Opening Early Market for Low-Carbon Building Materials in China

Executive Summary

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The content included in this report does not represent the views of the above experts, their institutions, or project supporters.

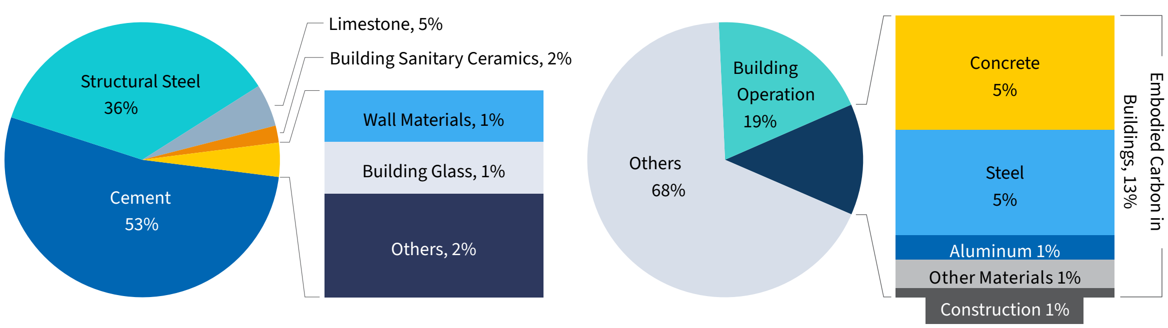
About RMI

RMI is an independent nonprofit, founded in 1982 as Rocky Mountain Institute, that transforms global energy systems through market-driven solutions to align with a 1.5 °C future and secure a clean, prosperous zero-carbon future for all. We work in the worlds' most critical geographies and engage businesses, policymakers, communities, and NGOs to identify and scale energy system interventions that will cut climate pollution at least 50 percent by 2030. RMI has offices in Basalt and Boulder, Colorado; New York City; Oakland, California; Washington, D.C.; Abuja, Nigeria; and Beijing, People's Republic of China.

Kick-starting a Low-Carbon Building Materials Market through Buyer Actions

Reducing emissions from building materials is critical for China to meet its dual carbon targets. In 2020, CO_2 emissions from all building materials exceeded 2.3 billion tons, accounting for more than 20% of the country's total emissions. Cement and steel,[i] which are primarily used in construction, are the largest contributors, accounting for 53% and 36% of emissions in construction materials respectively (see Exhibit 1, left). Using low-carbon building materials is also critical to reducing the life-cycle emissions of buildings, as embodied carbon (i.e., emissions from manufacturing, transporting of building materials, and construction) accounts for 41% of a building's life-cycle emissions in China (see Exhibit 1, right). Therefore, pursuing early opportunities to expand the market and applications for low-carbon building materials, especially for cement and steel, is becoming increasingly urgent.

Exhibit 1 **Emissions from major building materials in 2020 (left) and breakdown of building material emissions in China (right)**

