Accelerating Industrial Decarbonization in China: Key Climate Actions for Iron and Steel Companies

Report / June 2024

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 world's most critical geographies and engage businesses, policymakers, communities, and NGOs to identify and scale energy system interventions that will cut greenhouse gas emissions at least 50 percent by 2030. RMI has offices in Basalt and Boulder, Colorado; New York City; Oakland, California; Washington, D.C.; and in Beijing, People's Republic of China.

Authors and Acknowledgments

Authors

Shuyi Li
Ting Li
Wei Li
Shutong (Lucy) Lu
Peishan Wang
Boya Zhang

Authors listed alphabetically. All authors from RMI unless otherwise noted.

Contacts

Shuyi Li, sli@rmi.org

Acknowledgment

The authors thank Xiyuan Liu, and Yujun Xue from RMI, and Zheng Dong from Tsinghua University for offering their insights and perspectives on this work.

This report was prepared by RMI and sponsored by HSBC. The views and opinions expressed in this report are only those of the authors.

Table of Contents

Abbreviations

ACA	Absolute contraction approach
CBI	Climate Bond Initiative
CCUS	Carbon capture, utilization, and storage
DRI	Direct reduction iron
EAF	Electric arc furnace
GCP	Global Carbon Project
GHG	Greenhouse gases
GSCC	Global Steel Climate Council
IEA	International Energy Agency
IEA NZE	International Energy Agency's Net-Zero by 2050 scenario
IPCC	Intergovernmental Panel on Climate Change
MEE	Ministry of Ecology and Environment
MIIT	Ministry of Industry and Information Technology
MPP	Mission Possible Partnership
MPP TM	Mission Possible Partnership's Technology Moratorium scenario
NDC	National Determined Contribution
NDRC	National Development and Reform Commission
R&D	Research and development
OECM	One Earth Climate Model
SBTi	Science Based Targets initiative
SDA	Sectoral Decarbonization Approach
TCFD	Task Force on Climate-Related Financial Disclosures
UTS	University of Technology Sydney

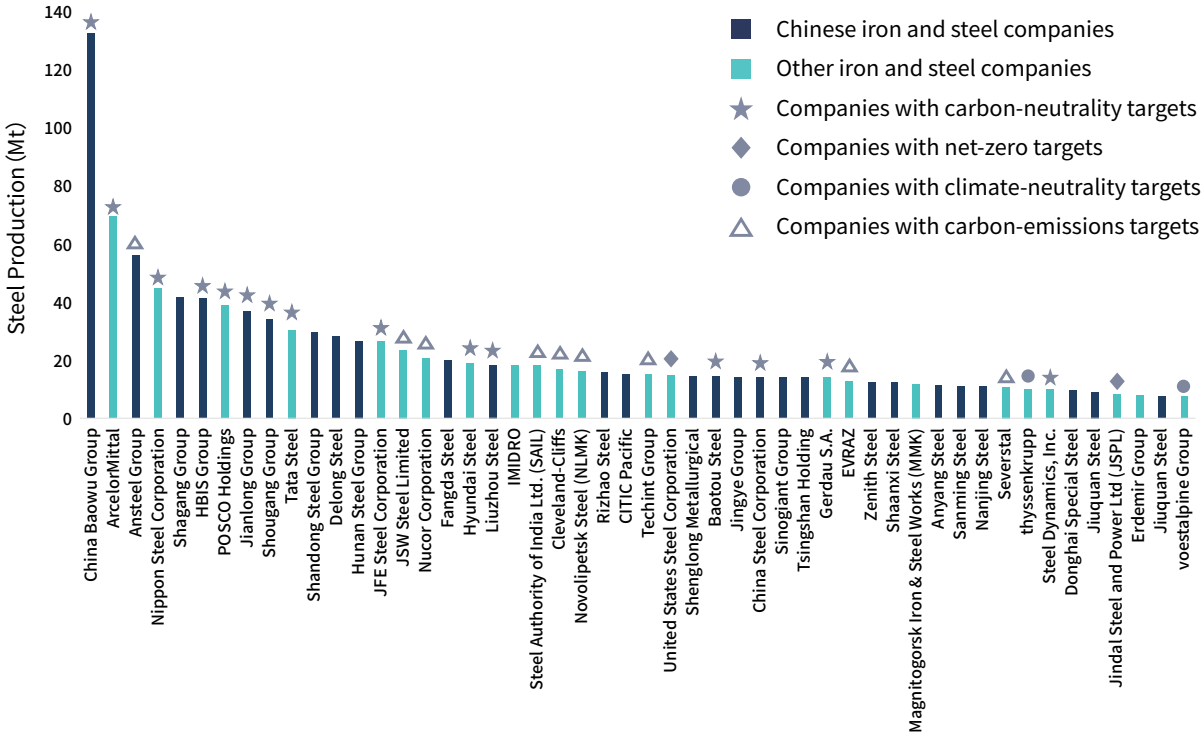
Executive Summary

The iron and steel industry, as one of the highest emitting sectors, will take 4.8%–10.9% of the global carbon budget, which is only 400 gigatons for the next 30 years for a 67% chance of staying within 1.5°C of warming.[1] At the current pace of development and carbon emissions, the carbon budget projected for steel will be used up in 5–12 years. With more than half of the world's steel production, China remains a key geography when it comes to steel decarbonization. Climate actions by Chinese iron and steel companies are critical not only to China's carbon neutrality goal, but also to emissions reductions in the global iron and steel industry.

This report provides a comprehensive summary of international target-setting guidances, examining their boundaries and pathways under the 1.5°C climate goal by 2050. While global practices serve to guide Chinese iron and steel companies to set climate-aligned targets, an industry-level target broken down from China's national goals of carbon peaking by 2030 and carbon neutrality by 2060 will help direct companies' level of ambition and pace of transition. Moreover, companies can refer to the technological feasibility of carbon reduction levers to set practical climate targets.

Currently, while leading companies' climate targets are in place, clarity and comprehensiveness remain core criteria to assess the targets' effectiveness. As shown in Exhibit ES1, 28 of the top 50 global iron and steel companies have set some type of climate targets, of which 19 are committed to carbon neutrality, net zero, or climate neutrality. Among the 27 Chinese iron and steel companies, 7 have set carbon-neutrality targets, representing 28.4% of China's steel production in 2022. The commitments from Chinese iron and steel companies signal a profound shift toward sustainable and green development.

Exhibit ES1 **Carbon Targets Set by the Top 50 Iron and Steel Companies by Output**



As of September 2023

Scaling up scrap utilization and promoting primary steelmaking with lower emissions are critical transition pathways for China's steel industry. Scrap utilization will need to be enhanced through better recycling systems to support up to 60% of steel production from scrap-based electric arc furnace (EAF) processes by 2050. Primary steelmaking is expected to be decarbonized through deploying technologies with clean hydrogen-based processes as a promising option, or adding carbon capture and storage (CCS) to existing fossil fuel-based processes. While multiple emissions reduction technologies and relevant processes exist, at the corporate level, the choice of pathways is subject to their current processes and transition strategies.

Proper management mechanisms can help with doubling down real actions, where internal and external measures are both important. Internal measures include incorporation of carbon management into corporate decision-making construction, securing enough financial support, investing in innovation and R&D, capacity building, and carbon information management, etc. External measures are mainly comprised of supply chain management, corporate branding, and external cooperation.

