow domestic guidelines—and expressed a desire for more opportunities to access carbon footprint

training and policy guidance. Atlas Copco observed discrepancies across the industry in methodologies, databases, assumptions, and reporting formats, and recommended promoting the harmonization of global product carbon footprint methodologies and reporting standards, as well as the adoption of industry-specific Product Category Rules (PCR). Danfoss also suggested unifying calculation methods and data standards. Jiande Hailuo Cement called for the establishment of unified industry standards to ensure the "scientific rigor and fairness" of accounting. TBEA offered a more direct assessment of the current market: the boundaries, data requirements, and audit rigor vary significantly across different institutions, and some certifications suffer from a "focus on form over substance" problem—after obtaining a certificate, companies still cannot identify emission reduction potential, and carbon footprints risk becoming mere "bid document materials." Companies recommend referencing unit product energy consumption limits to establish industry-specific unified accounting rules and baseline values, with the accounting focus placed on raw materials and production processes that companies can control and that account for a high share of emissions. Donchamp Technology also felt the differences in domestic and international methodological requirements

Differences: Domestic green factory evaluation focuses on quantitative assessment based on domestic standards with supporting reports, while the European EPD requires compliance with ISO 14025 and the corresponding Product Category Rules (PCR), with higher data requirements and stricter review procedures.

The Guangzhou Emissions Exchange further noted that domestic and international method ologies are not yet fully aligned, and export-oriented enterprises may need to establish two parallel accounting systems, facing the pressure of "dual compliance."

2. The development of carbon footprint databases and supply chain/ industry chain data sharing constitute another cluster of frequently raised recommendations. ECA HealthCare Inc hopes to improve local databases and product accounting rules. People's Cable Group recomm ends establishing a locally representative carbon footprint factor database for

the industry. Zhongke Lvran indicated that basic data in emerging fields such as green fuels is insufficient, forcing enterprises to rely on foreign databases for accounting, with some data showing poor alignment with actual domestic processes; it recommends

building an emission factor database covering major industrial and energy products and opening access interfaces to industry associations and enterprises. Henan Energy Group Heavy Equipment Co., Ltd. proposed establishing an industry chain carbon data sharing and docking platform to standardize supplier carbon disclosure requirements. Atlas Copco also recommended adopting digital data exchange standards and distinguishing between direct and indirect suppliers in supplier self-assessment questionnaires to reduce the impact of non-applicable issues on scoring. Based on its verification practices, CVC Certification & Testing Co., Ltd. pointed out that domestic

The factor database still has issues such as insufficient coverage, inconsistent standards, and inadequate granularity.

Some projects still rely on international databases like Ecoinvent, and it is recommended that the factor database be continuously developed as a public good.

3. Coordination and mutual recognition across multiple departments and markets also affect the development of corporate carbon footprints.

Zhongke Lvran said that mutual recognition mechanisms for standards and data between different departme nts have not yet been established, and companies may need to conduct repeated accounting and verification.

In the international market, there is also a lack of clear mutual recognition channels between domestic accounting r esults and international certifications such as ISCC and RSB.

Companies suggest establishing a unified national carbon footprint management platform to promote mutual recognition of accounting standards, data formats, and certification results, achieving "one-time accounting, multi-party acceptance." Atlas Copco proposed that large group headquarters should coordinate data requirements from different regions in a unified manner, and future regulatory requirements should also consider the practical operations and scalability needs of complex global supply chains.

4. Cost and corporate benefits are a key concern for enterprises going forward. People's Cable Group believes that green certification and carbon footprint accounting processes are relatively complex and costly, and some downstream users lack sufficient awareness of the full life-cycle benefits of green products, leaving green products facing a "premium dilemma." The company recommends providing fiscal and financial support such as tax incentives for

low-carbon technology R&D and green credit, and explicitly requiring priority procurement of green and low-carbon products in power grid construction and government investment projects. Danfoss recommends providing more guidance and support to small and

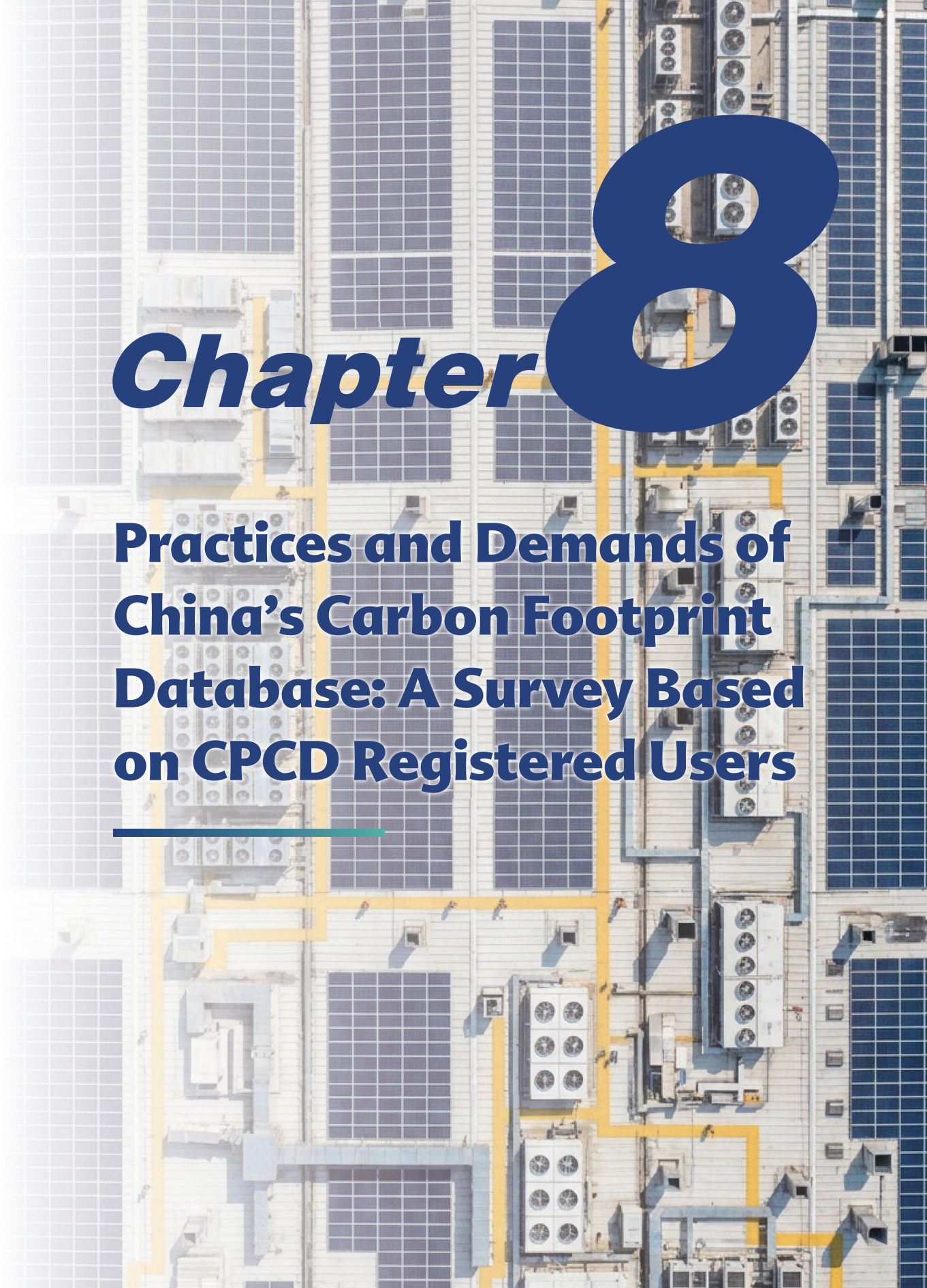
medium-sized enterprises (SMEs) in the supply chain. Zhongke Lvran proposes offering subsidies covering a certain percentage of costs to SMEs completing carbon footprint accounting for the first time, and promoting an "industry platform-based third-party accounting" model. Hangzhou Jinlin Carbon Sequestration Technology believes that current relevant policies "lack continuity, and policy updates are disjointed," hoping that authoritative organizations will issue guidelines and provide large-scale databases, while retaining flexibility and inclusiveness in assessment on a scientific basis. CVC Certification & Testing Co., Ltd. and Guangzhou Emissions Exchange also noted that SMEs are relatively weak in terms of capital, technology, and data infrastructure, and that barriers to participation should be lowered through public services, fee subsidies, leadership from chain-leading enterprises, and integration with carbon finance.

5. How carbon footprint data reflects corporate emission reduction efforts and aligns with assessment requirements is another issue of concern to some companies.

Goldwind Science & Technology proposed that in the future, efforts should be made to achieve "integration of electricity and carbon, and confirmation of carbon reduction rights" to address the problem that green electricity used in production cannot be traced. Hangzhou Jinlin Carbon Sequestration Technology and Jiande Hailuo Cement both suggested promoting the linkage between carbon footprint assessment and carbon trading. Zhongke Lvran recommended clarifying the acceptance standards and procedures for using carbon footprint data as foundational data for mechanisms such as CCER, s o that carbon footprints can become "marketable assets." Zhejiang AL Mine, on the other hand, hopes that assessment documents concerning the full lifecycle of products will clearly indicate the specific stages and boundaries involved.

Enterprises' opinions on policies are closely linked to actual operations. The deeper the accounting, certification, and data collection efforts, the more specific the issues raised. The concerns highlighted by surveyed enterprises mainly focus on unified accounting rules, local databases, supply chain data, domestic and international mutual

recognition, talent and cost support, as well as the integration of carbon footprint data with green electricity and carbon trading. Whether future policies can be steadily implemented by enterprises will ultimately be reflected in whether the same set of data can be accepted by multiple parties, whether real emission reductions can be identified, and whether investments can generate sustainable business value.



Chapter 8

Practices and Demands of China's Carbon Footprint Database: A Survey Based on CPCD Registered Users

From July 23 to August 1, 2026, CPCD conducted a real-name questionnaire survey targeting all registered users of CPCD (39,406). The identities and contact information of respondents could be verified, which helps reduce random responses and duplicate submissions, thereby enhancing the accountability and credibility of the survey results.

This survey aims to understand users' actual situations in product carbon footprint accounting, database usage, and professional service procurement, and to grasp the usage of product carbon footprint data in real work scenarios in China.

A total of 370 valid questionnaires were collected in this real-name survey, of which 212 users agreed to be listed in the public acknowledgment list by personal name, institution name, or both, accounting for 57.3%; 20 users agreed to be listed in the acknowledgment list by CPCD user ID or other public identifiers. Combining the above two categories, a total of 232 people agreed to be listed in the acknowledgment list under some public identifier, accounting for 62.7%.

It should be noted that this survey is a voluntary survey conducted among CPCD registered users, not a random sampling of enterprises and practitioners nationwide. Therefore, respondents' awareness, query, and usage rates of CPCD are inevitably higher than those of the general practitioner community; meanwhile, active users who have already participated in product carbon footprint projects and have clear needs for the database are also more willing to participate in the survey. Consequently, the proportions presented in this chapter mainly reflect the actual situation of CPCD users and the active practitioner community in product carbon footprint in China, and cannot be directly interpreted as the market share of the national carbon footprint database or the overall situation of all enterprises nationwide.