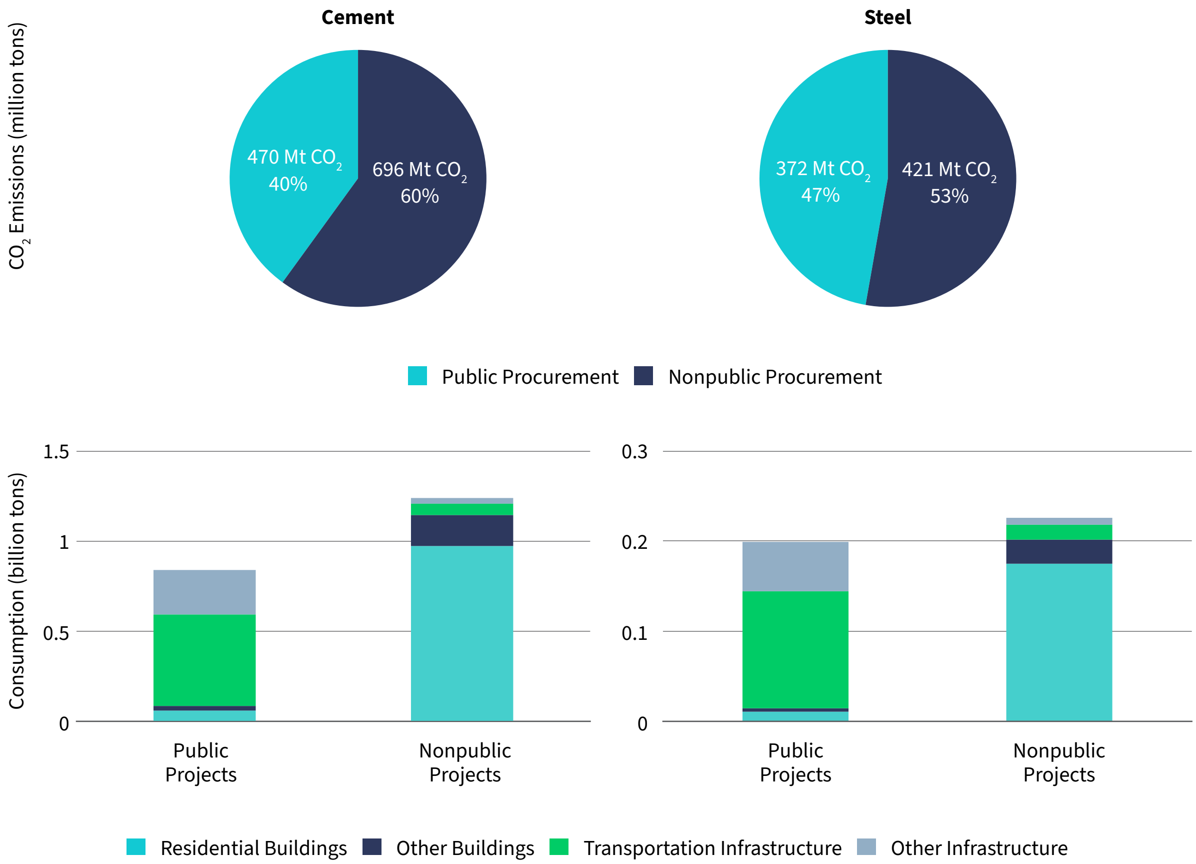


RMI Graphic. Source: RMI analysis, China Building Materials Federation (left). International Energy Agency (IEA), **https://www.iea.org/reports/co2-emissions-in-2023/**; Building Energy Research Center Tsinghua University, *Annual Report on Building Energy Efficiency Development in China 2024*; Building Energy Research Center Tsinghua University, China Association of Building Energy Efficiency, *2023 China Building and Urban Infrastructure Carbon Emissions* Report (right).

Government procurement for public projects represents the majority of China's building materials demand. Utilizing low-carbon procurement to reduce upstream emissions is an essential strategy. According to our estimation, in 2022, government purchases of cement and steel reached 780 million tons and 200 million tons, accounting for 40% and 47% of the total CO_2 emissions from cement and steel production, respectively (see Exhibit 2). Promoting low-carbon building materials in public projects can create an early market, drive coordinated emissions reductions across the industrial chain, and establish standards for production, certification, and use of these materials. This approach serves as a model for the whole construction industry and therefore has the potential to be scaled up.

i Cement itself is typically not used directly in construction projects but rather in the form of concrete. However, since CO_2 emissions from cement production account for approximately 86% of the total emissions in concrete production, we reference cement as the main focus when discussing CO_2 emissions of major building materials.

Exhibit 2 **Consumption and emissions of cement and steel in public and nonpublic projects in China, 2022**



Note: RMI's calculations are based on the 2020 Input-Output Table, National Bureau of Statistics of China, the *China Investment Statistical Yearbook*, and the *China Construction Industry Statistical Yearbook*. In 2022, the number of affordable rental housing units reached 2.4 million, which, assuming an average area of 60 square meters per unit, accounted for 5.6% of the total residential building completion area in that year. In 2022, the share of public procurement in nonresidential building construction was estimated to be 14.0%, and in transportation and other infrastructure construction it was estimated to be 88.5%.

RMI Graphic. Source: RMI analysis

Many countries are advancing public procurement of low-carbon building materials to promote green development for public buildings and infrastructure. In the EU, 23 of 27 member states have enacted National Action Plans. The US government has launched a Buy Clean Program, and states including California and Washington have additionally incorporated clean procurement into legislation.
In 2024, China has accelerated policy efforts, improving product carbon accounting and certification mechanisms, and advancing low-carbon procurement. Including low-carbon requirements in public procurement has become a priority, with supporting policies, standards, and mechanisms continuously under development.

The Transition from Green Procurement to Low-Carbon Procurement

China has built a solid policy foundation for promoting green building materials through green procurement schemes and programs. Since its national initiative began in 2013, numerous policies have been introduced (see Exhibit 3). By 2024, 87 green building material standards had been issued, with certification rules for 51 of them, and over 9,100 certificates across 40 product categories. Additionally, by 2022, 48 cities and districts had piloted government procurement models to promote green buildings and materials, accelerating their adoption. However, current green building materials mostly include durability, health, and environmental metrics, with disclosure requirements for CO_2 emissions in only a few building materials and no CO_2 threshold or rating system. The urgent next step is to move the system from green to low carbon.

Exhibit 3 **Timeline of key supporting policies for green and low-carbon building materials in China**

RMI Graphic.

To transition from green procurement to low-carbon procurement, the design of the public procurement system should include five critical components: clear definition of the scope of low-carbon procurement, improved data transparency and labeling systems, established carbon performance standards for building materials, incentives for the production and use of low-carbon materials, and ensured implementation through effective monitoring and evaluation (see Exhibit 4). In addition, the success of low-carbon procurement depends on the coordinated efforts of multiple stakeholders, including building material producers, construction companies, government procurement agencies, investors and financial agencies, and certification organizations.