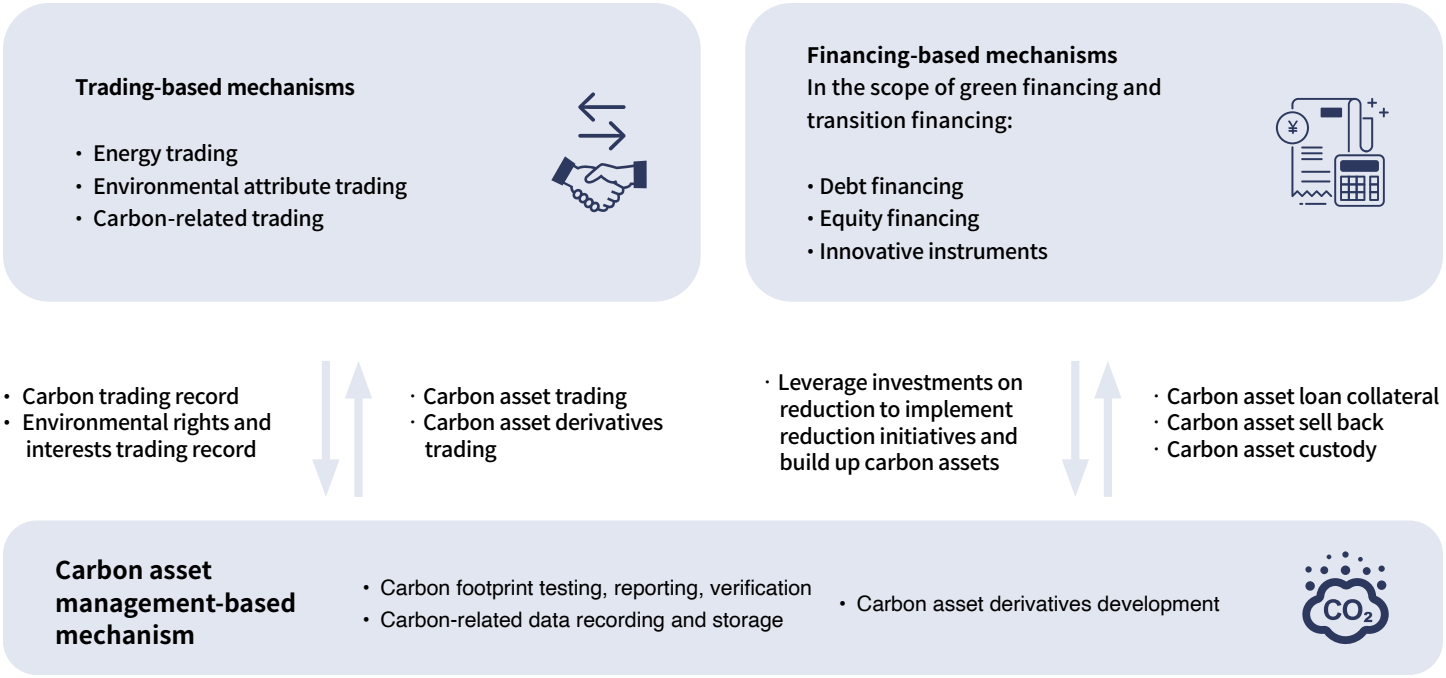
The transition of the steel industry requires significant technological breakthroughs and advancement of corporations' capabilities. This calls for substantial financial support and establishment of a risk-sharing mechanism to enable emissions reduction levers from deployment to wide-scale application. To better equip companies with enough support, the report illustrates how three types of market mechanisms and their synergies can help iron and steel companies implement emissions reduction initiatives:

- **Trading-based mechanisms**, including energy trading, environmental attribute trading, and carbon-related trading. These mechanisms are designed to create incentives for corporations to further their decarbonization actions through the most flexible and cost-effective approach.

- **Financing-based mechanisms**, including green finance and transition finance solutions. Once effectively utilized, these mechanisms lower the financing threshold for companies with low-carbon transition needs.

- **Carbon asset management-based mechanisms**, which use a science-based carbon footprint accounting methodology that records and stores information on corporations' emitting and emissions reduction activities. The information not only helps iron and steel companies communicate better with upstream and downstream companies but also helps them to know their carbon-related activities better. Once recorded correctly, that information can be converted into "assets" that bring additional cash flow in different scenarios.

Exhibit ES2 **Synergies of Market Mechanisms**



Overall, the successful transition of China's steel industry requires efforts from not only the iron and steel companies, but also other key stakeholders, including policymakers, financial institutions, industry associations, etc. Joint integrated efforts are a must to set the flywheel spinning:

- At the industry level, carbon reduction targets and roadmaps in line with China-specific features can help set the scene for companies.
- At the company level, iron and steel companies should improve clarity and comprehensiveness of carbon targets, for example, setting feasible interim targets to monitor carbon reduction progress, specifying the boundary and scope of emissions, including action plans behind commitments, etc.
- Iron and steel companies are encouraged to leverage their key position along the value chain, and closely collaborate with their upstream and downstream players to accelerate the establishment of a comprehensive carbon emissions management mechanism.
- Iron and steel companies are also encouraged to actively participate in existing market mechanisms to ease financial pressure and even fully capture market opportunities.
- Iron and steel companies need to leverage their advantages such as high strategic position in China's economy and large asset base to actively engage in mechanism innovations to support their efficient transition.

Introduction

The Sixth Assessment Report released by the Intergovernmental Panel on Climate Change (IPCC) in 2021 states that to have a 67% chance of keeping global temperature rise to 1.5°C, the carbon budget is 400 gigatons as of 2020. Given the persistent increase of global CO_2 emissions in recent years, not overshooting that mark presents a massive global challenge. In this context, many countries and companies have taken action to reduce carbon emissions. As of September 2023, 150 countries had announced targets or commitments related to net-zero emissions, covering nearly 90% of global carbon emissions; and over 50% of the world's top 2,000 companies by annual revenue had set targets for limiting carbon emissions and taken the lead in implementing emissions-reduction initiatives.

As a major global emitter of greenhouse gases (GHGs), China responded to this global trend with a "dual-carbon" commitment, announced in 2020, to strive for peak carbon dioxide emissions before 2030 and carbon neutrality before 2060. China has nearly half of the world's industrial capacity and over one-sixth of the world's population. Industrial emissions account for about 60% of its total. The iron and steel industry — the biggest emitter among China's heavy industries and responsible for about 17% of the country's total carbon emissions — is under the greatest pressure to decarbonize. The industry's decarbonization pathway and implementation of emissions-reduction technologies are critical to meeting China's dual-carbon goals.

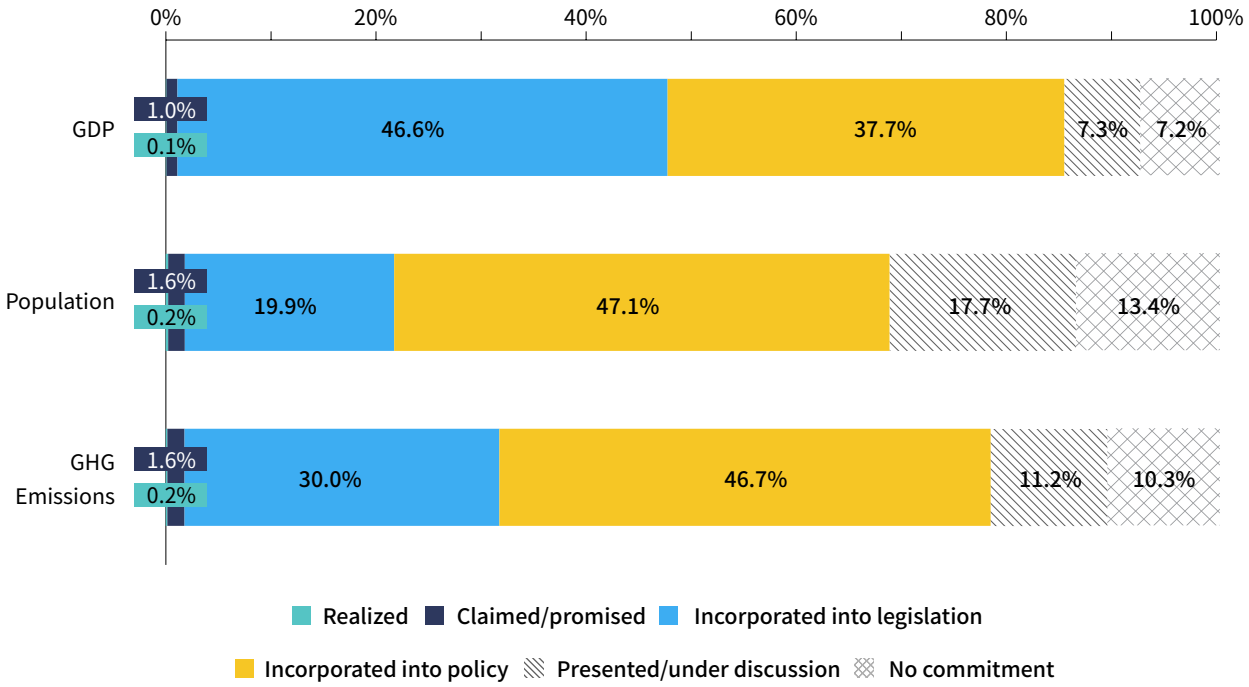
This report starts with an overview of global carbon-neutrality trends and experience and analyzes the practices and market mechanisms under existing guidelines. China's iron and steel industry can refer to these findings to help companies develop systematic strategies aligned with the country's climate goals.

Carbon Reduction in the Iron and Steel Industry under Carbon-Neutrality Trends

Setting decarbonization targets and roadmaps has become a global trend for the iron and steel industry.