The foundation of real-name registration, a relatively high proportion of frontline practitioners, and a complete question structure covering databases, costs, uses, difficulties, and needs, still leave this survey and analysis with certain limitations. Nevertheless, this real-name questionnaire survey remains extremely valuable, providing relatively direct user evidence for identifying specific issues in current product carbon footprint practices and the direction of database development.

8.1 Enterprises and third-party professional institutions are the main user groups in product carbon footprint practices

- Dual-subject structure: enterprises (buyers, 38.1%) and third-party professional institutions (service providers, 33.5%) are nearly evenly matched, together accounting for 70%;
- Experience concentrated in service institutions: 91.1% of third-party institutions have produced formal results, with project experience more than twice that of enterprises. Enterprises mostly rely on outsourcing, resulting in insufficient internal capability accumulation;
- The demand does not come from "major emitters": among enterprise users, 51.8% come from manufacturing and consumer goods (driven by export chains), while users in high-emission industries such as steel and non-ferrous metals account for only 22.7%.

Among the 370 respondents, 141 were enterprise users, accounting for 38.1%; 124 were professionals from third-party verification, certification, consulting, testing, or evaluation institutions, accounting for 33.5%. Together, these two groups totaled 265 people, or 71.6%. This composition means that the survey covered both buyers and providers of product carbon footprint services, with the two groups being similar in size but opposite in role. The subsequent analysis of service costs, which distinguishes between "actual payment" and " actual quotation," is premised on this sample structure.

Enterprises are the direct demand side for product carbon footprint accounting, disclosure, certification, and supply chain management, and they are also the primary providers of production activity data, product information, and supply chain data.

Third-party professional institutions, on the other hand, undertake accounting, consulting, verification, certification, testing, and evaluation work, providing professional services to various enterprises and industries.

The industry distribution of enterprise users is more concentrated. Among the 141 enterprise users, 55 are from the machinery and equipment, automotive, electronics, and new energy manufacturing industries, accounting for 39.0% of enterprise users; 18 are from the textile, light industry, food, and other consumer goods industries, accounting for 12.8%; 17 are from the steel, nonferrous metals, building materials, and chemical industries, accounting for 12.1%; and 15

are from the energy industry, accounting for 10.6%. This distribution pattern is not consistent with the carbon emission characteristics of these industries. Steel, nonferrous metals, building materials, and other industries are typical high-emission sectors, yet users from industries such as machinery and equipment and automotive electronics, which are more involved in foreign trade and exports, account for the largest proportion, followed by users from industries like textiles, light industry, and food, which are highly related to residents' daily lives. This indicates that market and consumer-side demand can better drive the development of product carbon footprint-related work.

A total of 73 people from the equipment manufacturing and consumer goods sectors, accounting for 51.8% of enterprise users; while the energy and raw materials industries, which account for a higher share of national carbon emissions, together have only 32 people among enterprise users, accounting for 22.7%. This distribution is inconsistent with the sectoral structure of greenhouse gas emissions, because the demand for product carbon footprints is driven by trade and disclosure requirements of downstream products, rather than by emission scale. This point will be directly confirmed in Part III.

Practical experience in product carbon footprints is mainly accumulated on the side of third-party service institutions, rather than within enterprises. Grouped by identity, among third-party professional institutions, those who have used the CPCD database and produced formal carbon footprint accounting results account for 93.2%, those involved in more than 6 projects account for 61.3%, those involved in more than 20 projects account for 41.1%, and those who frequently use the database for multiple formal projects account for 62.1%; during the same period, the corresponding four proportions for enterprise users were 86.3%, 37.6%, 20.6%, and 45.4%, respectively.

This gradient indicates that in most cases, companies outsource product carbon footprint accounting to external agencies rather than conducting it with internal teams. As a result, experience in repetitive methodology application, data retrieval, and report preparation is concentrated within service providers.

This structure serves as the common premise for understanding the three key points discussed later in this chapter: service providers are the primary users of databases; "use for third-party verification, certification, consulting, and evaluation" ranks as the second most frequent purpose; and systematic

discrepancies emerge between companies and third-party institutions regarding reasonable service fees.

Geographically, the 370 responses covered 30 provincial-level administrative regions as well as Hong Kong, Macao, and Taiwan. Beijing, Shanghai, Guangdong, Jiangsu, and Zhejiang together accounted for 55.4%, consistent with the geographic distribution of product carbon footprint service providers and export-oriented manufacturing industries.

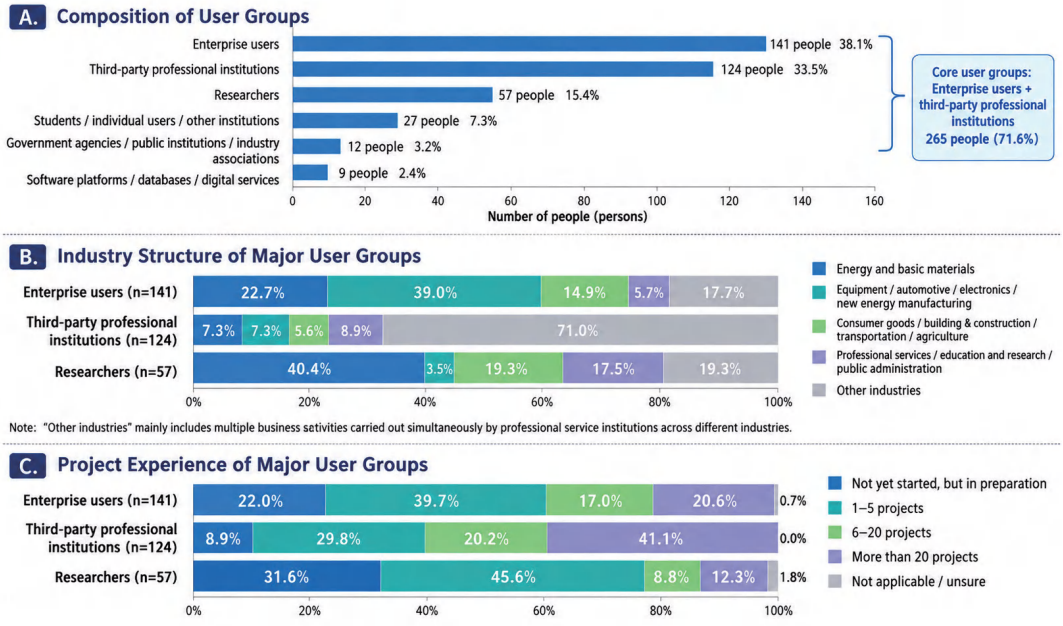


Figure 7 User structure characteristics of survey respondents

8.2 Multiple data sources constitute the basic usage pattern of product carbon footprint databases

- Multi-source usage is the norm: respondents use an average of 3.5 data sources, with 71.9% using more than 3, indicating that a single database cannot support projects;
- Domestic and international databases are " complementary rather than substitutive";
- In terms of reach: CPCD (domestic) leads in coverage;
- Primary database: ecoinvent (international) conversion rate 57.1% vs CPCD 36.3%;
- Cross-border compliance scenarios: the share of international databases as primary source surges to 61.4% (26 percentage points

higher than in general scenarios)—because being "accepted" matters more than being "accurate";

- Selection criteria ranking: 1. External acceptability (55.4%)＞2. Localization and methodological transparency＞3. Price/ease of use.

Most respondents use multiple data sources in parallel in their work, as a single database is insufficient to support a complete accounting project. On average, each respondent uses 3.48 data sources; 266 people (71.9%) use 3 or more, 92 people (24.9%) use 5 or more, and only 38 people (10.3%) rely on a single source. The degree of parallel usage increases with practice intensity: respondents involved in 1–2 projects use an average of 3.11 sources, while those involved in more than 20 projects use 4.30. By affiliation, third-party professional institutions average 3.86 sources per person, higher than the 3.06 for corporate users.

CPCD is the data source with the broadest coverage used in this survey, while ecoinvent is the database most frequently selected as the primary working data source. At the c ontact/usage level, CPCD leads ecoinvent by 23.6 percentage points, but at the primary-use level, the relationship reverses, with ecoinvent slightly ahead at 34.6% compared to CPCD's 30.5%.

The conversion rate for ecoinvent is 57.1%, meaning that approximately 6 out of every 10 contacts/users consider it their primary

source of use; the conversion rate for CPCD is 36.3%; for CLCD and TianGong, the rates are 13.1% and 1.2%, respectively, indicating that most contacts/users do not adopt them as their primary source after querying.

Among users who have both encountered/used the two, ecoinvent's dominant position is more pronounced. In the full sample, 193 people (52.2%) have encountered/used both CPCD and ecoinvent; of these 193, 106 (54.9%) primarily use ecoinvent, while 44 (22.8%) primarily use CPCD—a ratio of approximately 2.4 to 1. By contrast, among the 118 people who have encountered/used CPCD but not ecoinvent, 69 (58.5%) primarily use CPCD. This comparison rules out the confounding factor of unequal exposure/usage opportunities: when users have actual experience with both databases, their choice tilts toward the international database.

Domestic and international databases exhibit a complementary rather than substitutive relationship in practice. By usage combination, 232 people (62.7%) use both domestic databases (CPCD, CLCD,

Tiangong) and international databases (ecoinvent, Sphera LCA for Experts, openLCA Nexus); 100 people (27.0%) use only domestic databases; 22 people (5.9%) use only international databases; and 9 people (2.4%) rely solely on public or literature data.

From a co-occurrence perspective, 62.1% of CPCD users also use ecoinvent, while 86.2% of ecoinvent users also use CPCD. This indicates that the vast majority of international database users also rely on local data sources, with the two serving different roles within the same project: local sources are primarily used for queries and partial foreground data, while international databases are mainly used for background data and the core accounting framework. Accounting practices that completely exclude local data sources account for only 5.9% of the sample.

In compliance scenarios involving export trade and carbon border adjustment mechanisms, reliance on international databases is significantly higher. Among the 57 respondents whose stated purposes include "meeting export trade, international client, carbon border adjustment mechanism, or other compliance requirements," 52.6% primarily use ecoinvent and 8.8% primarily use Sphera LCA for Experts, with the two international databases together accounting for 61.4%; 19.3% primarily use CPCD. In contrast, among the remaining 313 respondents, 31.3% primarily use ecoinvent and 32.6% primarily use CPCD.

Between cross-border compliance scenarios and non-cross-border scenarios, the primary usage ratio of international databases differs by approximately 26 percentage points. This difference reflects the acceptability requirements of the accounting results: when the results need to be submitted to overseas clients or used for cross-border mechanism filings, the data source itself becomes one of the conditions determining whether the results can be accepted.

The primary criterion for users when selecting a database is whether the data can be accepted by external parties, followed by localization and methodological transparency, with price and ease of use ranking lower. At the current stage, users' evaluation criteria for databases are focused on the usability and defensibility of the data, rather than the convenience of the tool.

How usability is defined varies structurally across user groups with different primary data sources, and these differences align with the external review pressures they face. Among users who primarily use ecoinvent, 64.1% cite "reliable data quality and external acceptability" as a selection

criterion, higher than the 47.8% among users who primarily use CPCD. Those citing " compatibility with internationally mainstream databases, accounting standards, or software" account for 25.0%, nearly three times the 8.8% among primary CPCD users. Those citing "clarity of data sources, years, system boundaries, and calculation methods" account for 53.1%, higher than the 43.4% among primary CPCD users. Conversely, primary CPCD users place greater emphasis on coverage scope (55.8%, compared to 42.2% for ecoinvent users) and price acceptability (26.5%, compared to 14.1%). From a user perspective, CPCD data still needs to improve data quality reliability and enhance background information (data sources, years, system boundaries, etc.).