Exhibit 4 **Key elements of a low-carbon public procurement system for building materials**

Low-Carbon Procurement Scope	Data Calculation and Certification System	Carbon Requirements for Products, Services, and Suppliers	Incentives for Low-Carbon Products, Services, and Suppliers	Implementation System with Monitoring and Evaluation
✓ Goods ✓ Projects ✓ Services	✓ Product life-cycle carbon emissions data ✓ Carbon emissions calculation methods for products and projects ✓ Low-carbon product certification and information disclosure system	✓ Procurement item list ✓ Product threshold limits ✓ Supplier evaluation criteria	✓ Direct financial incentives ✓ Indirect financial incentives ✓ Nonfinancial incentives	✓ Centralized procurement ✓ Development and public release of green/low-carbon procurement documents ✓ Project performance acceptance and evaluation

RMI Graphic. Source: RMI analysis

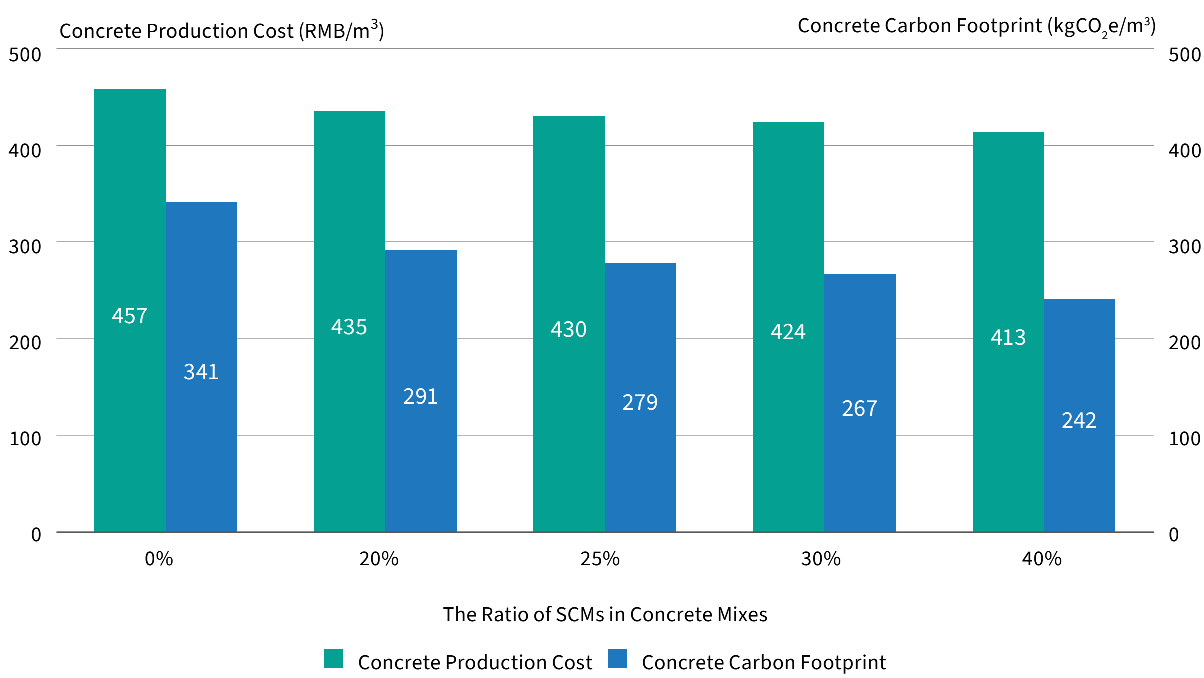
We identified three key missing links in the current public procurement system to transition from green to low carbon: cost viability, carbon data transparency, and incentives and safeguards for application. Leveraging public procurement to explore feasible pathways, strengthening carbon accounting and certification, and improving incentives are critical to overcoming slow adoption. These steps will energize both suppliers and procurers and guide the next phase of advancing public procurement for low-carbon materials.