With a broad consensus on the need for global climate action, many countries have made carbon-neutrality commitments. By September 2023, 6 of the world's 198 countries claim they have already achieved carbon neutrality, while 60 are actively considering or discussing carbon-neutrality commitments. Among the 84 countries that have made carbon-neutrality commitments, 27 have written them into law and 49 have incorporated them into policy to bolster efforts to curb carbon emissions. The countries that have made carbon-neutrality commitments account for 85.5% of the global gross domestic product (GDP), 68.9% of the population, and 78.5% of global carbon emissions (see Exhibit 1). In general, these 84 countries aim to reach their carbon-neutrality targets between 2030 and 2070, including 62 countries aiming for 2050 and 7 aiming for 2060.

Exhibit 1 **Coverage of Global Carbon-Neutrality Commitments**

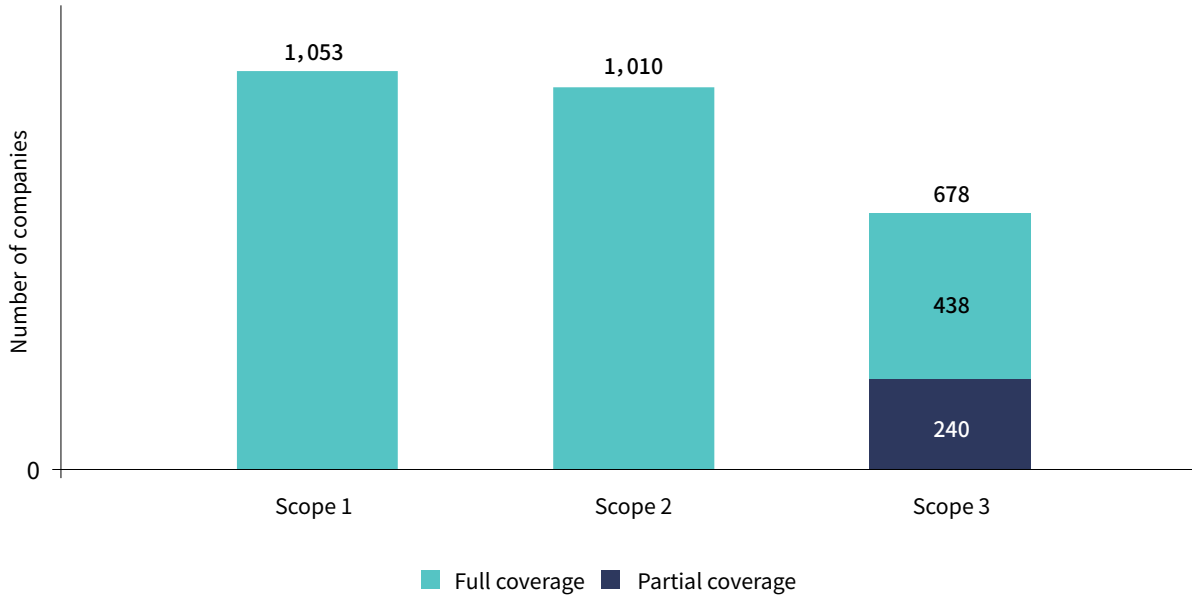


As of September 2023

Source: Net Zero Tracker[2]

Companies around the world are also incorporating carbon neutrality into their corporate strategies. Among the top 2,000 companies by annual revenue, 1,270 have set emissions-reduction targets — specific emissions-reduction volumes as well as reduction ratios — to align with the 1.5°C climate goal and achieve carbon neutrality. As of September 2023, 918 companies have made carbon-neutrality commitments. Of these, 652 companies, including Chinese companies, have included carbon-neutrality commitments in their corporate strategies. As seen in Exhibit 2, although most of the commitments cover Scope 1 and Scope 2 emissions, 438 companies also explicitly target Scope 3 emissions in their carbon-reduction commitments for a higher level of governance.[i]

Exhibit 2 Coverage of Corporate Carbon-Neutrality Commitments



As of September 2023

Source: Global Carbon Budget[3]

The target for global carbon-reduction initiatives is based on the remaining global carbon budget — the total carbon-emissions allowance for keeping the temperature increase within a given range. Since 2006, the Global Carbon Project has been calculating and updating the budget based on new carbon emissions generated each year.[4] In 2014, the IPCC Fifth Assessment Report included the concept of a remaining global carbon budget for the first time. In the Sixth Assessment Report released in 2021, the remaining global carbon budget was calculated based on the approximate linear relationship between peak global average temperature and cumulative carbon emissions.

Exhibit 3 shows the remaining global carbon budget after 2020 under different temperature-increase targets and the probabilities of achievement. The most widely used reference indicator is the total remaining global carbon budget of 400 gigatons (Gt), assuming a target year of 2050 for achieving net zero and a 67% probability of keeping the temperature rise within 1.5°C.

i Scope 1 emissions refers to direct emissions from a company; Scope 2 emissions refers to indirect emissions from energy purchased by a company (including electricity, steam, heating, and cooling); and Scope 3 emissions refers to indirect emissions occurring in a company's value chain.

Exhibit 3 Remaining Global Carbon Budget beyond 2020 (Gt CO_2)

Temperature Control Target \ Probability	17%	33%	50%	67%	83%
1.5°C	900	650	500	400	300
1.7°C	1,450	1,050	850	700	550
2.0°C	2,300	1,700	1,350	1,150	900

Source: IPCC[5]

The remaining global carbon budget is allocated by industry to guide stakeholders to set reasonable emissions-reduction targets. As shown in Exhibit 4, several organizations using different modeling methods and calculation boundaries have determined that the remaining carbon budget for the iron and steel industry is 4.8%–10.9% of the total. In 2020, global steel production was 1.86 billion tons, with total Scope 1 and Scope 2 carbon emissions of about 3.6 Gt. Based on these estimates, the carbon budget for the iron and steel industry will be used in 5–12 years if the industry continues to grow at the current pace. Therefore, as a major GHG emitter, it is critical that the iron and steel industry reduce its emissions.

Exhibit 4 Carbon Budgets for Global Iron and Steel Industry as Estimated by Different Models

	OECM	IEA NZE	MPP TM
Remaining global carbon budget (Gt)	400	500	640
Carbon budget for the iron and steel industry (Gt)	19	53.2	69.6
Share of iron and steel industry to global carbon budget	4.8%	10.6%	10.9%
Carbon budget for the iron and steel industry under the remaining global carbon budget of 400 Gt (Gt)	19	42.4	43.6

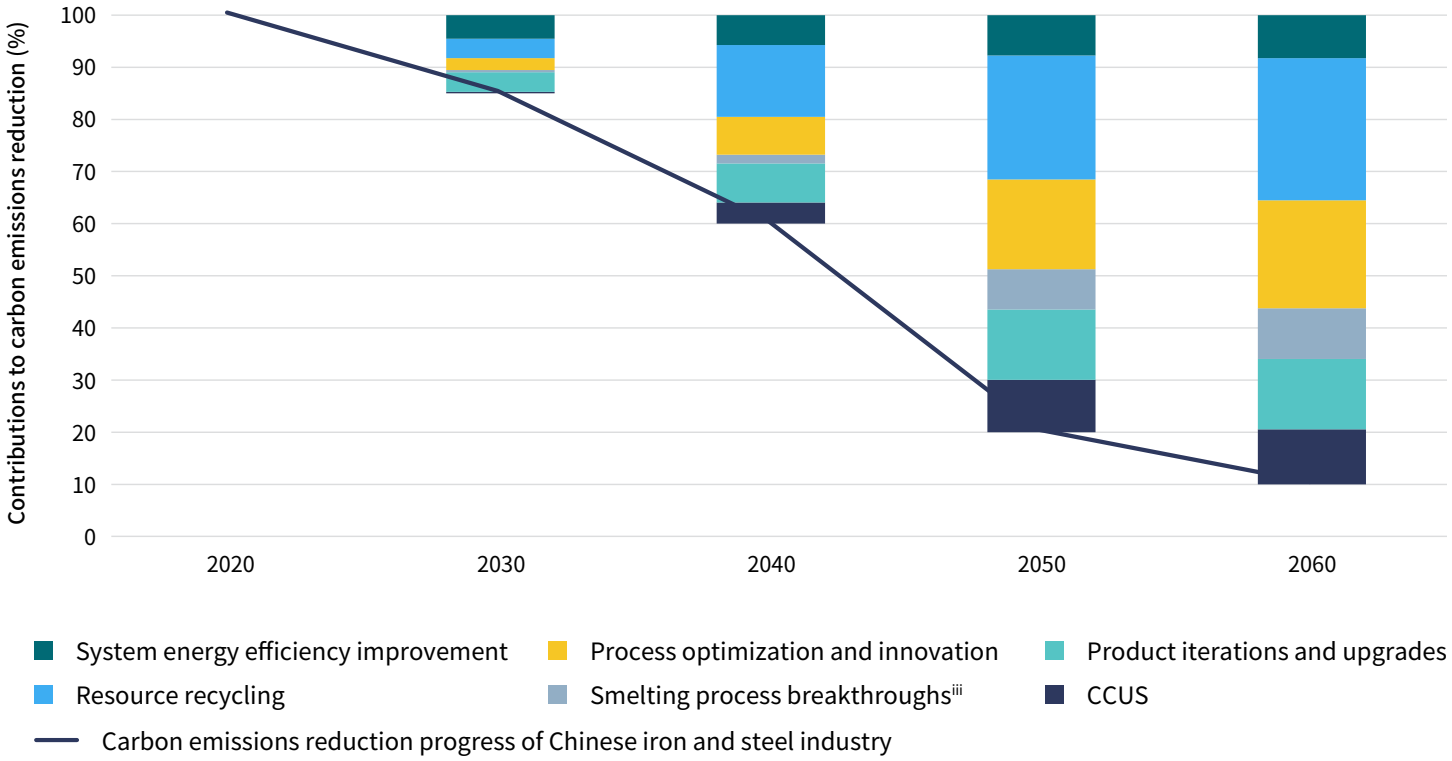
Source: UTS,[6] SBTi,[7] and MPP[8]. RMI analysis