Based on the survey results, a preliminary understanding can be gained that the current usage landscape of product carbon footprint data in China can be summarized into three levels:

- At the access/usage level, local databases have the broadest coverage;
- At the primary-use level, international databases hold an advantage in high-intensity projects and cross-border compliance scenarios;
- At the usage-pattern level, over 60% of users rely on both types of sources simultaneously, with the two forming a complementary rather than replacement.

The formation of this landscape is mutually corroborated by the findings that "external acceptability" ranks first among user selection criteria, and "international compatibility" rises significantly among specific user groups. The competition between databases essentially takes place at the stage of whether accounting results can pass scrutiny by clients, certification bodies, and auditors, rather than at the level of data retrieval convenience.

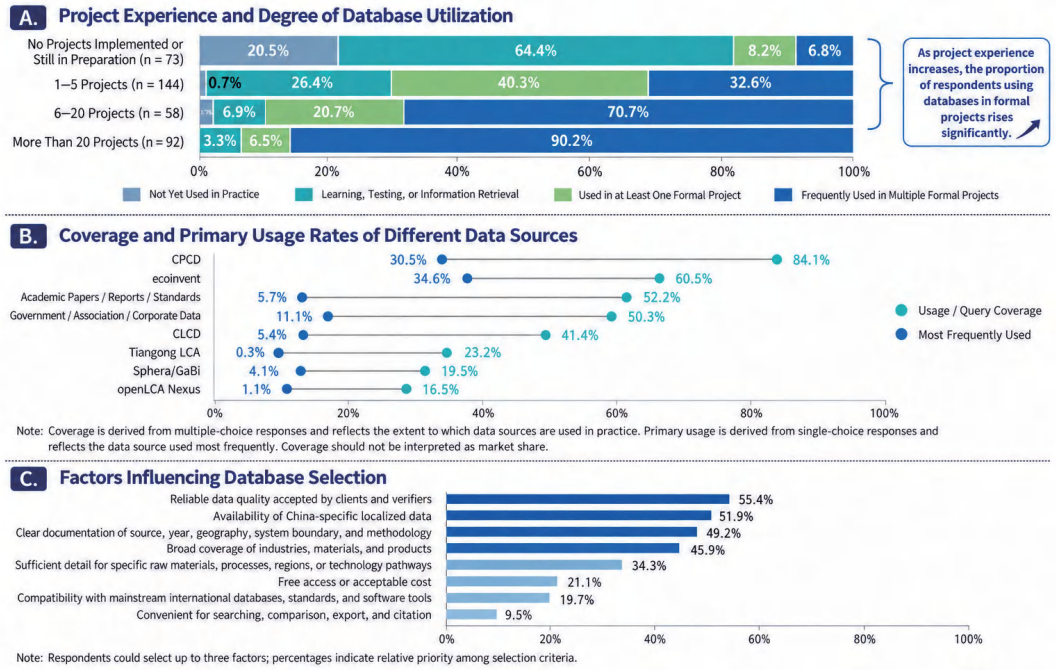


Figure 8 Usage Characteristics of Carbon Footprint Databases

8.3 Customer requirements and supply chain disclosure are the most important application scenarios for product carbon footprint data

- External applications outweigh internal ones: responding to customer/supply chain requirements (48.6%) and third-party certification (37.6%) rank as the top two; internal carbon reduction diagnosis accounts for only 10.8%, and does not increase with experience;
- Companies calculate carbon to "prove it to customers," not to "guide their own improvements."

The use of product carbon footprint data is driven primarily by external information requirements, while internal emission reduction decision-making needs rank last. Meeting customer requirements or supply chain carbon data disclosure requirements accounts for 48.6%, and use for third-party verification,

certification, consulting, evaluation, software, or model development accounts for 37.6%. Enterprises' independent assessment of product carbon footprint levels

accounts for 36.5%, carrying out carbon labeling, carbon declarations, green product evaluation, or certification accounts for 34.1%, use for ESG reports, sustainability reports, or other information disclosure accounts for 27.6%, use for scientific research, papers, projects, policy research, teaching, or training accounts for 23.5%, meeting export trade, international customer,

Carbon Border Adjustment Mechanism, or other compliance requirements accounts for 15.4%, and conducting internal carbon reduction diagnosis, product design optimization, or process improvement accounts for only 10.8%.

Among these eight uses, the four that point to external stakeholder information requirements (customer and supply chain, carbon labeling and certification, ESG disclosure, and export and cross-border compliance) together account for 53.7% of all selections, while the only option directly targeting production process improvement ranks last.

Narrowing the scope to the demand side makes this structure even clearer. Among 141 corporate users, the average number of selections per person was 2.49, and the most frequent use among corporate users was responding to downstream customers' data requirements, a proportion 5.4 times that of internal decarbonization diagnostics. In contrast, among 124 third-party professional institutions, the most frequent use was undertaking third-party

verification, certification, consulting, evaluation, and model development (66.9%), followed by meeting customer requirements or supply chain disclosure (54.8%) and carbon labeling certification (48.4%).

Internal carbon reduction diagnosis is not only the least selected purpose, but it also does not increase with the accumulation of practical experience. When grouping enterprise users internally by project experience, the proportions of those selecting "conducting internal carbon reduction diagnosis, product design optimization, or process improvement" are as follows: not yet started 9% (n=11), preparing 20% (n=20), 1–2 projects 6% (n=32), 3–5 projects 17%

(n=24), 6–10 projects 15% (n=13), 11–20 projects 18% (n=11), and more than 20 projects 7% (n=29).

The proportions across groups fluctuate between 6% and 20%, showing no upward trend with accumulated experience. Each subsample is relatively small, insufficient to support t rend judgments, but enough to indicate that this purpose has not become mainstream at any level of practical intensity. A large amount of carbon footprint research

has not supported a strong demand for internal corporate carbon reduction projects. This indirectly reflects that the current depth and level of carbon footprint work are insufficient to directly support internal corporate carbon reduction efforts, often remaining superficial or merely addressing customer audits. Carbon footprint research and analysis urgently need improvement.

In contrast, the proportion of "meeting customer requirements or supply chain disclosures" under the same grouping mostly ranges from 45% to 83%. This comparison indicates that the increase in the number of product carbon footprint calculations completed by companies has not been correspondingly translated into support for product design and process improvements; the primary flow of calculation results is external submission rather than internal use. Of course, this could also be due to respondents omitting some options when answering the questionnaire.

Export and cross-border compliance is a requirement of specific subsets rather than a universal driver, and in most cases it appears in conjunction with customer requirements. A total of 57 respondents (15.4% of the full sample) selected "meeting export trade, international customer, carbon border adjustment mechanism, or other compliance requirements," ranking 7th among the 8 purposes. Among these 57 respondents, 54.4% also selected "meeting customer requirements or supply chain carbon data disclosure." This indicates that cross-border compliance requirements in most cases do not independently trigger accounting, but are instead transmitted to suppliers through overseas customers' procurement and disclosure clauses. A related fact has already been presented in Part 2: the proportion of this group primarily using international databases is 61.4%, significantly higher than that of the remaining respondents. Taken together, these two results suggest that cross-border compliance scenarios not only determine whether accounting is conducted, but also determine which data sources are used.

Third-party verification, certification, and carbon labeling constitute the second tier of demand, with such demand frequently accompanying customer and supply chain disclosure requirements. In the full sample, "use for third-party verification, certification, consulting, evaluation, software, or model development" accounted for 37.6%, and "conduct carbon labeling, carbon declarations, green product evaluation, or certification" accounted for 34.1%, ranking second and fourth, respectively. In terms of

co-occurrence relationships, 65 respondents (17.6%) simultaneously selected "customer requirements or supply chain disclosure" and "carbon labeling or certification," while 61 respondents (16.5%) simultaneously selected "customer requirements or supply chain disclosure" and "third-party services." These two high-frequency combinations indicate that certification and verification activities are largely supporting verification steps undertaken to meet downstream requirements, rather than independent market demand. The most frequent co-occurrence combination was "customer requirements or supply chain disclosure" and "enterprise self-assessment" (73 respondents, 19.7%), reflecting the dual nature of the same action: enterprises gain an understanding of their own product carbon footprint levels while responding to external requirements.

The intended use determines the nature of the data requirements imposed on users, which forms a closed loop with the results presented in Part 2. When the primary destination of the accounting results is submission to clients, certification bodies, auditing parties, or overseas purchasers, the foremost attribute of the data is not precision but acceptability and defensibility. This explains why "whether the data quality is reliable and can be accepted by clients, certification bodies, or auditing parties" ranks first among selection criteria at 55.4%, and also why, in cross-border compliance scenarios, the primary usage rate of international databases is approximately 21 percentage points higher.

Conversely, when the accounting results are primarily used for internal process comparison and design optimization within an enterprise, users tend to place greater emphasis on data resolution and timeliness. However, the current sample shows that the scale of such demand (10.8%) is not yet sufficient to substantively steer the direction of database supply. This structural fact serves as a prerequisite for understanding the two subsequent sections: the pricing benchmark for service fees and users' expectations regarding database functionality are both built upon the constraint that "results must be accepted externally."

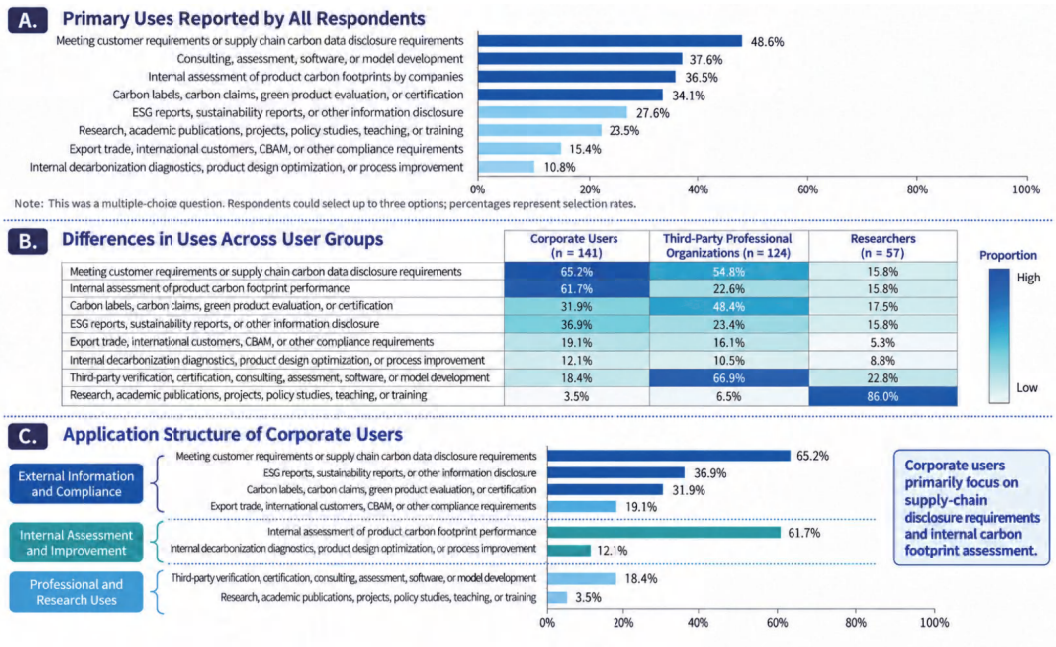


Figure 9 Application scenarios of carbon footprint databases

8.4 The price for single-product carbon footprint accounting services is mainly concentrated in the range of 10,000 to 30,000 RMB

- Actual transaction price: mainstream range 10,000–30,000 RMB per product (median), with 86.5% below 50,000 RMB;
- Contradiction in expected prices: expected average of 16,500 RMB vs. actual average of 30,700 RMB—an underestimation 46%;
- Among experienced users who have undertaken 20+ projects, 51.6% still believe a reasonable price should be ≤1 RMB—indicating that the service itself is not standardized, and delivery boundaries are unclear.