Improving Cost-Effectiveness of Using Low-Carbon Building Materials

Concrete

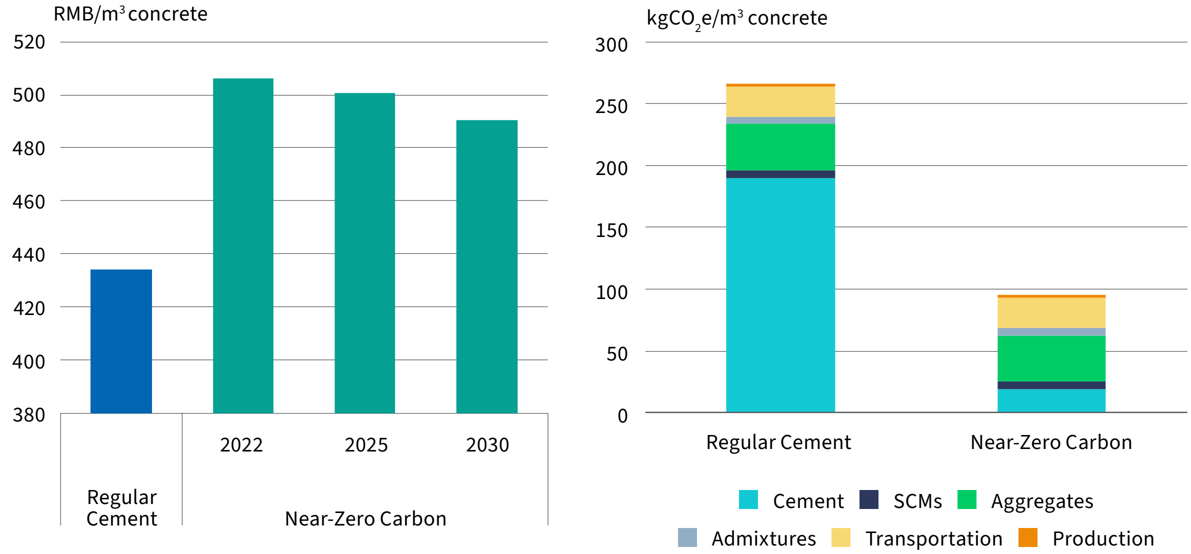
Because 86% of the carbon footprint of ready-mix concrete comes from raw materials and 95.9% of cement emissions come from clinker production, there are three main ways to reduce the carbon footprint of concrete: increasing the use of low-carbon supplementary cementitious materials (SCMs), applying low-carbon cement technologies (e.g., energy efficiency, alternative fuels, raw material substitution, and carbon capture and storage), and exploiting the carbon sequestration potential of concrete. In the short term, the greatest potential lies in the increased use of SCMs, with the potential to increase the ratio of SCMs from the current 10%–20% level to 30%–40% with materials such as fly ash or ground granulated blast furnace slag (GGBFS), offering both cost and carbon reduction benefits (see Exhibit 5). However, long-term reductions will depend on new technologies to decarbonize cement production. Although low-carbon cement may initially increase costs, it offers significant emissions reductions as technologies mature (see Exhibit 6). In addition, carbon sequestration, while not yet widely used, is expected to become a promising method as research and pilot projects progress.

Exhibit 5 **Concrete production costs and carbon footprint at different SCM ratios**



Note: Using C30 concrete as an example.
RMI Graphic. Source: RMI analysis

Exhibit 6 **Costs (left) and emissions (right) of concrete by using low-carbon cement**

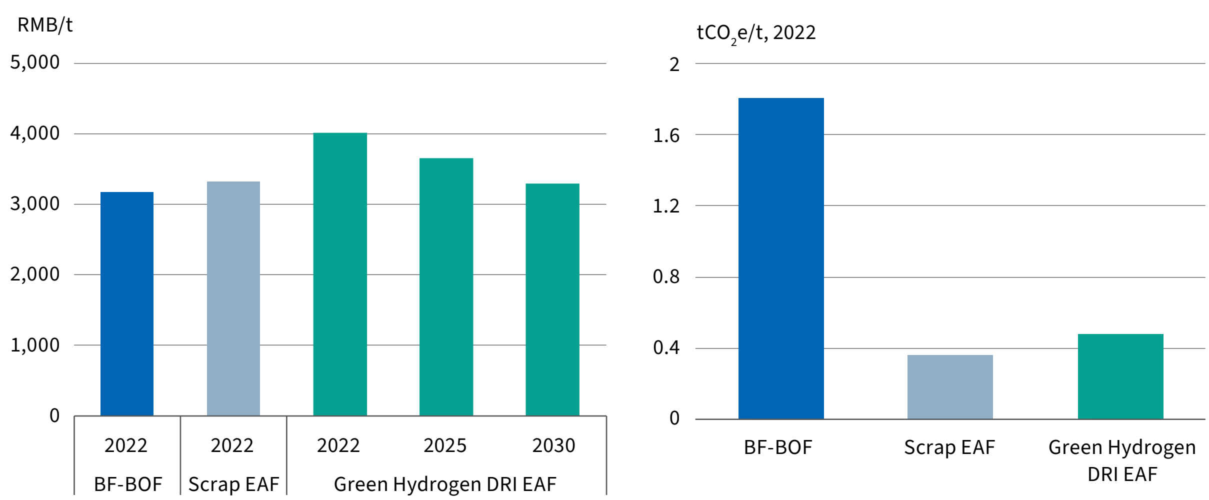


Note: Regular cement refers to cement produced through traditional cement clinker manufacturing processes. The assumption for near-zero cement is based on RMI's report *The Road to Net Zero: Decarbonization in China's Cement Industry*, which identifies CCUS and fuel substitution as the primary decarbonization technologies. The data is based on a 30% SCMs scenario.
RMI Graphic. Source: RMI analysis