Initial research lays out industry-wide decarbonization pathways under China's dual-carbon targets.

In 2020, the Chinese government has committed to achieve carbon peaking before 2030 and strives to achieve carbon neutrality before 2060. Since announcing the “dual-carbon” goals, China has established the 1+N policy framework. “1” functions as the overarching guidance with two policy documents “Working Guidance for Carbon Dioxide Peaking and Carbon neutrality in Full and Faithful Implementation of the New Development Philosophy” and “Action Plan for Carbon Dioxide Peaking Before 2030.” “N” functions as actions plans and policy measures for key sectors and industries. For the iron and steel industry, the “Implementation Plan for Carbon Peaking in Iron and Steel Industry” has been drafted by NDRC, MIIT, and corresponding ministries. Published in 2022, the “Guiding Opinions on Promoting the High-Quality Development of the Steel Industry” jointly released by MIIT, NDRC, and MEE, emphasizes the need to enhance innovation capabilities, optimize the industrial structure, and promote green and low-carbon development to ensure that the steel industry achieves carbon peaking before 2030.[9] “Carbon Peaking Action Plan for Industrial Sectors by 2030” further proposes the demonstration and promotion of technologies such as H_2-DRI and CCUS. It also aims to steadily increase the development of EAF short-process steelmaking, with a quantitative target to take over 15% of the market by 2025 and over 20% by 2030.[10] In the finance aspect, transition finance standards of the iron and steel industry have been drafted based on the G20 transition finance framework by the People's Bank of China and will be released for public consultation.

The iron and steel industry in China follows an approach to emissions reduction similar to the global industry as illustrated above. However, given that the country’s production capacity is dominated by blast furnace-basic oxygen furnace (BF-BOF) steelmaking with relatively young assets and primarily fueled by coal, the timeline for deployment of specific technologies varies. According to the China Iron and Steel Association, energy-efficiency improvements will contribute 30% of carbon reduction through 2030 and is a priority for carbon-emissions reduction in the short term. Around 2040, resource recycling will account for about 40% of carbon-emissions reduction, and short-process production utilizing steel scrap will replace the traditional long process at an accelerated pace. From 2050 to 2060, processes such as CCUS and hydrogen-based steelmaking are expected to be economically viable, and help drive China’s iron and steel industry to near-zero-emissions production.[11]

Exhibit 5 Carbon-Emissions Reduction Pathways for China's Iron and Steel Industry and Anticipated Contributions



RMI Graphic. Source: China Iron and Steel Association

Tools and Practices for Iron and Steel Companies to Set Carbon Targets

Target setting tools should follow climate commitment and technical feasibility.

Many organizations around the world have developed principles and guidelines for iron and steel companies to set and achieve climate-aligned emissions-reduction targets. These include the Steel Science-Based Target-Setting Guidance published by SBTi; the Responsible Steel International Standard (Version 2.0) published by ResponsibleSteel; and the Steel Climate Standard published by the Global Steel Climate Council (GSCC).

International target-setting guidance are in place for reference, but differ in boundary and pathway selections.

Among the guidelines for companies, the Steel Science-Based Target-Setting Guidance and the Steel Climate Standard provide methodologies for setting targets that meet the 1.5°C climate goal, whereas the Responsible Steel international Standard (Version 2.0) lays out 13 principles and provides certifications to qualified steelmaking sites and steel products. Below compares methodologies for setting carbon targets — the Steel Science-Based Target-Setting Guidance and Steel Climate Standard — along two dimensions, as summarized in Exhibit 6:

- Accounting boundaries: The Steel Science-Based Target-Setting Guidance offers two accounting boundaries applicable to different target-setting approaches: the core boundary, and Scopes 1, 2, and 3. Comparing the core boundary with operational boundary from Steel Climate Standard, we have found that they both cover the main processes of steel production (whether outsourced or not), but their difference lies in whether upstream production processes are included, as shown in Exhibit 7. The Steel Climate Standard covers all upstream Scope 3 emissions, including coal, iron ore, natural gas, and limestone extraction and processing, while the Steel Science-Based Target-Setting Guidance covers upstream production of syngas/hydrogen.

- Technology routes: The Steel Science-Based Target-Setting Guidance considers two technology routes for steel production: long-process steelmaking based on iron ore[ii] and short-process steelmaking based on scrap recycling. The guidance offers specific methods for companies to set their targets based on the share of steel scrap, whereas the Steel Climate Standard assesses different production pathways adopted by companies according to a unified emissions target.

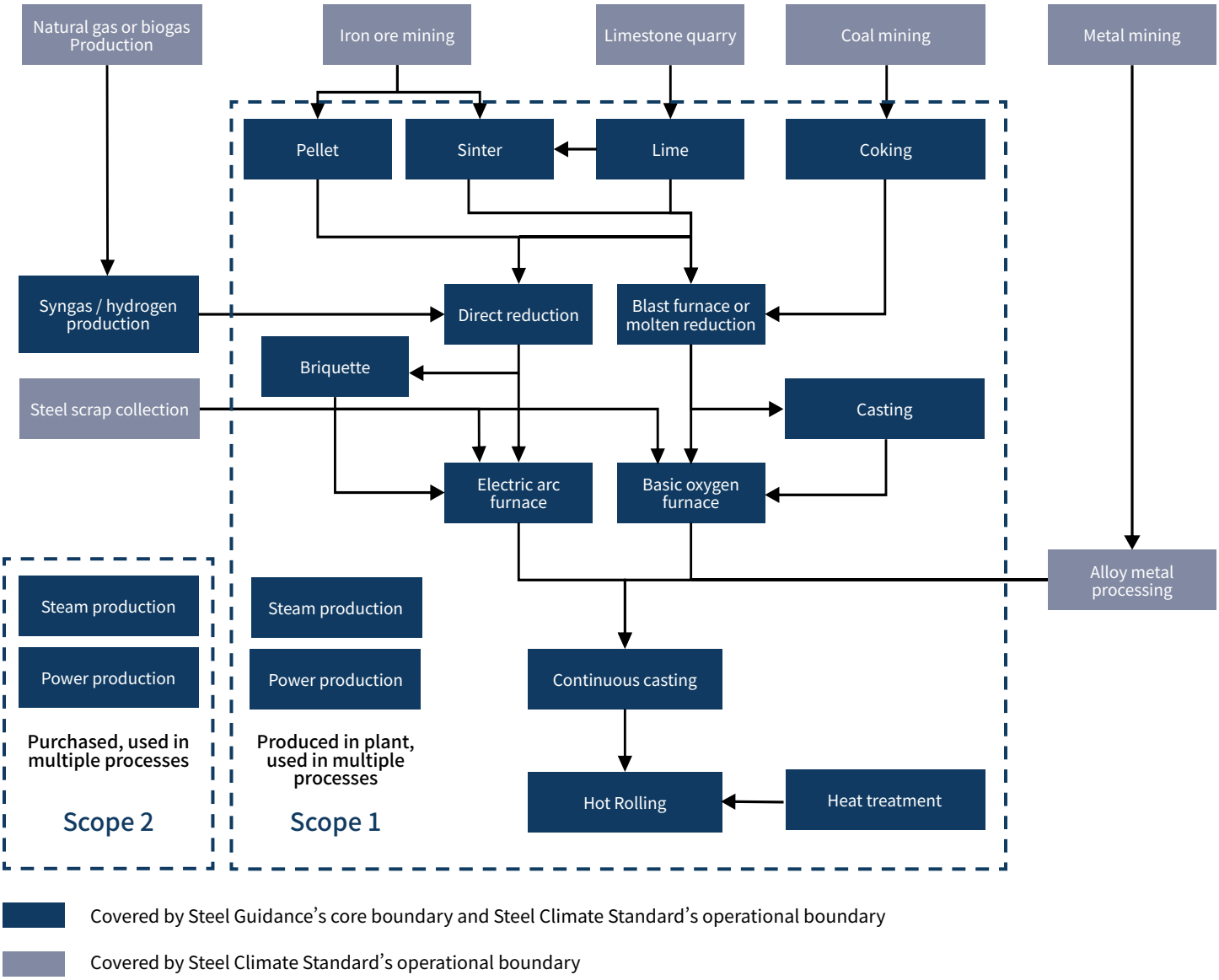
ii Long-process steelmaking includes BF-BOF and some other routes based on iron ore, e.g. hydrogen-based steelmaking.