The actual service fees for externally commissioned carbon footprint accounting and reporting of a single product are concentrated in the range of RMB 10,000 to 30,000.

Specifically, 69.3% of quotes are at or below RMB 30,000, and 86.5% are at or below RMB 50,000 (based on 163 responses with explicit pricing). The weighted average estimated using interval midpoints is approximately RMB 30,000. Based on

publicly available sources we could retrieve, no other domestic study has been found that systematically discloses the price distribution of single-product carbon footprint accounting services based on a survey of real-name users.

The price distributions given by buyers and sellers differ in shape, with the buyer distribution being wider. The median ranges of the two groups are consistent, both falling between 10,000 and 30,000 RMB, but the proportion of corporate users in the tier above 30,000 RMB is 13.5 percentage points higher. It should be noted that the two groups answered on different bases: corporate users responded based on actual commissioned costs, while third-party institutions responded based on actual quotes or contract amounts. The former may include additional communication, data collection, and revision costs. Therefore, the difference between the two should not be directly interpreted as the gap between quoted and transaction prices, but it does indicate that single-product accounting services do not have a single price in actual transactions—rather, there is a clear tiered differentiation.

The reasonable cost perceived by users is significantly lower than the actual cost they observed. Cumulatively, 62.0% believe that a reasonable cost should be 10,000 yuan or less, while only 20.2% of actual quotes fall below 10,000 yuan. Pairwise comparison of responses that provided specific amounts for both questions shows that 66.2% expected a price lower than the actual price they observed, 21.8% expected a price equal to the actual price, and 12.0% expected a price higher than the actual price. Using the midpoint of each interval as an estimate, the actual average is approximately 30,700 yuan, while the expected average is approximately 16,500 yuan, a difference of about 46%. This substantial gap directly reflects t he lack of a unified pricing standard for third-party carbon footprint accounting services.

Third-party agencies must consider a range of factors when quoting, such as auditor/verifier travel, management costs, and person-day costs, but these factors are not uniformly regulated and are difficult for clients to understand. Meanwhile, clients naturally hope to purchase third-party services at the lowest possible cost, yet they clearly underestimate the basic costs of accounting services and fail to appreciate the value of the service.

The divergence between buyers' and sellers' expected prices is greater than the difference in actual prices between the two parties.

For the same service, buyers' reasonable

price range is concentrated in the thousands of yuan, while sellers' reasonable price range is concentrated in the tens of thousands of yuan, a difference of about one order of magnitude. This divergence contrasts with the aforementioned actual transaction distribution: the median actual transaction price range (10,000 to 30,000 yuan) aligns with the expectations of third-party institutions, but shows a significant gap from the expectations of enterprise users.

Expected prices rise systematically with accumulated practical experience, indicating that underestimation mainly comes from groups that have not yet actually participated in projects. The proportion of those who consider a reasonable fee to be 10,000 yuan or less drops from 88.9% in the preparation stage to 51.6% among groups with more than 20 projects. This gradient suggests that underestimation of service costs is negatively correlated with the degree of actual participation: respondents who have completed multiple projects have a more realistic judgment of the investment required for data collection, boundary confirmation, and report preparation. Even so, among the group with the deepest practical experience, more than half still believe that a reasonable fee should not exceed 10,000 yuan, while the median actual quotation range observed in this group is 10,000 to 30,000 yuan.

About 40% of respondents believe it is difficult to give a unified reasonable price, or did not choose a specific price range—a proportion that in itself indicates that the service has not yet been standardized. Differences in product complexity, data availability, and delivery depth have not yet been compressed into comparable pricing units. This echoes the 10.5% who said "fees cannot be separated when combined": the accounting service currently lacks both a unified price anchor and a unified delivery boundary.

Data pricing is not the most concentrated concern among users, ranking below data availability and consistency. Price pressure mainly falls on entities that need to call data in bulk and continuously, rather than on individual enterprises with lower project frequency.

The product carbon footprint services market exhibits three characteristics:

- First, a price range has already formed, with the mainstream transaction price for external outsourced accounting of a single product ranging from 10,000 to 30,000 yuan, but the delivery boundaries have not yet been unified, and over 10% of transactions cannot be priced on an itemized basis;
- Second, there is a systematic

divergence in value judgments between buyers and sellers, and this divergence narrows as buyers gain more practical experience, indicating that the main source of divergence is a difference in understanding of the workload rather than bargaining positions;

- Third, on the data supply side, users' willingness to pay points to a layered structure of "public provision of basic data, marketization of value-added services," rather than a binary choice between fully free and fully commercialized.

Together, these three characteristics indicate that pricing is not currently the primary constraint in the market—data availability and consistency rank higher—but the opacity of pricing methods and divergent perceptions of value will continue to affect the scalability of the service market.

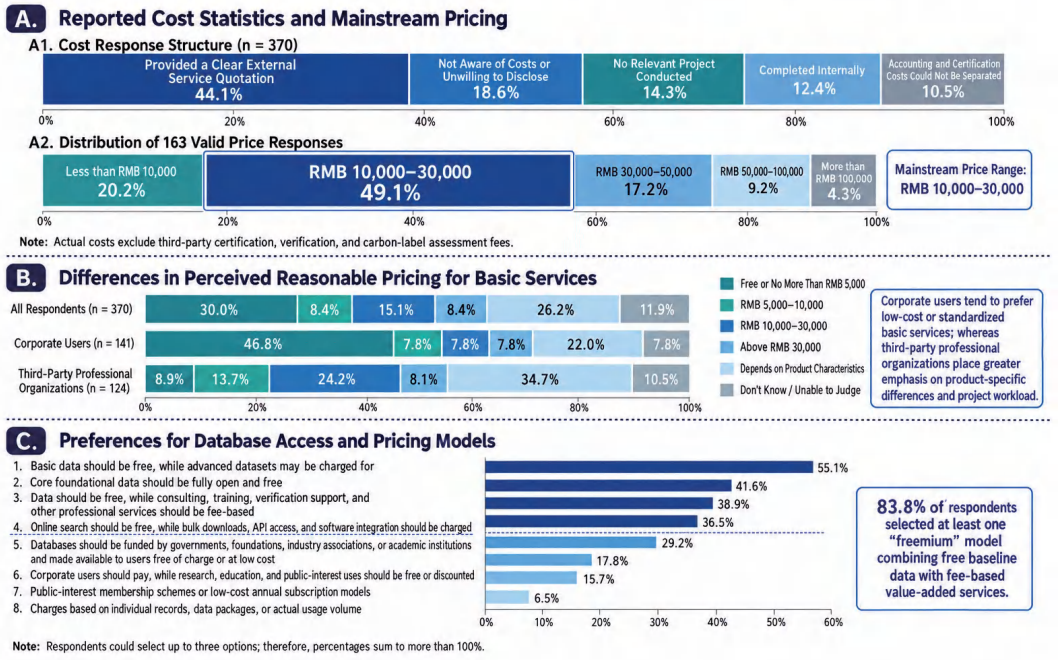


Figure 10 Cost characteristics of purchasing carbon footprint services

8.5 Issues in Practice, Handling Approaches, and Future Expectations

- The biggest pain point is not the cost, but "unavailability" and " reluctance to use";
- 71.6% cannot find localized/specific process data;

- 54.3% face conflicting results from multiple databases and don't know which to trust;
- 44.1% believe the data descriptions are not transparent, making it impossible to judge applicability;
- What users want most is not "AI" or "fancy features," but "complete and traceable basic information" (60.3% of votes)—source, year, boundary, methodology.

The most concentrated problem respondents face when using carbon footprint databases is the lack of localized Chinese data as well as specific product, material, and process data.

Among the 370 respondents, 265 selected this issue, accounting for 71.6%. 201 respondents reported that results varied significantly across different databases and were unsure which one to choose, accounting for 54.3%; 163 believed that explanations of data sources, years, regions, system boundaries, or calculation methods were insufficient, accounting for 44.1%.

These three issues all directly relate to the underlying data supply of the database: first, whether applicable data exists; second, how to choose when multiple datasets are available; and third, whether the scope of data applicability can be determined based on complete information. In comparison, data pricing, search functionality, and expert support, while also affecting practical use, are not the primary concerns identified in this survey. The data gap is mainly reflected in insufficient regional representation and product granularity, rather than merely an insufficient number of entries in the database.

Significant differences in results across databases do not in themselves imply that any particular result is necessarily incorrect; the key issue is whether the differences can be explained. Variations in region, year, technology route, energy structure, system boundary, allocation methodology, and data quality can all lead to different carbon footprint values for similar products. In the survey, 54.3% of respondents reported not knowing which database to choose, and 44.1% felt that source and methodology descriptions were insufficient, indicating that the difficulty users face is not merely differing values, but rather that the available information is inadequate to support applicability judgments.

The way different user groups handle data gaps is related to their access to data. Among enterprise users, 52.5% obtain primary data from suppliers, customers, or production departments, higher than the 46.0% of third-party professional institutions and 22.8% of researchers, reflecting that

enterprises are closer to data on their own production and supply chain activities. Among third-party professional institutions, 71.0% choose similar substitute data, and 63.7% search for public sources. Third-party institutions and researchers typically handle multiple enterprises, products, or research subjects simultaneously, and thus rely more heavily on external databases and public information.

Users' primary demand for future databases is not to add complex features, but to improve the basic descriptions of each data entry. 223 respondents hope that future databases will prioritize providing more complete descriptions of data sources, years, regions, system boundaries, and calculation methods, accounting for 60.3%, ranking first among all feature options; 190 people hope to improve keyword search, industry classification, and condition filtering, accounting for 51.4%; 150 people hope to add data quality scores, applicable scenario descriptions, and recommended usage levels, accounting for 40.5%. These three demands correspond to data transparency, data search efficiency, and data selection criteria, reflecting that users need not only more numerical values, but also to know where the values come from, what scenarios they apply to, and how they should be used.

The open-ended questions further indicate that users prioritize supplementing granular data on basic raw materials, intermediate industrial goods, and sectors where China has competitive advantages. Of the 370 responses, 203 provided substantive content, accounting for 54.9%. Among the demands targeting specific industries and product categories, chemicals and chemical products accounted for 25.6%, ranking first across all categories.

Users repeatedly called for updating outdated data, cleaning duplicate or erroneous entries, clarifying system boundaries and sources, adding cross-category data comparisons, optimizing search and filtering, supporting export to Excel and common data formats, providing API interfaces, retaining data versions and edit history, as well as adding AI-based recommendations, simple accounting templates, and user error-reporting features. These responses indicate that future database development must simultaneously address data coverage, data quality, usage functionality, and operational collaboration—but the most fundamental task remains the creation of data that is traceable, comparable, and applicable t o actual production conditions in China.