Steel

Scrap-based steelmaking and hydrogen-based direct reduced iron (DRI) steelmaking are the main low-carbon steelmaking pathways. RMI estimates that use of an electric arc furnace (EAF) with scrap is a cost-effective low-carbon option with only a 5% green premium and only 20% of the emissions of the blast furnace–basic oxygen furnace (BF-BOF) pathway under current conditions, with further reductions expected as the grid decarbonizes. In 2022, the emissions of DRI were 27% of BF-BOF levels (see Exhibit 7). By 2030, as green hydrogen–based DRI becomes commercialized, the green premium is projected to drop from 26% in 2022 to 3%, greatly expanding the economics of low-emissions steel.

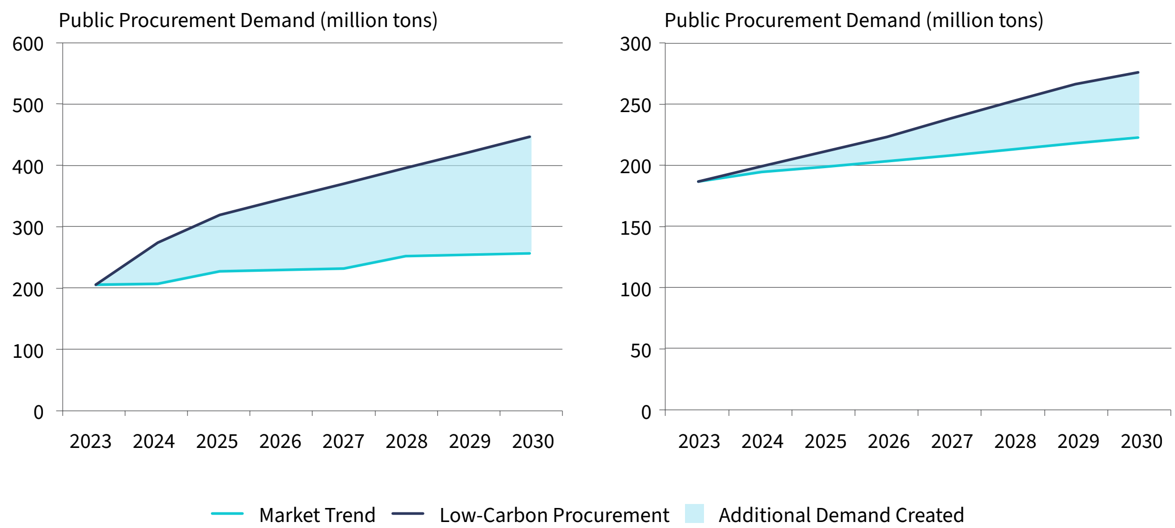
Exhibit 7 **Costs (left) and carbon footprint (right) of steel under different production pathways**



RMI Graphic. Source: RMI analysis

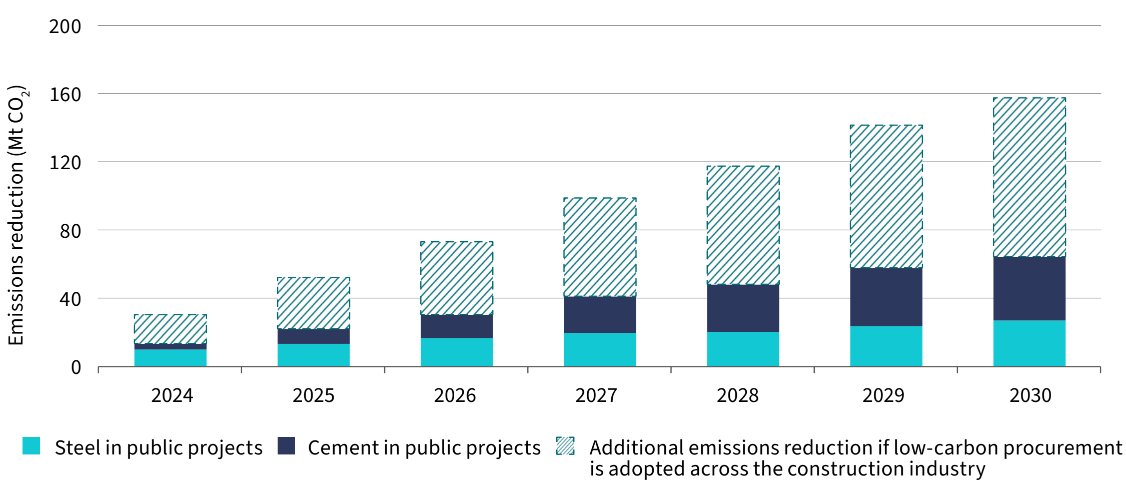
Leveraging low-carbon procurement in government projects can create an expansive early market for low-carbon building materials and generate direct emissions reduction benefits. RMI estimates that by 2030, public procurement could generate demand for 45 million tons of low-emissions steel and 277 million tons of SCMs and near-zero carbon cement. This represents an additional demand for 19 million tons of low-emissions steel and 83 million tons of low-carbon concrete materials above the business-as-usual scenario (see Exhibit 8). By 2030, low-carbon public procurement alone could reduce CO_2 emissions in the steel and cement industries by 27 million tons and 37 million tons from 2024 levels, respectively (see Exhibit 9). If adopted across the construction industry, low-carbon procurement could avoid 61 million tons of emissions from steel production and 97 million tons of CO_2 from cement production annually by 2030.