Exhibit 6 Comparison of Differences in Guidelines on Carbon Target Setting for Iron and Steel Companies

	Steel Science-Based Target-Setting Guidance	Steel Climate Standard
User group	Iron and steel companies	Iron and steel companies
Accounting scope	Scopes 1, 2, and 3 Core boundary excludes emissions from raw material production; excludes cold rolling and coating	Operational boundary includes emissions from raw material productions; excludes cold rolling and coating
Differentiates between long-process pathway based on iron ore/short-process pathway based on steel scrap or not	Yes	No
Publishing organizations	SBTi	GSCC
Date published	July 2023	August 2023

Source: SBTi,[12] GSCC,[13] and RMI analysis.

Exhibit 7 Comparison of Accounting Boundaries in Carbon Target-Setting Guidelines for Iron and Steel Companies



RMI Graphic. Source: RMI analysis

In addition, there are guidelines for financial institutions to assess whether their investment portfolios are aligned with their climate goals. These include the Sustainable STEEL Principles, which are a set of commitments to adopt a common measurement and disclosure framework designed for banks to support the steel industry in forging a pathway to net-zero carbon emissions; the Disclosure Framework and Implementation Guidelines issued by the Task Force on Climate-Related Financial Disclosures (TCFD); and the Steel Eligibility Criteria of the Climate Bonds Standard and Certification Scheme issued by the Climate Bonds Initiative (CBI). While often referred to in terms of climate-related financial disclosures, TCFD has not developed assessment guidelines specific to the iron and steel industry. CBI's Certification Standard for the Iron and Steel Industry refers to the methodology of the Sustainable STEEL Principles in assessing a company's compliance with the 1.5°C climate goal.

For China, more detailed industry-level guidance on the overall target needs to step up.

Existing climate target assessment methods provide a methodological reference for carbon target setting and offer many lessons. For example, climate targets are broken down to the industry level and ultimately translated into corporate actions. The SDA methodology for high-carbon industries establishes an average emissions benchmark for global companies to reference when they develop more targeted transition strategies and actions.

However, most of the 1.5°C temperature targets in the world require achieving carbon neutrality by 2050, which may differ from the targets actually set by countries. As the global carbon budget has not yet been implemented in each country, the principle of "common but differentiated responsibilities" should be considered. Companies at different stages of development and in different regions may not be able to fully adhere to the international carbon targets. Therefore, it is necessary to explore the method for evaluating carbon targets in the Chinese context and design the corresponding tools and methodology.

Summarizing the above methods for evaluating climate targets reveals three things that should be considered when setting carbon targets in line with domestic conditions:

1. **Define the emissions pathway or target of the industry in line with national conditions:**
   While companies are supposed to set their targets based on the carbon budget, as pointed out by the above guidelines and is often the practice globally, China's iron and steel companies are suggested to also consider country specific emission trajectory and the industry's overall target.

   At present, China's iron and steel industry is yet to have official target in the form of total carbon budget or carbon intensity. And the timeline of national-level carbon peaking and carbon neutrality remains one of the key reference for companies' target setting, and some companies accordingly set their timeline to peak emissions and reach carbon neutrality, without enough information on total carbon or carbon intensity cut.

   However, to effectively guide actual emission reduction, it is necessary to set more specific quantitative targets or emissions-reduction pathways, both at sector level and company level. An ambitious enough yet reasonable target should reflect the national development plan for high-emissions industries, as well as take into account the feasibility of emission-reduction levers. When a sector level clear enough target is in place, it will bring more clarity for companies to follow and adjust.

2. **Set targets based on the feasibility of different technology pathways:**
   Steel products based on iron ore are significantly different in carbon intensity from those based on steel scrap, and the difficulties of implementing emissions-reduction technologies for the two are also different. Thus, carbon emissions targets must account for the development of emissions reduction under the iron ore–based and steel scrap–based pathways. Unlike many countries where iron and steel production is dominated by short processes (i.e., scrap-based steel), China's industry is dominated by BF-BOF production, which makes emissions reduction more difficult and expensive. The international community generally sets the same long-term carbon targets for both long and short processes as the average carbon intensity of the iron and steel industry is expected to converge. However, in China, it is worth exploring separate carbon targets for long and short processes to avoid setting targets that are too idealistic to achieve.

3. **Accelerate the development of a comprehensive localized iron and steel database:** The authenticity and reliability of data are essential for making an accurate carbon-footprint assessment. In general, collecting and using on-site data is preferable, but getting complete and accurate data from iron and steel companies is challenging. Thus, the practice internationally is to prioritize on-site data, while also relying on credible databases such as those published by the IPCC, IEA, World Steel Association, and governments (e.g., the United States and the European Union). Therefore, while efforts are in place, there is an urgent need to further accelerate development of a national and industry recognized iron and steel industry database to support the accuracy, authenticity, and traceability of carbon accounting by its iron and steel companies.

What's for now and what's ahead for Chinese steel companies: target setting, technology pathway, and management mechanism

Target setting: the clarity matters

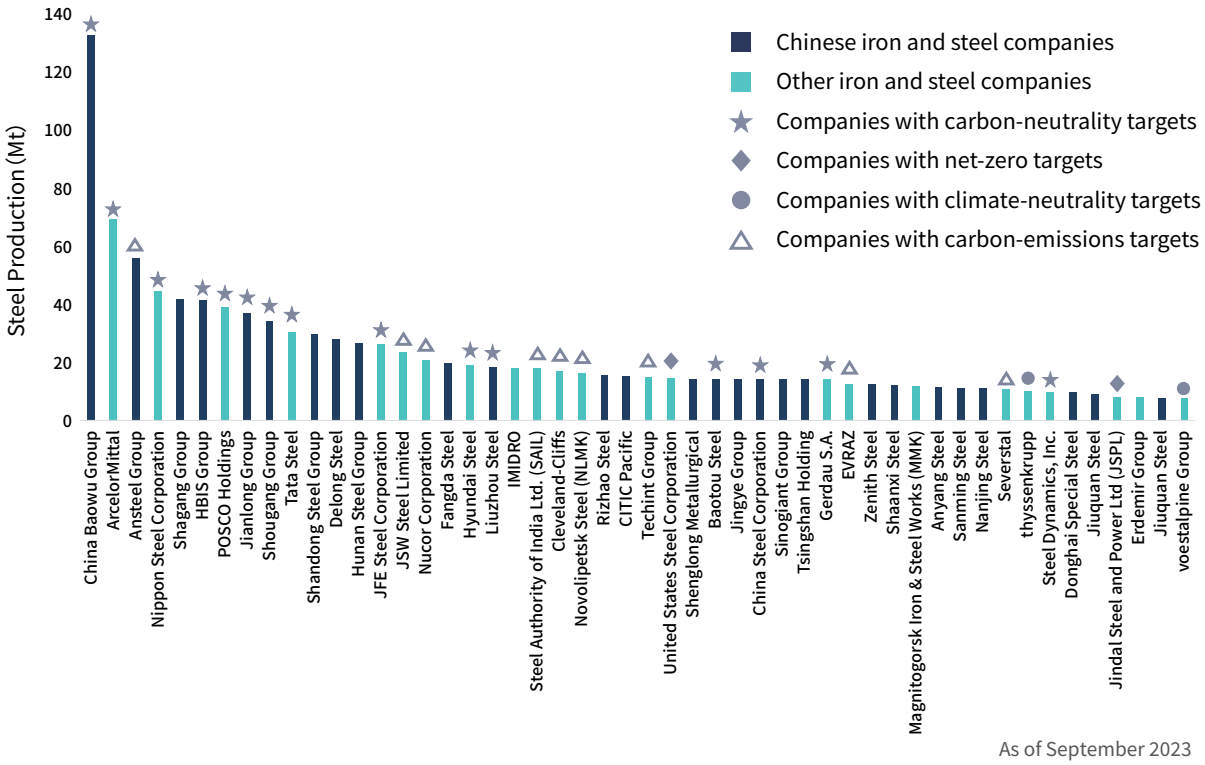
Reasonable carbon targets should meet climate science, national, and industry requirements for emissions reduction, as well as the company's emissions-reduction ambitions and capabilities. To ensure the carbon targets are able to guide actions, companies are suggested to set clear and comprehensive emissions-reduction targets, meaning that there are enough details on the overall and milestone targets, the total carbon volume and carbon intensity, the coverage of GHG types, and their scope, etc. Besides these, there are also other supporting targets companies can consider, like energy consumption and renewable energy use. After these targets are set, associated roadmaps, timelines, and action plans are necessary to help secure actual actions.