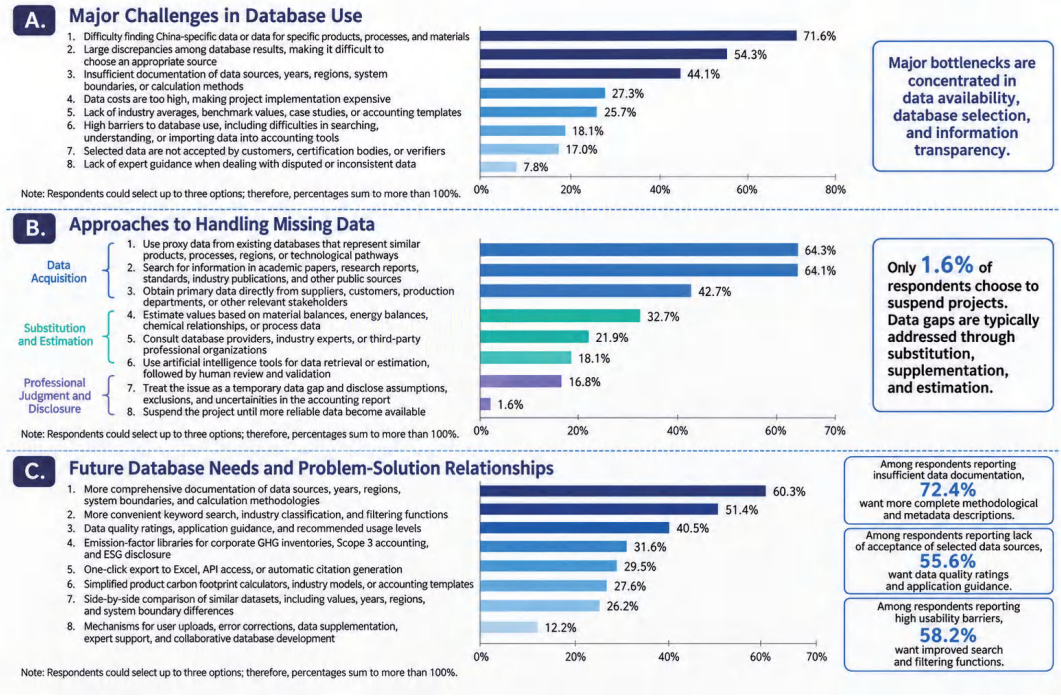


Figure 11 Problems encountered in the use of carbon footprint databases

Appendix 1 Milestones in Carbon Footprint at Home and Abroad

Timeline	Domestic	International
January 2025	The "Guidelines for the Development of Product Carbon Footprint Calculation Standards" were publicly released, clarifying the development roadmap and technical requirements for specific product carbon footprint standards. Four government departments announced the first batch of 15 recommended group standards for industrial product carbon footprint calculation rules. The 2023 electricity carbon footprint factors were released simultaneously, laying the groundwork for a national database to support product carbon footprint calculations.	The EU's revised Construction Products Regulation has taken effect. The regulation introduces a digital product passport, which is required to contain information on product performance, compliance, and sustainability, and provides a data foundation for more reliably calculating the carbon footprint of buildings throughout their entire life cycle.
February 2025	Four departments, including the Ministry of Ecology and Environment, issued the "Opinions on Promoting Voluntary Disclosure of Corporate Greenhouse Gas Information," explicitly calling for the development of standards related to product carbon footprint calculation and information disclosure to guide and support enterprises in disclosing product-level carbon emissions information.	The European Commission released the "Omnibus I" comprehensive simplification package, proposing to narrow the scope of the Corporate Sustainability Reporting Directive (CSRD) and adjust the disclosure timeline. Carbon and sustainability disclosure has shifted from a phase of unilateral expansion to a new phase characterized by the parallel goals of "enhancing comparability and reducing the burden on businesses."
March 2025	The China National Accreditation Service for Conformity Assessment (CNAS) released the "General Implementation Rules for Product Carbon Footprint Labeling and Certification (Trial)" and the China Product Carbon Footprint Label, systematically defining for the first time the certification model, certification process, label design, and post-certification supervision requirements.	The Science Based Targets initiative (SBTi) released the first draft of the "Corporate Net-Zero Standard" V2 for public comment, beginning the redesign of rules for corporate Scope 1, Scope 2, and Scope 3 targets as well as supply chain actions. At the time, this document was a draft for public comment and not an official standard.
April 2025	The Ministry of Finance and other departments released the "Corporate Sustainability Disclosure Guidelines No. 1—Climate (Trial) (Draft for Public Comment)," which proposed disclosing greenhouse gas emissions according to Scopes 1, 2, and 3, laying the institutional foundation for incorporating product carbon footprint data into corporate value chain disclosures. At the time, this document was a draft for public comment.	The European Union's Joint Research Centre (JRC) published a report on carbon footprint accounting methods for industrial batteries, providing a technical foundation for carbon footprint declarations under Article 7 of the EU Battery Regulation and subsequent supporting rules.

Timeline	Domestic	International
May 2025	The State Administration for Market Regulation solicited public comments on 48 proposed national standard projects, including "Greenhouse Gases—Quantification Methods and Requirements for Product Carbon Footprints—Wood and Bamboo Products," further expanding the reserve of national standards for product carbon footprints.	The European Commission released a comprehensive assessment of the final updated versions of member states' National Energy and Climate Plans. The EU's net greenhouse gas emissions in 2030 are projected to decrease by approximately 54% compared to 1990 levels, approaching the statutory target of 55%.
June 2025	Four ministries and commissions announced the second batch of recommended group standards for industrial product carbon footprint calculation rules, bringing the cumulative total for the first and second batches to 38 group standards. On National Low-Carbon Day, the Ministry of Ecology and Environment released its first "Progress Report on the Development of Product Carbon Footprint Management Systems (2025)," systematically summarizing progress in China's carbon footprint policies, standards, factors, certification, and local pilot programs.	The EU published the Environmental Footprint Category Rules (PEFCR) for clothing and footwear products, establishing a unified life-cycle environmental impact assessment methodology covering the raw materials, production, logistics, use, and end-of-life stages.
July 2025	The State Administration for Market Regulation and two other departments publicly released the first batch of pilot certification catalogs for product carbon footprint labeling and certification, covering 17 product categories including lithium batteries, photovoltaics, steel, electronics and electrical appliances, electrolytic aluminum, cement, and wood products. Product carbon footprint labeling and certification has moved from the stage of general rules to the implementation phase for specific products.	The United Kingdom launched an electric vehicle subsidy program, incorporating the sustainability and carbon emissions performance of vehicle and battery production into the evaluation of eligibility for vehicle subsidies; the climate performance of products and manufacturing processes now directly influences financial subsidies.
August 2025	The General Office of the Communist Party of China Central Committee and the General Office of the State Council publicly released the "Opinions on Promoting Green and Low-Carbon Transition and Strengthening the Development of the National Carbon Market," proposing that by 2027, the national carbon emissions trading market should fundamentally cover major emitting industries in the industrial sector, while strengthening data quality and the development of carbon pricing mechanisms.	The European Commission launched a call for evidence regarding embedded emissions accounting methods, adjustments to free allowances, and rules for offsetting carbon prices already paid in third countries during the formal phase of the Carbon Border Adjustment Mechanism (CBAM), to refine supporting regulations ahead of its full implementation in 2026.

Timeline	Domestic	International
September 2025	The China National Accreditation Service for Conformity Assessment (CNAS) issued the first batch of 17 specific implementation rules for product carbon footprint labeling and certification, which respectively define the functional units, system boundaries, data requirements, and calculation and certification procedures for the relevant products.	ISO and the GHG Protocol announced a strategic partnership, planning to harmonize existing greenhouse gas accounting standards at the organizational, product, and project levels and jointly develop new accounting rules, marking the start of institutional coordination between the world's two leading carbon accounting frameworks.
October 2025	The Ministry of Ecology and Environment and two other departments released the 2024 carbon footprint factors for electricity. The national average carbon footprint factor for electricity is 0.5777 kilograms of CO_2 equivalent per kilowatt-hour, a 6.9% decrease from 2023. Carbon footprint factors for major power generation types as well as transmission and distribution were also released.	The simplified amendment to the EU's CBAM regulation officially took effect, establishing arrangements such as a uniform 50-metric-ton mass threshold. At the same time, the GHG Protocol launched a public consultation on revisions to its Scope 2 guidelines, proposing hourly-level matching, deliverability, and stricter requirements for emission factor hierarchies; this Scope 2 document remains a draft for public comment. ISO and the GHG Protocol also announced the joint development of new product-level greenhouse gas accounting standards.
November 2025	Multiple institutions jointly updated and released a background database on lithium-ion battery carbon footprints, containing over 1,200 data entries covering 28 major production regions in China's lithium-ion battery industry chain, further accelerating the development of specialized industry databases.	SBTi released the second round of public comments on Version 2 of the "Corporate Net-Zero Standard," continuing to refine requirements for Scope 3, procurement, value chain collaboration, and corporate transition plans. This version is not yet the final standard.
December 2025	The Ministry of Ecology and Environment, along with six other departments, issued the "Guidelines for the Construction of a Product Carbon Footprint Factor Database," which, together with the guidelines for standard development released earlier this year, forms a dual-pillar system of standards and data. The Ministry of Finance, along with nine other departments, issued "Corporate Sustainability Disclosure Standard No. 1—Climate (Trial)," explicitly requiring the disclosure of greenhouse gas emissions classified under Scope 1, Scope 2, and Scope 3; until the scope and requirements are separately stipulated, implementation is voluntary for enterprises.	The EU issued a package of supporting regulations for the formal implementation phase of CBAM, covering embedded emissions accounting, third-party verification, certificate pricing, adjustments to free allowances, and default values, in preparation for the full implementation of the rules in 2026.

Timeline	Domestic	International
January 2026	The Ministry of Ecology and Environment issued the "Guidelines for the Compilation of Provincial-Level Greenhouse Gas Inventories (2025 Edition)," expanding the scope of gases and sectors covered to enhance the scientific rigor, standardization, and practicality of local greenhouse gas inventories.	The GHG Protocol released its first "Land Sector and Removals Standard," incorporating agricultural land use and certain carbon dioxide removal technologies into the corporate greenhouse gas accounting framework.
February 2026	The Ministry of Industry and Information Technology and three other departments announced the third batch of recommended group standards for carbon footprint calculation rules for industrial products, including a total of 73 standards covering tires, synthetic ammonia, hydrogen, methanol, and copper processing products. The cumulative total of recommended standards across the three batches now stands at 111.	The California Air Resources Board approved the initial regulations for corporate greenhouse gas reporting and climate financial risk disclosure, advancing the implementation of SB 253 and SB 261. Under these regulations, eligible companies are required to disclose Scope 1 and Scope 2 emissions starting in 2026, and to include Scope 3 emissions beginning in 2027.
March 2026	The second edition of the National Greenhouse Gas Emission Factor Database was released, with the total number of factors increasing to 576 and including carbon emission intensity data for key products such as crude steel and unwrought aluminum. The "Ecological and Environmental Code of the People's Republic of China" was adopted. Article 1,036 explicitly establishes, for the first time at the national legislative level, a system for product carbon footprint calculation, tiered management, labeling and certification, and information disclosure.	The GHG Protocol released the Phase 1 white paper on "Action and Market Instruments" (AMI) and solicited feedback, proposing separate reporting for physical GHG inventories, market-based inventories, and the impact of actions. This white paper is not a draft standard; a formal draft standard is planned for a subsequent public comment period.
April 2026	The State-owned Assets Supervision and Administration Commission of the State Council publicly released the "Guidelines for the Construction of Green and Low-Carbon Supply Chains in Central Enterprises (Trial)," incorporating full life-cycle carbon footprints, the coverage rate of green and low-carbon assessments of upstream suppliers, and product carbon footprint levels into procurement and supplier evaluation tools.	ISO published ISO 19870-1:2026, establishing a method for quantifying greenhouse gas emissions from hydrogen production—from raw material sourcing to the gates of the hydrogen production plant—further translating the "color classification" of hydrogen into accountable and comparable product carbon footprint rules.