Exhibit 8 **Additional demand for low-carbon steel (left) and low-carbon concrete (right) created under the low-carbon procurement scenario**



Note: Low-carbon steel includes EAF with scrap and green hydrogen DRI; low-carbon concrete binding materials include SCMs and near-zero carbon cement.
RMI Graphic. Source: RMI analysis

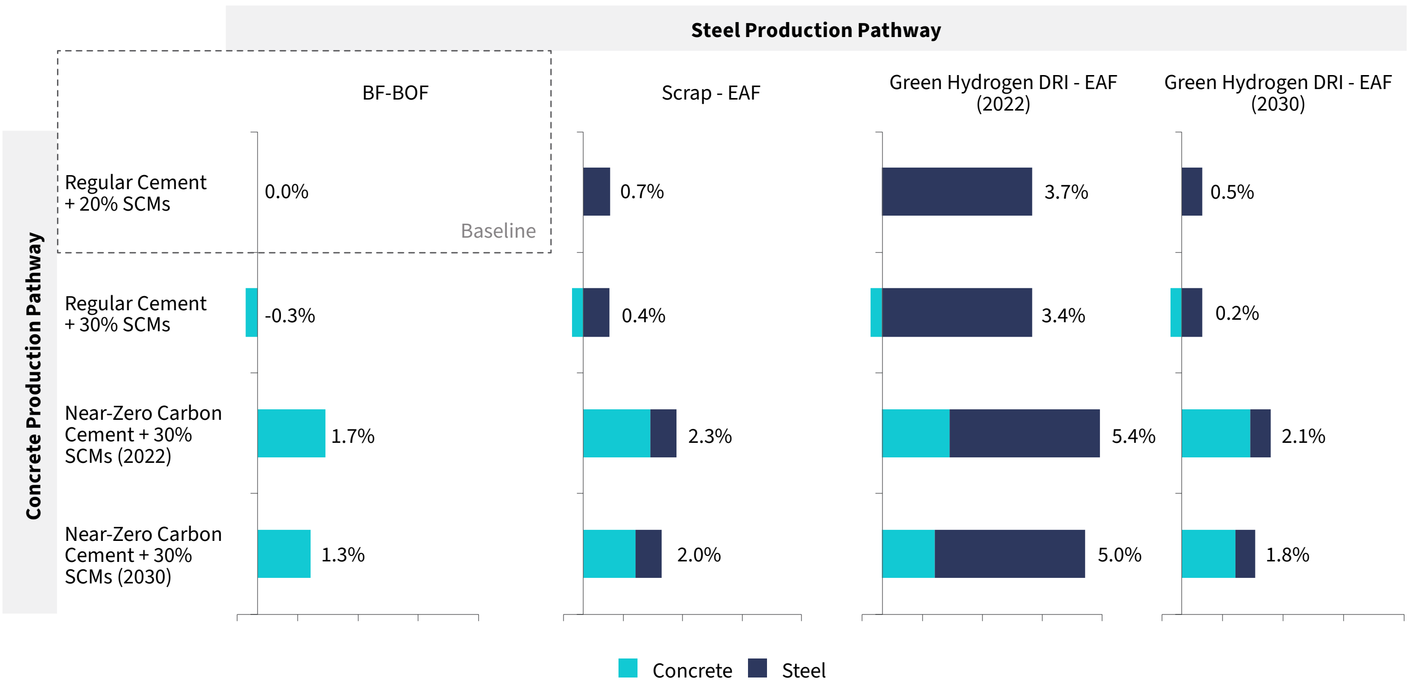
Exhibit 9 **Emissions reductions achieved by adopting low-carbon public procurement and an industrywide adoption scenario**



RMI Graphic. Source: RMI analysis

Promoting low-carbon building materials involves manageable costs, often with economic benefits. RMI finds that using low-carbon materials can reduce emissions at minimal cost increases or even result in savings. For instance, increasing SCM use and adopting scrap-based steel raises construction costs by just 8 RMB/square meter (m^2), a 0.4% premium, while achieving a 142 kg CO_2/m^2 reduction at an equivalent abatement cost of 56 RMB/ton CO_2 — below China's average carbon market rate of 90 RMB/ton, indicating an economic advantage (see Exhibit 10). Although near-zero carbon concrete and steel may have higher near-term costs, scaling technologies like green hydrogen DRI could limit cost increases to 36 RMB/m^2, with a premium of up to 2%, by 2030.