In 2022, the world's top 50 iron and steel companies by output produced 1.12 billion tons of steel, or 60.3% of the world's total.[14] These major iron and steel producers are located in 13 countries across five continents. Their carbon-reduction targets and actions are critical to emissions reduction in the industry globally.

As shown in Exhibit 8, 28 of the top 50 global iron and steel companies have set some type of climate targets, of which 19 are committed for carbon-neutrality, net-zero, or climate-neutrality. Among the 27 Chinese iron and steel companies, 7 have set carbon-neutrality targets which representing a 28.4% of China's steel production volume in 2022. Among the 23 major producers outside of China, 8 have made carbon-neutrality commitments, 2 have made net-zero commitments, and 2 have made climate-neutrality targets. Of the global top 50 steel companies, 15 that have set carbon-neutrality targets with most setting 2050 as their target year and a few setting 2045 and 2060 as their target year.

Most of the global iron and steel companies among the top 50 producers clearly state the scope of emissions when defining carbon emissions targets. The majority cover both Scope 1 and Scope 2 emissions, and a few include Scope 3 emissions in their targets. China's iron and steel companies follow the *Guidelines on Greenhouse Gas Emissions Accounting Methods and Reporting for Iron and Steel Producers in China (for Trial Implementation)*, which covers the same scope as Scope 1 and Scope 2.

Exhibit 8 **Carbon Targets Set by the Top 50 Iron and Steel Companies by Output**



Note: "Companies with carbon-emissions targets" denotes companies that have emissions-reduction targets other than carbon-neutrality goals.

RMI Graphic. Source: RMI analysis

The practice of setting interim targets varies considerably among companies. Interim targets are guiding target values set between a base year and a carbon-neutrality target year. They are designed, first, to assess the effectiveness of carbon-reduction efforts, so companies can make timely adjustments to ensure they meet their long-term targets. Second, these targets affect a company's total emissions before it reaches its long-term goal. Even if the end point — carbon neutrality — is the same, total emissions will be lower for companies that reduce their emissions quickly than for those that increase and then decrease their emissions. Thus, interim targets help ensure companies reach their ultimate carbon targets in a way that minimizes their total emissions. Third, the reduction in carbon emissions may not always be linear, declining slower or faster depending on factors such as technological maturity and cost.

Interim targets break down the ultimate carbon target into more specific milestones to ensure companies neutralize carbon emissions in stages. All 19 of the top 50 iron and steel companies by output that have long-term carbon-neutrality goals have set interim reduction targets to guide and track their emissions-reduction progress.

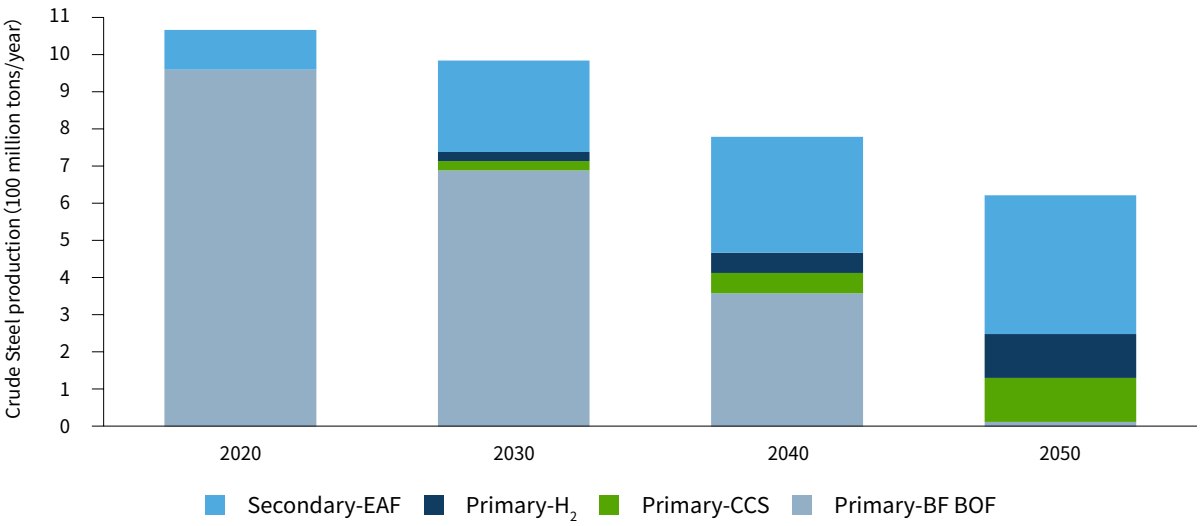
Ideal carbon targets contain a base year, base-year emissions performance, target year, and target-year emissions performance, providing clear and comparable information for investors, consumers, and relevant organizations. Currently, iron and steel companies describe their interim emissions targets in three ways. The first way — commonly used by producers in Europe, the United States, Japan, and South Korea — identifies a base year in the past, and states the percentage of decrease in total emissions or emissions intensity of the target year compared with the base year.

The second, typically used by Chinese companies, identifies a peaking year in the future as the base year, and states the percentage of decrease in total emissions of the target year compared with the base year. For example, a Chinese iron and steel company may identify a year before 2025 as the peaking year and set the interim target at 2030–2035. Under the context of development and carbon reduction, the "total control" target set by the company aligns with China's dual-carbon goals. The third way of defining interim targets, which is commonly used by India's iron and steel companies and is consistent with India's nationally determined contribution commitment for the industry, sets a target emissions intensity for the target year.

Technology pathway: massive scale-up of scrap utilization and the need to promote lower-emission primary steelmaking

Various scenario analyses have pointed out the importance of both scrap utilization for secondary steelmaking and lower-emission primary routes with the hydrogen-based ones as good examples. In RMI's scenario, in order to achieve a "Net Zero by 2050" aligned pathway for the Chinese steel sector, 60% of China's steel production could come from scrap-based EAF by 2050, 20% based on hydrogen, and the rest relying on fossil fuel should be equipped with CCS. Although the current scrap resources are insufficient, as China enters the latter stage of industrialization and urbanization, and as the recycling system improves, there will be growing scrap availability. Hydrogen and CCS, while the costs are relatively high today, potential cost reduction brought by both technology advance and economies of scale could make a cost parity possible in the future.[15]

Exhibit 9 **Production Route Projection of China's Steel Industry (2020–2050)**



RMI Graphic. Source: RMI

The choice of emissions-reduction technologies varies from company to company depending on their circumstances and strategic plans. For example, Baowu Group and Arcelor Mittal, the two largest crude steel producers, have developed detailed carbon-reduction roadmaps covering specific technology pathways and corresponding deployment windows. However, there are significant differences between the two in terms of how much the technologies they chose will contribute to emissions reductions.

- Baowu Group produces about 10.9% of the steel in China, mainly using the long process. Replacing long-process production capacity with EAF steelmaking involves early decommissioning of blast furnaces, and would reduce the economy of the original investment. Furthermore, steel scrap resources

in China are limited, and the economic advantages of short-process steelmaking are not evident. Therefore, Baowu Group plans to aggressively develop hydrogen-based steelmaking to optimize the utilization of long-process production capacity while expanding its business into the upstream hydrogen energy industry. By expanding into the whole supply chain — hydrogen energy production, storage, transportation, refilling, and usage — Baowu hopes to build momentum for growing the company.