Timeline	Domestic	International
May 2026	The international standard project proposed by China, "Product Carbon Footprint (CFP) Digitization—Part 2: CFP Data Exchange Formats and Guidelines," was successfully approved by the International Electrotechnical Commission (IEC), becoming the first international standard on product carbon footprint digitization led by China.	The European Commission published a draft implementing act for the Carbon Border Adjustment Mechanism (CBAM) regarding deductions for carbon prices already paid by third countries and launched a four-week public consultation, detailing requirements such as proof of payment, currency conversion, and third-party certification.
June 2026	Five departments, including the National Development and Reform Commission, issued the "Guidelines for Accounting for Non-Fossil Energy Electricity Consumption (Trial)," establishing three accounting methods—physical recognition, transaction recognition, and allocation recognition—and clarifying their integration with systems such as product carbon footprint. On National Low-Carbon Day, the Ministry of Ecology and Environment released the "Progress Report on the Development of Product Carbon Footprint Management Systems (2026)," systematically summarizing progress made since 2025 in standards, factor databases, certification, and application scenarios.	SBTi officially released Version 2.0 of the "Corporate Net-Zero Standard." ISO published ISO 14025:2026, updating the internationally recognized rules for environmental product declarations.
July 2026	The State Council issued the "15th Five-Year Plan for Building a Beautiful China," explicitly calling for the improvement of the product carbon footprint management system, the refinement of labeling, certification, tiered management, and information disclosure systems, and the promotion of international mutual recognition of product carbon footprint rules.	SBTi launched a second round of public consultation on the draft update to the "Net-Zero Standard for the Electricity Sector," continuing to refine requirements for Scope 1 through Scope 3 targets, low-carbon electricity, and transition plans for electricity companies.

Appendix 3 List of Enterprises and Researchers Involved in the On-site Survey

ECA Healthcare Inc.

Our company's product carbon footprint calculating project is mainly to meet the requirements of international customers and export markets, enhance product competitiveness, and at the same time understand the carbon emissions throughout the product life cycle, providing a basis for energy conservation, carbon reduction, and green development.

Regarding the quotation for the carbon footprint project, we conduct carbon footprint accounting together with ISCC and other projects through third-party certification bodies. The overall quotation is approximately 40,000–50,000 RMB, but the specific amount attributable to the carbon footprint component alone is not yet clear.

The main benefits of carbon footprint to us are enhancing customer recognition, meeting green procurement requirements, strengthening export competitiveness, and providing data support for energy conservation, consumption reduction, and green management.

The main difficulties in implementation are the difficulty in obtaining supply chain data, the heavy workload of data collection, and differences in understanding of accounting standards, which hinder front-end basic data collection. The company addresses these by strengthening communication with suppliers, establishing internal data management mechanisms, and completing accounting with the help of third-party institutions and emission factors from databases.

We are generally quite satisfied with the current policies on carbon footprint. We suggest further unifying domestic and international accounting standards, improving local databases and product accounting rules, reducing the cost for enterprises to conduct carbon footprint assessments, and enhancing international recognition.

Researcher: Zhiyuan Ning

Jinhua Li Jia Yuan Bioengineering Co., Ltd.

Our company chose to undertake the product carbon footprint accounting project mainly to meet customer requirements, and also to understand our own carbon emissions so that we can take targeted measures to reduce them.

Regarding pricing, we choose to bundle this project with other projects each year for both execution and quotation, which improves efficiency and avoids redundant work. Taking carbon inventory as an example, carbon footprint, carbon inventory, and other certification projects require essentially the same basic documentation. Quoting several projects together and arranging similar on-site audit schedules improves efficiency and makes it easier for certification bodies to plan. Calculated on a total-price basis, it amounts to approximately 20,000–30,000 RMB per year.

The main benefit of conducting carbon footprint assessment is that it not only meets customer requirements but also gains customer recognition, while simultaneously enhancing the company's carbon management

efficiency. During the data collection process, we actively mobilized the cooperation of suppliers and internal company personnel to provide relevant calculation values promptly and accurately. Once the data collection was complete, most of the difficulties were significantly reduced. The remaining calculation and verification work was handled with the assistance of third-party organizations, and the on-site verification also proceeded smoothly.

We currently have no other recommendations regarding carbon footprint policies and will continue to carry out related work.

Researcher: Zhiyuan Ning

TSI Group

Our company's products are divided into those derived from shrimp and crab shells and those from fermentation. In order to compare data across different sources, respond to customer concerns about carbon footprint data, and meet diverse customer needs, we have been conducting carbon footprint assessments for several consecutive years.

The current market price is approximately RMB 15,000–20,000, with travel expenses fluctuating slightly each year, and the total cost generally falls within this range. The government now encourages companies to obtain relevant certifications (ISCC) and collect carbon emission data. Our factory in Jiangsu has received government subsidies, so the price is acceptable.

The primary purpose of conducting carbon footprint assessments is to meet customer needs, while also enhancing the competitiveness of our products in the market. In terms of challenges, some data involves supplier confidentiality, and suppliers have shown low willingness to provide such information during collection. The solution is to sign confidentiality agreements with suppliers, after which they provide basic data within the agreed scope, such as energy consumption data and product output.

Our current observation is that different customers adopt inconsistent carbon footprint standards (some require ISO 14067, while others accept domestic guidelines). We hope that relevant authorities can provide enterprises with carbon footprint training and policy guidance, which would help companies better understand and advance their carbon footprint projects.

Researcher: Zhiyuan Ning

Henan Energy Group Heavy Equipment Co., Ltd.

The company's direct reason for undertaking carbon footprint work is the mandatory requirement for applying for green factory certification, as carbon footprint quantification data is a core supporting document for the national-level green factory review. The company also hopes to gain a clear understanding of emissions during raw material acquisition, transportation, and production processes, identify high-emission stages, and make improvements accordingly.

The benefits of carbon footprint work are mainly reflected in additional points for applications, higher review pass rates, and improved energy efficiency and reduced energy costs through optimizing the energy consumption structure. This work also helps the company establish a long-term management mechanism, laying

the foundation for future low-carbon product certification.

The main difficulty encountered during the accounting process is the lack of professional accounting talent. The solution is to collaborate with third-party professional institutions to conduct accounting training and unify accounting boundaries and methods.

Regarding policy sentiment, we believe that carbon footprint is gradually evolving from a voluntary effort to a quasi-mandatory requirement. It is recommended to establish a platform for sharing carbon data across the industry chain and to standardize supplier carbon information disclosure requirements.

Researcher: Xinzheng Sun

People's Cable Group Co., Ltd.

Our company actively responds to the "dual carbon" goals. As a national high-tech enterprise integrating R&D, manufacturing, and sales, we have always upheld the principle of " Quality cables made by the people, for the people." With the rising green barriers in international trade and the increasing requirements for green supply chains in areas such as State Grid and new energy, carrying out carbon footprint management is not only a "passport" for market access but also a core driver for the company's transformation from "traditional manufacturing" to "green intelligent manufacturing." Since 2019, our company has conducted carbon footprint accounting or certification for major products annually, which helps us understand our carbon emission baseline and optimize product design from a full life-cycle perspective.

The most significant benefits are the "green brand premium" and "cost reduction and efficiency enhancement." The quantitative management of carbon footprints has earned us multiple national and provincial honors, including the 2025 Henan Province "Zero-Carbon" Factory Demonstration Enterprise and "National Green Factory" titles, helping us secure major contracts in bidding processes for large enterprises such as State Grid and PetroChina, as well as in export business across more than 40 countries. On the other hand, through precise accounting, we identified the areas with the greatest emission reduction potential, and implemented measures such as waste pressure utilization in air compressors and self-built distributed photovoltaic power stations, achieving substantial cost reduction and efficiency gains.

Our company's main difficulties currently lie in the acquisition of full life cycle data and the unification of accounting standards, especially the difficulty in tracing the carbon e mission factors of upstream raw materials such as copper and aluminum. We have adopted a strategy of "digital empowerment + industry-academia-research collaboration," establishing a digital intelligent management center for energy and carbon, achieving intelligent monitoring of the entire process from energy consumption to carbon emissions. At the same time, we leverage our role as a chain-leading enterprise, participate in the formulation of relevant national and group standards, and strive to break down data barriers.

We believe the current policy direction is clear, but there is still room for optimization at the implementation level: green certification and carbon footprint accounting processes are relatively complex and costly, and some downstream users have insufficient awareness of the full lifecycle benefits of green products, leading to a "premium dilemma" for "green cables." It is recommended to accelerate the improvement of unified carbon

footprint accounting standards and certification systems, promote the establishment of a local carbon footprint factor database, strengthen targeted fiscal, tax, and financial support, provide support for low-carbon technology R&D and green credit, and clarify priority procurement requirements for green and low-carbon products in public sectors such as power grid construction and government investment.

Researcher: Xinzheng Sun

Jiaozuo Railway Cable Co., Ltd.

The company conducts carbon footprint work to understand the greenhouse gas emissions throughout the product lifecycle, support emission reduction, and simultaneously improve internal operational efficiency and save costs.

In terms of revenue, internally tap potential to reduce costs, and externally leverage carbon footprint inclusion to gain market access.

Difficulties during implementation include incomplete basic data, with raw material consumption and waste data scattered across different departments, as well as missing historical data. The company has leveraged its energy management system and smart meters to fill measurement gaps, with each department reporting data on a monthly basis.

Regarding current policies, the overall impression is that the policy direction is supportive, but specific implementation remains unclear, standards are inconsistent, requirements are fragmented, and there is a lack of detailed local guidance. Companies mainly rely on customer demands, third-party consulting, and self-exploration.

Researcher: Xinzheng Sun

Goldwind Science & Technology Co., Ltd.

The company's carbon footprint work is driven by three main factors. First, international market access requirements: the French Energy Agency sets maximum limits on carbon emissions for wind turbines, requiring manufacturers to commit to and submit proof of full lifecycle emissions. Projects without such documentation cannot obtain approval, making carbon footprint a new threshold for market access. Second, international key customer requirements: European power companies have launched sustainable supply chain strategies, requiring suppliers to complete full lifecycle environmental assessments (LCA) a nd environmental product declarations (EPD). Products without EPD are not eligible for bidding. Third, national policy requirements: the National Energy Administration issued the " Action Plan for Standardization Enhancement of Energy Carbon Peak and Carbon Neutrality," listing the carbon footprint standard system for energy equipment as a key special action.

In terms of costs, our experience is that different consulting and certification agencies charge different fees, and the fees also vary significantly depending on product complexity. For hybrid towers, energy storage, and wind turbine products, costs range from 30,000 to 600,000 RMB. In recent years, as more institutions have entered this business, prices have shown a gradual downward trend.