Exhibit 10 **Incremental costs of applying low-carbon building materials in a public building (RMB/m^2 building)**



Note: The labels indicate the premium rate compared to using regular cement with a 20% SCM ratio and BF-BOF steel. The baseline for building construction cost is 2,042 RMB/m^2, with steel costs at 286 RMB/m^2 and concrete costs at 204 RMB/m^2.
RMI Graphic. Source: RMI analysis

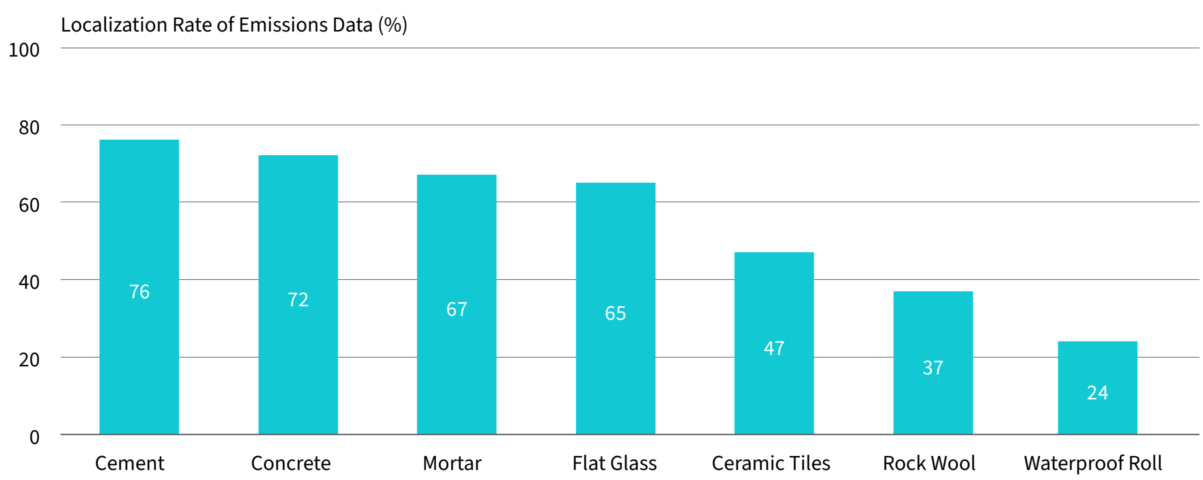
Developing Product Carbon Accounting and Certification for Low-Carbon Building Materials

China's carbon footprint management for building materials is in its early stages, with challenges limiting the adoption of low-carbon practices across supply chains. Advancing low-carbon public procurement requires strengthening carbon accounting through localized material databases and robust standards, as well as enhancing evaluation and certification mechanisms for broader downstream adoption.

China is establishing a general product carbon accounting framework aligned with international standards, but further refinement of Product Category Rules (PCRs) on consistency and comparability is essential for the application of low-carbon building. Few PCR national standards are currently published, with most published as industry standards or group standards, leading to inconsistencies and poor comparability. Accelerating national and industry PCR standards is key to establishing authority and comparability for low-carbon building materials.

The carbon footprint of building materials varies widely due to regional differences in raw materials, production processes, and technology. The widely used international databases like **Ecoinvent**, are mainly based on European status, which cannot fully reflect China's condition. A localized emissions database is critical for accurately assessing domestic production emissions (see Exhibit 11).

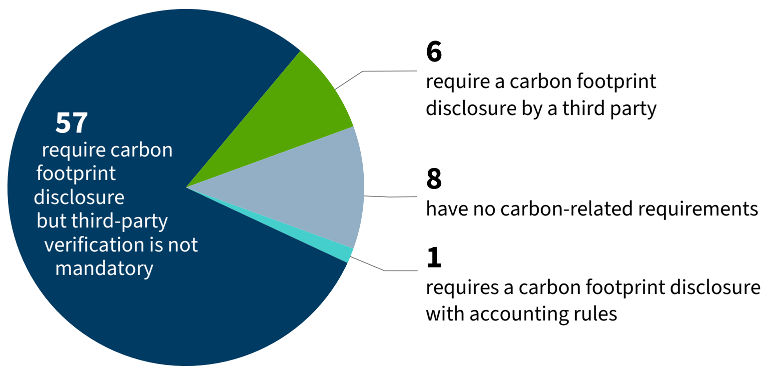
Exhibit 11 **Localization level of emissions data for major building materials**