- Arcelor Mittal, by contrast, has invested more in electric steelmaking to reduce emissions. With new direct reduction iron (DRI)–EAF technology, the company is increasing the portion of EAF steel production capacity while eliminating the long-process blast furnace-basic oxygen furnaces' production capacity.

Some companies have emissions-reduction measures that extend beyond their production processes. For example, Arcelor Mittal purchases carbon offset credits, which it says neutralize the last 5% of carbon emissions, which tend to be difficult and expensive to address. Ansteel Group, which does mining and beneficiation in addition to its iron and steel smelting business, incorporates carbon emissions reduction from ore mining by constructing green mines. Jianlong Group, Shougang Group, and Tata Steel have added green logistics to their emissions-reduction roadmaps to help address Scope 1 emissions (from intracompany transport) and part of its Scope 3 emissions (from transport between the company and upstream and downstream companies).

Management mechanism: a spectrum of to-dos

The carbon related management mechanism is a system of safeguards and measures companies can adopt to support carbon-reduction actions. Internal carbon management includes mechanism construction, financial support, investment in innovation and R&D, capacity building, and carbon information management. External carbon management is mainly comprised of the company's supply chain, corporate image, and external cooperation.

Organizational structure and funding are key to ensuring that carbon-emissions reduction actions remain effective over the long term. Most of the leading iron and steel companies have set up divisions or committees dedicated to carbon management, supporting carbon emissions reduction by investing dedicated funds and developing carbon financial products to leverage external funds.

For example, Baowu Group has set up a carbon-neutrality fund of 50 billion yuan to help develop low-carbon steel production. It also has issued China's first low-carbon transition bond, investing all the proceeds in a hydrogen-based shaft furnace system for its subsidiary, Zhanjiang Iron & Steel. The European Investment Bank offered Arcelor Mittal a loan of €75 million to build waste and by-products conversion and utilization projects that will help develop low-carbon steelmaking technologies. Leading iron and steel companies have taken initial steps in securing specialized low-carbon finance, but these industry players will need to ensure sustainable funding for decarbonization through a variety of mechanisms as they emerge.

Market Mechanisms That Support Iron and Steel Companies Achieving Climate Targets

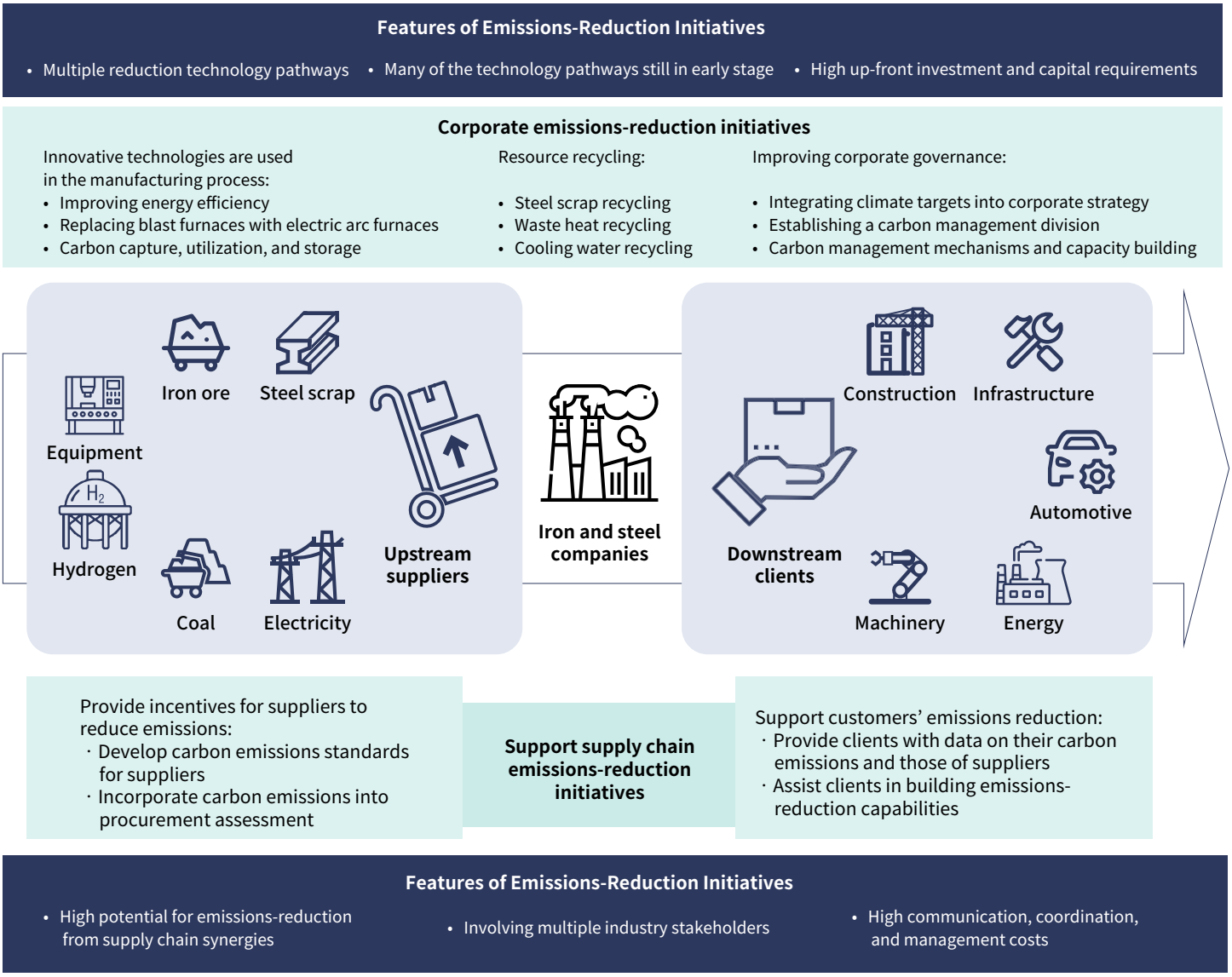
Capital access and supply chain management

Most of the world's leading iron and steel companies have made progress setting corporate carbon targets that meet climate goals and completing the corresponding carbon-reduction roadmaps. China is the world's largest steel producer and consumer. About half of the world's top 50 iron and steel producers by output are Chinese companies, and those that have carbon targets account for 18.6% of global output. Climate action by these companies is critical to meeting China's carbon-neutrality goal, to emissions reduction in the global iron and steel industry, and even to downstream companies. However, Chinese iron and steel companies still face considerable challenges in achieving their climate targets and taking large-scale emissions-reduction initiatives.

To illustrate the specific challenges to Chinese iron and steel companies in their efforts to reduce carbon emissions, Exhibit 10 examines the industry from the perspective of the entire value chain — including measures that iron and steel companies can implement as well as emissions-reduction efforts by players across the supply chain. Given the complexity of the steel production process, thorough emissions reductions require technological innovation. Both technological innovation and the at-scale application of new technologies require significant financial support and a high degree of risk tolerance. How to access the capital needed for transition is a key challenge to the industry.

In addition, the value chain of the iron and steel industry is diversified and complex. The upstream and downstream processes include ore collection, smelting, processing, manufacturing, and distribution, involving many steps and multiple industries. To more significantly reduce emissions in collaboration with upstream and downstream partners requires close communication. How to avoid cost increases caused by increased coordination and management is another major challenge.

Exhibit 10 Impacts of Iron and Steel Companies on Carbon Reduction in the Value Chain



RMI Graphic. Source: RMI

Financial Pressure

Amid the energy crisis and global economic headwinds, the cost of fuel for steel production has risen sharply and remains high. At the same time, weakened consumption and declining demand for steel have led to a significant drop in steel prices, taking a heavy toll on profitability in the iron and steel industry. According to the China Iron and Steel Association, the purchase cost of coking coal and blown coal of the benchmarked iron and steel companies increased by 24.9% and 24.3%, respectively, in 2022 over the previous year. Revenues of key iron and steel companies decreased by 6.35% and the profits shrunk 72.27%, putting greater financial pressure on the iron and steel industry in a complicated and uncertain market.[16]

At the same time, the iron and steel industry urgently needs to transition to low-carbon production. As a high emitter accounting for about 7% of global GHG emissions, iron and steel companies are subject to increasingly stringent environmental requirements.[17] The European Union, for example, has set ambitious emissions-reduction targets, requiring the iron and steel industry to reduce carbon emissions by 55% by 2030 and 80%–95% by 2050 compared with its carbon emissions in 1990.