The benefits are reflected in three aspects: reduced product development costs, as the company

independently learned and completed carbon footprint accounting, saving substantial product consulting fees in the later stages; received government incentives, having obtained certification based on the Zhongguancun association standard it led in drafting, and in 2025 it received a 200,000 RMB cash reward from the Beijing Economic-Technological Development Area; strongly supported international market expansion, as the certified products are highly recognized by international customers, with orders on hand increasing year by year.

In terms of challenges, the carbon footprint accounting process is complex and time-consuming, covering multiple stages from raw material acquisition to waste disposal. The solution is to work closely with professional technicians and suppliers to thoroughly map out the entire product lifecycle. In addition, product data involves collaboration across multiple departments, making it difficult and time-consuming to obtain multi-stage,

multi-regional data. The solution is to ensure full cooperation between internal and external parties and strengthen communication and coordination.

In practice, there are difficulties in coordinating electricity and carbon efforts. Green electricity used in production cannot be traced, carbon reduction effects cannot be verified, and different government departments oversee different aspects, which means that even when green electricity is used, only the average carbon footprint factor for electricity can be applied in accounting. It is recommended that electricity and carbon systems be integrated and carbon reduction be verified, paving the way for green, low-carbon products to enter the international market.

Researcher: Ye Tian

TBEA Co., Ltd.

TBEA's carbon footprint efforts are primarily market-driven. In the stages of qualification admission, bidding and procurement, and factory audit, product carbon footprint has become a mandatory requirement. Product carbon footprint has evolved from an early-stage differentiating bonus item to a basic threshold for supplier prequalification and bidding shortlisting—a rigid condition where "having a certificate may not earn extra points, but lacking one means direct disqualification." As leading companies in the industry have generally completed their carbon footprint initiatives, the industry-wide baseline for market access has been raised, creating competitive pressure where "those who don't act will fall behind."

In terms of cost, carbon footprint certification for conventional domestic bidding and tendering scenarios requires lower data traceability depth and accounting rule precision, with a focus on streamlined certification processes. The price for such certification of a single product typically ranges from 10,000 to 30,000 RMB. A representative example at the high end is certification under the procurement system of Électricité de France (EDF), which features clearly specified product category rules, a fixed emission factor database, and standardized accounting methodologies. The audit process includes rigorous data verification and on-site traceability, with the cost for a single product reaching over 200,000 RMB.

For physical manufacturing enterprises, the core attribute of carbon footprint is a market compliance tool. The benefits of conducting carbon footprint work are reflected in three levels: maintaining supplier qualifications to ensure inclusion in the qualified supplier list of downstream core customers; obtaining bidding entry

qualifications to avoid direct elimination due to missing certificates; and enhancing supplier ratings to create differentiated advantages and increase the probability of winning orders. Unlike carbon footprint work with a public welfare or research attribute, we believe that the carbon footprint investment of physical manufacturing enterprises must be linked to actionable commercial value. Pure theoretical accounting that cannot be converted into order growth, qualification improvement, or cost reduction lacks the commercial sustainability for long-term investment. Carbon footprint investment must be tied to actionable commercial value—this is the core logic for most manufacturing enterprises.

Current practical difficulties include: energy consumption data disaggregation is challenging—a single workshop may produce different products simultaneously, lacking metering methods or reasonable allocation rules, so only empirical estimation is possible; a large number of electronic components are counted by quantity rather than weight, which does not match the weight-based units of emission factors, resulting in a huge conversion workload; and tracing the source of raw material emission factors is difficult, requiring tracing upstream or even further upstream suppliers, which is not operationally feasible for enterprises.

From the perspective of manufacturing enterprises, the current domestic carbon footprint market suffers from the problem of "emphasizing form over substance." Different institutions vary significantly in their accounting boundaries, data requirements, and review standards, causing a large number of carbon footprint certifications to become mere "paper materials for bidding." After obtaining certificates, enterprises are unable to identify emission reduction potential or improve carbon management capabilities through the accounting process. It is recommended to draw on the approach of national energy consumption quota standards for products, establishing industry-specific, unified product carbon footprint accounting rules and baseline values, focusing accounting efforts on segments that enterprises can control and that account for a high proportion of impact, while adopting simplified treatment for segments such as end-of-life waste disposal where enterprises cannot exert influence, balancing scientific rigor with practical applicability.

Researcher: Ye Tian

Atlas·Copco (Atlas Copco AB)

The company conducts carbon footprint assessments primarily for four reasons: to identify emission reduction opportunities and systematically evaluate the full life-cycle carbon emissions of products; to support customers in achieving their decarbonization and sustainable development commitments; to feed carbon footprint data back into R&D, improving resource efficiency and environmental performance of products; and to respond to the growing demand for environmental transparency in customer procurement and regulatory compliance pressures.

The key benefits of carbon footprint work include identifying emission hotspots, optimizing products and sustainability performance, enhancing customer engagement and differentiation, and proactively addressing regulatory requirements.

Four types of challenges were encountered during implementation: product complexity and difficulty in defining boundaries, addressed by forming cross-departmental working t eams and establishing unified

accounting boundary rules by product category; insufficient supplier data and quality issues, addressed by proactively communicating with and training core suppliers, and using industry average data combined with sensitivity analysis for processes where primary data cannot be obtained; inconsistent methodologies and standard alignment issues, addressed by strictly following ISO 14067 and the GHG Protocol, and benchmarking "carbon calculators" with peers and customers using equivalent standards; and resource and professional capability issues, addressed by strengthening internal training and promoting unified coordination at the group headquarters to avoid duplication of efforts across regions.

We observe that customers are increasingly requesting carbon footprint data, and cli mate disclosure frameworks such as TCFD and CSRD continue to drive demand for life cycle information, while methodologies, databases, and reporting formats vary significantly across the industry. Suppliers often struggle to meet detailed data requirements due to limited resources and inconsistent reporting practices.

We recommend that companies coordinate at the group level to avoid duplicate submissions across regions, and distinguish between direct and indirect suppliers to ensure the effective advancement of related efforts. We also encourage further harmonization of PCF methodologies and reporting standards globally, promote industry-specific product category rules, support digital data exchange standards, and ensure that regulatory requirements remain practical and scalable for enterprises with complex global supply chains.

Researcher: Wei Liu

Danfoss (China) Investment Co., Ltd.

Danfoss conducts product carbon footprint assessments for three reasons: to respond to global climate goals and the company's carbon reduction strategy, quantify carbon e missions across the full product lifecycle, and provide a basis for low-carbon product design and supply chain emission reduction; to meet customer demand for transparent low-carbon product information in the industrial, building, and energy sectors; and to address evolving international regulations and market requirements, such as EU sustainability-related policies, the Carbon Border Adjustment Mechanism (CBAM), and corporate environmental information disclosure requirements, thereby further identifying and optimizing carbon emissions and driving low-carbon product upgrades.

The cost of carbon footprint assessment varies significantly depending on product complexity, data availability, and whether third-party certification is adopted. For products supported by existing LCA databases with simple structures, the cost is relatively low; for products involving multiple suppliers, complex materials, and global supply chains, the cost will be higher.

The current benefit of corporate carbon footprint is enhanced transparency of product carbon emissions, enabling the company to formulate more precise emission reduction measures based on data. Through carbon footprint report analysis, major e mission sources in raw materials, energy use, and supply chain processes can be identified and designs can be optimized accordingly. Carbon footprint data has also strengthened customer trust, helping Danfoss maintain a competitive edge in the low-carbon technology market.

Key challenges include difficulties in supply chain data collection, inconsistent data quality across different regions and suppliers, and discrepancies between various standards and calculation methods. The solutions

involve establishing a unified data collection process, strengthening collaboration with suppliers, adopting internationally recognized methods and standards (such as ISO 14067), and leveraging internal digital tools to improve data management efficiency.

Currently, carbon footprint-related regulations and customer requirements are rapidly increasing, serving as a major driver for corporate emission reduction. However, challenges remain in implementation, including inconsistent standards, significant differences in regulatory requirements across markets, and high costs associated with supply chain data acquisition. It is recommended that the international community further promote the harmonization of carbon footprint calculation methods and data standards, strengthen industry database development, and provide more guidance and support to small and medium-sized enterprises.

Researcher: Wei Liu

Beijing Zhongke Lvran International Energy Co., Ltd.

Zhongke Lvran is a comprehensive service provider in the green fuel sector. Based on an independent third-party data certification and traceability system, it offers one-stop solutions for the industry, ranging from carbon footprint management and green rights development to asset circulation and monetization.

Our approach to product carbon footprint is an inevitable requirement for industry development. The green fuel industry is transitioning from the demonstration stage to large-scale development, but the sector generally faces three core challenges: the lack of credible data support makes certification difficult, asymmetric supply-demand information makes trading difficult, and the difficulty in quantifying green value makes carbon asset development challenging. Carbon footprint management is precisely the foundational capability that unlocks the full value chain closed loop of "production-monitoring-certification-assetization-trading."

Currently, carbon footprint costs vary significantly depending on the service model:

Service Model	Cost Range (per product)	Description
Traditional third-party verification	RMB 10,000–50,000	Engaging a third-party agency takes approximately 2–4 weeks and requires manual data collection; costs depend on product complexity and accounting boundary, such as full life cycle versus selected stages.
Digital platform accounting	RMB 5,000–20,000	Using an intelligent accounting platform can improve data collection efficiency by approximately 30% and reduce labor costs. An annual LCA database subscription fee is required, approximately RMB 20,000–50,000 per year, but it can be amortized across multiple products.
Including international certification, such as	RMB 50,000–300,000	Depending on company size and supply chain complexity: RMB 50,000–150,000 for small and medium-sized enterprises, and RMB 150,000–300,000 or more for large groups or complex supply chains. This includes audit fees, official system fees, and consulting service fees; certificates are valid for one year.

The benefits of our company's carbon footprint work are mainly reflected in four aspects: meeting international green compliance requirements and helping enterprises address carbo n tariff mechanisms such as

CBAM; after carbon footprint data is stored on the blockchain, it forms traceable data assets that can be directly used for green credit assessment, carbon asset development, and carbon trading, transforming green value into economic value; helping products gain recognition from certification bodies and trust from purchasers, supporting premium product sales; and through a one-time data construction, serving multiple business scenarios such as certification, trading, and green rights development over the long term.

The carbon footprint accounting process faces four types of difficulties: upstream supply chain data is difficult to obtain, especially since smallholder farmers in the biomass raw material collection stage lack the capacity to record carbon emission data, and some suppliers are unwilling to disclose carbon emission data due to commercial sensitivity. Our solution is to automatically collect key data as an independent third party through interfaces or IoT devices, while signing confidentiality agreements to ensure data security; accounting standards are not unified, and the materials required for various certification processes are complex, making it difficult for clients to clarify and prone to low efficiency and errors in manual work. Our solution is to use a unified data foundation to accommodate output requirements under different standards; data quality and traceability are difficult to guarantee, as a large amount of key data currently remains in paper ledgers a nd Excel spreadsheets, raising doubts about data authenticity. Our solution is to form an immutable data chain through blockchain notarization and automated collection; the carbon asset development cycle is long and monetization channels are not smooth, so our solution is to provide one-stop, full-process support from data collection to green rights trading.