RMI Graphic. Source: RMI analysis

China's green building material standards currently include the disclosure of carbon emissions information for a few building materials, including ready-mixed concrete, but there is not yet a quantitative threshold or metric. Low-carbon metrics fall into three categories: (1) carbon footprint analysis as a required environmental attribute without specific emissions limits; (2) optional carbon footprint reporting via environmental product declarations (EPDs) or footprint reports; and (3) carbon emissions grading, with specified emissions limits for star-rated materials. Among the 72 green building material standards currently adopted by the China National Accreditation Administration (CNCA), only the standard for steel components in buildings requires a carbon footprint report with clearly defined benchmark ratings, 6 standards require a carbon footprint report prepared by a third party, and 57 standards mandate a carbon footprint report but do not require third-party verification nor set carbon footprint limits. Additionally, 8 standards have no carbon-related requirements.

Exhibit 12 **Carbon-related requirement of 72 green material standards adopted by the CNCA**



RMI Graphic. Source: RMI analysis

To enhance low-carbon material evaluations, existing standards should be expanded with specific carbon footprint limits, adopting a phased approach to gradually introduce mandatory carbon footprint thresholds for green building materials. It is also important to conduct evaluation programs with building materials producers to collect up-to-date carbon footprint information and to develop tools, such as a rating system, to evaluate and define low-carbon building materials for broader applications.

Creating Safeguards and Incentives for Implementations and Innovations

To foster better implementation, projects suitable for use of low-carbon building materials must first be identified. This report highlights infrastructure projects, public buildings, and rural housing as priority areas for low-carbon material applications:

- **Infrastructure projects** require large material volumes, feature simpler structures, and are ideal for using solid waste and supplementary materials. Primarily government-funded, these projects benefit from policy-driven low-carbon standards.

- **Public buildings,** central to early green material procurement pilots, have higher construction standards and established material systems, making them suitable for expanded low-carbon applications.

- **Rural housing** has high demand for construction and renovation in China, with policies to promote green building materials already in place. Integrating low-carbon materials here supports life-cycle decarbonization across rural residential projects.

In recent years, China's government procurement has increasingly supported green building materials, though carbon emissions limits are not yet integrated into most procurement standards. Embedding carbon emissions limits within procurement standards can occur at both the product and project level:

- **Product level:** Quantitative carbon footprint limits for structural materials in government projects can be introduced by revising existing green material standards.

- **Project level:** Setting embodied carbon limits per unit area in government construction projects enables better control of overall embodied emissions but requires enhanced standards and guidelines due to added accounting complexity.

Financial incentives play a key role in promoting low-carbon materials. Government rewards and subsidies, typically tied to green certification, stimulate production. Internationally, governments often allow a price premium in public procurement to encourage low-carbon material adoption. Nonfinancial measures, such as streamlined approvals and priority project processing, also incentivize low-carbon material use.

Performance-based standards (PBSs) are increasingly favored for their flexibility, especially in cement and concrete production. PBSs focus on the final product's performance — strength, durability, environmental impact — without specifying production methods, encouraging innovation while reducing costs and environmental impact. While PBSs promote flexibility, robust performance testing and pilot programs are essential to ensure new materials meet standards and can be scaled reliably.

Near-Term Actions

In the near term, China can advance public procurement of low-carbon building materials by:

- **Scaling recycled materials:** Expand production of recycled low-carbon materials by integrating circular economy practices with low-carbon concrete development, using local resources like construction waste, fly ash, and GGBFS. For concrete below C30 strength, aim to increase SCM ratios to 30% or higher. Promote scrap-based steelmaking by improving the scrap collection, sorting, and recycling system.

- **Developing standards and collecting data:** Prioritize the development of PCR standards for essential materials like concrete, cement, glass, and ceramics. Develop industry standards on product emissions accounting and low-carbon material certification to ensure wide application and compliance. Foster industry-wide data collection through carbon footprint competitions and EPD platform development, guiding leading enterprises to enhance carbon data collection and identify emissions levels that reflect China's status.

- **Incorporating carbon limits:** Add quantitative low-carbon requirements to green material standards and procurement criteria. Set carbon footprint limits for high-embodied-carbon materials (e.g., steel, concrete) in public project bids or pilot embodied carbon limits per unit area.

- **Implementing incentives:** Establish incentives for low-carbon material production, certification, and application, including financial rewards, bidding advantages, and streamlined approval processes to drive sector-wide collaboration.

- **Piloting and testing:** Explore early applications with pilot projects, weigh the feasibility of PBSs for low-carbon building materials innovations, and prioritize applying low-carbon concrete in infrastructure, public buildings, and rural housing projects.

RMI, China Building Materials Federation, *Opening Early Market for Low-Carbon Building Materials in China,* 2024, **https://rmi.org/insight/opening-early-market-for-low-carbon-building-materials-by-public-procurement-in-china/**

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