Policy recommendations: It is hoped that in the future, a unified national carbon footprint management platform can be established more quickly, enabling "one-time accounting, multi-party acceptance"; promote mutual recognition and alignment of carbon footprint accounting methods and certification results between China and Europe; accelerate the development of an emission factor database covering major industrial products and energy products; issue specific operational guidelines for carbon asset development, clarifying the integration pathways between carbon footprint data and mechanisms such as CCER; include carbon footprint accounting in the scope of green credit support, and promote the "industry platform proxy accounting" model to reduce costs for small and medium-sized enterprises.

Researcher: Wei Liu

Hangzhou Jinlin Carbon Sequestration Technology Co., Ltd.

Our company is primarily engaged in the research and development of carbon emission reduction, carbon conversion, carbon capture, and carbon sequestration technologies, as well as biomass fuel processing and crop straw treatment, processing, and utilization services.

Driven by the "dual carbon" goals and related policies, we believe that to achieve carbon neutrality across all industries in the future, it will be necessary to develop a large number of negative carbon technologies and conduct professional quantitative assessments. Moreover, it will be essential to establish project methodologies that can be incorporated into the national CCER framework, and subsequently engage in carbon emission rights trading. Under such circumstances, these technologies and products will inevitably also need to undergo carbon

footprint assessments.

The current carbon footprint cost varies depending on project requirements. For a mining project that only completes the carbon emission reduction accounting module in the green mine assessment, the cost is 10,000–30,000 RMB; for a package covering all carbon services in the green mine assessment, the cost is 100,000–150,000 RMB; if CMA or other assessment qualifications are required, the cost ranges from 500,000 to 1.5 million RMB.

The main benefits of conducting a carbon footprint assessment include quantifying energy-saving and emission-reduction potential, improving production efficiency, reducing energy consumption costs, and supporting participation in government evaluations such as the green mine assessment, thereby obtaining related incentives and service conveniences. Currently, most carbon footprint reports produced by enterprises are not used for carbon emissions trading.

The main difficulties lie in the lack of clarity regarding the full process and full life cycle of projects, as well as incomplete ledger data. For different project scenarios, the challenges center on identifying sources and sinks, establishing emission inventories, and conducting scientific calculations. We evaluate the carbon footprint of environmental processes and related products based on the fundamental principles and methods of international and national standards, with scientific rigor as the guiding criterion.

The current policies are not sustainable, and there are issues such as disconnects in policy updates. It is hoped that authoritative organizations will issue authoritative guidelines, and authoritative institutions will provide large-scale databases, ensuring scientific rigor while preserving the flexibility and inclusiveness of the assessment. Accelerate the application of carbon footprint assessment to the CCER carbon trading market, promote the healthy and effective development of the carbon trading market, and align it with international standards.

Researchers: Wang Lin, Li Fang

Jiande Conch Cement Co., Ltd.

Jiande Conch is the first large-scale cement clinker base invested and constructed by Anhui Conch Group outside the province. Our first 5,000-ton production line is the first demonstration new dry-process cement line in Zhejiang Province.

Driven by the “dual carbon” target policy, our company has carried out carbon footprint work and attaches great importance to it. Conducting product carbon footprint assessment is a positive response to and quantification of low-carbon policies. It is of great significance to environmental protection and is also crucial to the company’s cement-related business.

The company currently outsources the overall business related to “dual carbon” products to a third-party technology service company, with a service fee of approximately 150,000 yuan per year. Carbon footprint-related business ultimately serves carbon trading. At present, it can guide energy conservation and emission reduction, ultra-low emissions, and improve production efficiency, thereby enhancing the company’s competitiveness.

The carbon emission-related business is currently in its early stages, with the biggest challenge being a lack

of specialization. The company has already established its own carbon accounting department, but the internal results differ from those of third parties, and there is currently a lack of appropriate standards and databases to guide carbon accounting work.

We believe that the national promotion of carbon footprint is an industry trend. We hope that unified industry standards will be established as soon as possible to guide carbon accounting, ensuring the scientific rigor and fairness of carbon accounting practices, which will facilitate the standardization of carbon inclusive mechanisms and carbon trading.

Researchers: Wang Lin, Li Fang

Jiande Hongshi Cement Co., Ltd.

Our company is a medium-sized cement clinker production enterprise and a subsidiary of Hongshi Holding Group. We operate two 4,000-ton-per-day new dry-process cement clinker production lines, equipped with 18MW pure low-temperature waste heat power generation, with a n annual output of 2.46 million tons of clinker. Our mine has been included in the National Green Mine List and has completed the construction of an intelligent green mine.

We believe that conducting carbon footprint assessments is a major trend under the background of the " dual carbon" goals, and it will be imperative in the future. At present, the Ministry of Ecology and Environment's Grade A rating assessment is the biggest driving force for us to carry out carbon footprint evaluations and build technical reserves.

Currently, the carbon accounting for the company's mining projects is bundled with the downstream cement plant's LCA carbon projects, with an annual carbon accounting service f ee of approximately 1.6 million yuan.

The company has done considerable work in converting diesel vehicles to electric power, and has already converted a significant proportion of mining trucks.

After conducting a carbon footprint assessment, it is possible to clearly understand how much carbon dioxide emissions have actually been reduced by the diesel-to-electric conversion. However, the carbon footprint assessment has not yet generated additional revenue.

The biggest challenge our company currently faces is the lack of professional expertise. Although we have designated carbon management officers, we must also equip ourselves with technical personnel who understand policy rules and possess relevant professional knowledge to carry out related work. At the same time, we hope that everyone in the industry can jointly abide by the rules and contribute to the development of carbon footprint initiatives. The company is also continuously advancing its green and low-carbon transformation, attempting to replace coal with waste biomass such as straw, with a substitution rate of 28%-30%, and aiming to achieve approximately 40% biomass substitution.

At present, we believe that the current carbon footprint-related policies are acceptable.

Researchers: Wang Lin, Li Fang

Zhejiang Anlian Mining Co., Ltd.

Zhejiang Anlian Mining Co., Ltd. is a large-scale integrated mining enterprise that combines limestone mining, deep processing of limestone products, and research and development of limestone utilization. It has been recognized as a national high-tech enterprise, a national green mine, and a provincial-level "specialized, refined, distinctive, and innovative" small and medium-sized enterprise.

Currently, our industry does not have the intrinsic drive to proactively conduct carbon footprint assessments, and carbon footprint reports cannot yet be converted into profitability. Driven by government requirements and policies, we are currently carrying out carbon footprint-related evaluation and accounting work in response to assessment indicators such as total energy consumption and energy consumption per 10,000 yuan of industrial output value.

In terms of costs, we are not yet familiar with the market conditions. Our company has arranged for technical personnel to carry out carbon accounting work in accordance with relevant requirements. As for benefits, they remain unclear at this stage.

The main difficulty our company currently faces is that if carbon footprint accounting is to be broken down by process and done in great detail, obtaining ledger data for each process poses certain challenges. To ensure the standardization and scientific rigor of carbon accounting, our company will subsequently record relevant ledger data by process in a targeted manner.

Regarding policies, if they target carbon emissions across the entire life cycle, we hope that the assessment documents can clearly specify which stages are included. The current management policies remain unclear in this regard.

Researchers: Wang Lin, Li Fang

CVC Certification & Testing Co., Ltd.

As a certification and testing institution, CVC has observed through its client service practices that the main drivers for enterprises to carry out product carbon footprint work include meeting downstream supply chain or bidding requirements, applying for green factories or zero-carbon factories, improving ESG ratings, and using it for product promotion. Among these, cases where chain-leading enterprises proactively conduct accounting based on their own responsibilities are relatively rare, while downstream customer requirements and bidding demands are more common. In its service projects, the cost for a single product carbon footprint accounting and certification typically ranges from approximately 8,000 to 20,000 RMB.

From the verification perspective, the practical difficulties lie not only in the lack of supply chain data, but also in incomplete bill of materials (BOM) and insufficient granularity of energy metering. For missing BOM items, some projects require disassembling products and weighing each component to supplement the basic data; for situations where multiple products share energy sources without fine-grained metering, energy allocation must be carried out using physical or non-physical parameters in accordance with standard requirements. Although these approaches can keep the accounting process moving forward, they also increase the workload and the uncertainty of the results.

Emission factors are another prominent issue. Some products or materials lack applicable factors, so similar factors must be selected while data quality assessments are conducted simultaneously; different databases may also provide different factor values for the same activity data, which can affect the comparability of accounting results. In addition, the number of enterprises that meet the assurance capability requirements for product carbon footprints remains limited, and certification bodies often need to guide enterprises in establishing relevant systems and documenting them. For small and medium-sized enterprises, cost pressures and insufficient market demand also weaken their willingness to participate.

Based on the above practices, CVC recommends that the carbon footprint factor database be continuously developed as a public good, improving the coverage, granularity, and standard consistency of domestic databases, and accelerating the international mutual recognition of domestic certification results.

At the same time, through mechanisms such as enterprise assistance, cost subsidies, leading enterprise-driven initiatives, and carbon finance integration, the threshold for s mall and medium-sized enterprises to carry out carbon footprint work should be lowered.

This also addresses the practical issue where green value struggles to translate into price premiums.

Researcher: Chen Shaoqing

Guangzhou Emissions Exchange

Based on its practices in regional carbon trading and public services, the Guangzhou E missions Exchange believes that the demand for product carbon footprints comes, on the o ne hand, from the requirements of the national and Guangdong provincial carbon footprint management system, and on the other hand, from the practical pressure imposed on export enterprises by international rules such as the EU Carbon Border Adjustment Mechanism (CBAM). For Guangdong, where foreign trade enterprises are concentrated, carbon footprint accounting and certification have gradually become compliance requirements for enterprises to enter certain overseas markets.

There is currently no unified range for the carbon footprint cost of a single product, as it is mainly influenced by product complexity, supply chain length, data availability, and certification standards. By building the Guangdong Carbon Label Information Management Platform, the trading center supports enterprises in completing carbon footprint information registration and certification applications online, thereby reducing intermediate steps and lowering accounting costs.

Compared with general market access and brand benefits, the trading center has observed that carbon footprint data has begun to enter green finance scenarios. In 2025, Guangzhou facilitated Guangdong Province's first "transition finance + carbon footprint" dual-certification loan, using product carbon footprint as a key performance indicator and linking loan interest rates to corporate emission reduction performance, enabling carbon footprint data to directly influence financing costs. This indicates that the value of carbon footprint is extending from certification proof to financial pricing.

The main difficulties in practice include insufficient upstream factor data and the fact that the standard system has not yet been fully aligned. Companies generally find it easier to obtain data on their own production

processes, but it is difficult to obtain accurate factors for upstream raw material production and basic energy consumption. In response, the trading center participates in the construction of national and Guangdong Province carbon footprint factor databases, and provides services such as registration and certification through the Guangdong Carbon Label Information Management Platform. In terms of standards, the r ules for different products and industries are still being refined, and differences in domestic and international methodologies place export companies under the "dual compliance" pressure of establishing two accounting systems. The trading center is also promoting the harmonization of rules by participating in the development of relevant standards.

The trading center recommends accelerating the mutual recognition and alignment between domestic standards and international rules, and further increasing public services and policy subsidies for small and medium-sized enterprises. At present, SMEs are relatively weak in terms of technical capability, financial strength, and data foundation. Without low-cost tools and sustained support, their policy participation and actual sense of benefit will remain limited.

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