Although many carbon-reduction solutions in the iron and steel industry are still in their early stages and relatively costly, it is critical that immediate reduction actions be taken and the necessary funding made available — which in turn will help improve the economics of new technologies needed for the industry to reach its carbon-neutrality target. RMI estimates that the total fixed assets required for the transition in the iron and steel industry through 2050 will be at least 1.6 trillion yuan.

However, iron and steel companies commonly find it difficult and expensive to secure financing. This is because the industry is one of the "two highs and one surplus" industries,[iii] with a high average gearing ratio and declining profitability in recent years. The industry mainly relies on debt financing, but the scale of bond issuance of iron and steel companies narrowed by 21.01% from January to November 2022 compared with the same period in 2021. Bonds with a maturity of one year or less accounted for 54.15% of the total issuance — short-term funds that cannot meet the long-term capital demand for the transition.[18]

In general, it is difficult for iron and steel companies to complete the low-carbon transition with their own funds or using traditional financing channels. And, because iron and steel is a high-carbon-emissions industry, it is controversial for these companies to secure funding through new green financing channels. As a result, iron and steel companies have limited access to funding for the low-carbon transition.

Complex Supply Chain Carbon Management

The iron and steel industry involves complex processes and is therefore closely connected to both upstream and downstream stakeholders. Iron and steel companies purchase different types of large equipment, such as blast furnaces, basic oxygen furnaces, and EAFs from upstream. They also need a continuous supply of raw materials and energy, such as iron ore, scrap materials, coal, electricity, and cooling water during operation. Their products are sold to industries that include construction, infrastructure, automotive, energy, and machinery. In the process of emissions reduction, the iron and steel industry must engage in extensive communications with upstream and downstream companies. Iron and steel companies should pursue carbon-emissions reduction in their procurement from upstream suppliers, thereby reducing Scope 2 and Scope 3 emissions. At the same time, they should maintain ongoing communication with customers regarding their requirements for emissions from steel materials to ensure product compliance.

However, the iron and steel industry faces great challenges in carbon-emissions management. First, it interfaces with a large number of other industries, each with its own technological characteristics and frameworks for emissions reduction. Iron and steel companies need to collaborate with each stakeholder to customize emissions-reduction plans and methods for evaluating the effectiveness of initiatives, leading to high communication and management costs. Second, emissions-reduction capabilities, willingness, and acceptable costs vary among stakeholders. The iron and steel industry, which is in the middle of the value chain, faces growing pressure to reduce emissions from downstream companies while

iii The "two highs" refer to resource-based industries with high pollution and high energy consumption, and the "one surplus" refers to industries with excessive capacity. We have observed that banks may set limits on the general credit business for the "two highs and one surplus" industries and grant a higher risk rating.

hardly passing on the pressure and costs of emissions reduction to other stakeholders. How to manage emissions-reduction targets and initiatives along the supply chain in a systematic and comprehensive manner, and how to distribute emissions-reduction responsibilities and costs in a reasonable and fair manner are core challenges for the iron and steel industry.

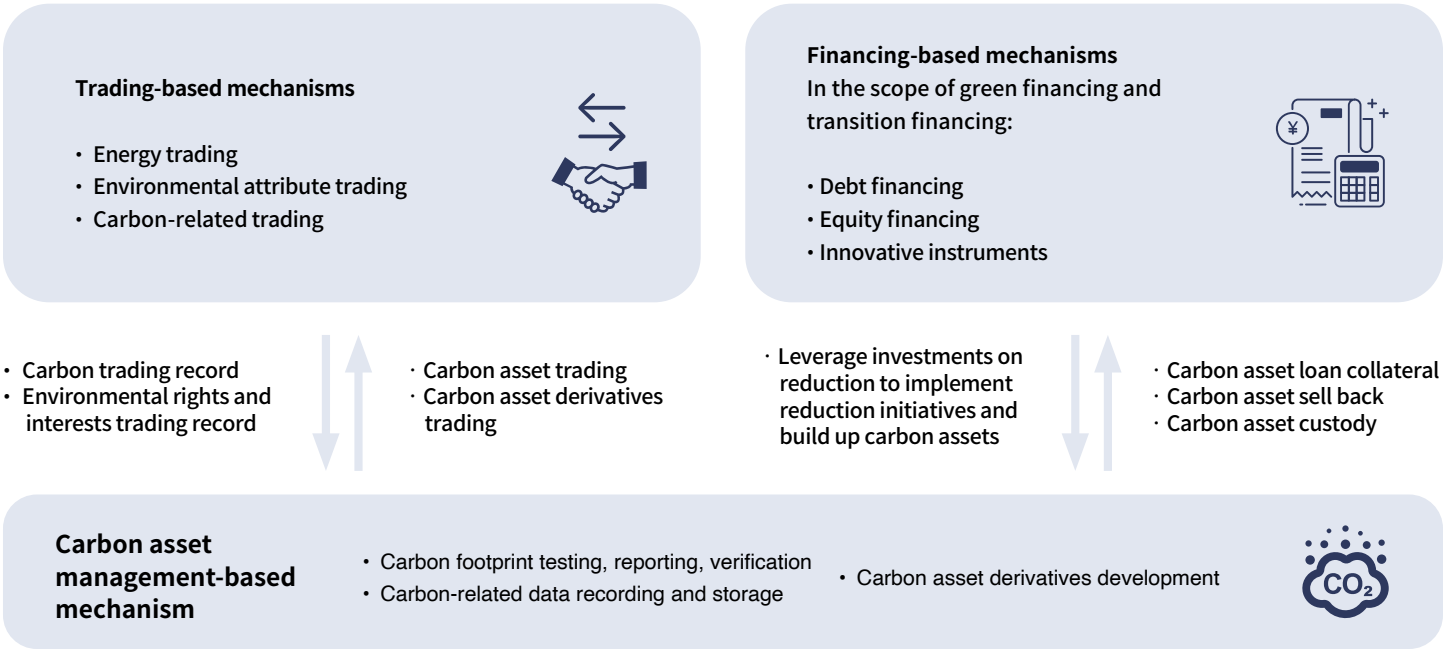
Trading, financing, and carbon-asset mechanisms

Market mechanisms, including financial markets, commodity markets, electricity markets, and carbon markets, play a key role in reducing corporate emissions. With market mechanisms, companies can gain broad access to resources, reduce the cost of emissions reduction, raise funds for transition, and adopt innovative and customized decarbonization solutions.

There are three primary market mechanisms available: trading based, financing based, and carbon asset management based. As shown in Exhibit 11, trading-based mechanisms mainly include energy trading, environmental-attribute trading, and carbon-related trading. These mechanisms are designed to help companies reduce carbon emissions in the most flexible and cost-effective way through market trading. Financing-based mechanisms mainly include green finance and transition finance. When effectively utilized, they help companies secure lower-cost funding for their low-carbon transition. Carbon asset management–based mechanisms are science-based carbon footprint accounting methodologies that record and store information on corporate emissions and emissions-reduction activities. The information not only helps iron and steel companies communicate better with upstream and downstream partners, but can also be converted into "assets" that attract additional cash flow in some scenarios.

This section illustrates how each of these three mechanisms and their synergies can help iron and steel companies implement emissions-reduction initiatives.

Exhibit 11 Synergies of Market Mechanisms



RMI Graphic. Source: RMI

Enhance cost-effectiveness through trading-based mechanisms.

The iron and steel industry has faced significant operating pressures in recent years. The cost of producing iron and steel has increased due to rising energy prices, while the demand for steel has continued to fall due to the global economic headwinds and overcapacity. Under these circumstances, iron and steel companies cannot raise prices to pass on their higher operating costs to customers. In addition, iron and steel companies are facing increasingly stringent environmental requirements. In the long term, environmental protection policies and regulations are necessary to achieve the targets of the Paris Agreement and promote the low-carbon transition, but in the short term, they present an additional cost to iron and steel companies.

In the absence of market mechanisms, the operating cost and emissions-reduction cost of iron and steel companies are relatively fixed and independent, requiring companies to address them separately. These costs may force iron and steel companies into bankruptcy or closure, and make it hard to achieve a sustainable development industry.

Trading mechanisms can provide a way for iron and steel companies to solve this problem, overcome their technological and capacity barriers, and significantly reduce the cost of emissions reduction. By participating in market trading, iron and steel companies can adopt the most cost-effective way to reduce emissions and maximize efficiency. Trading-based mechanisms allow companies to consider the costs of plant operation and emissions reduction in a holistic manner, thus promoting sustainable development of the industry. Currently, common trading-based mechanisms in the market include green power trading, green certificate trading, and carbon emissions trading.

Green Power and Green Certificate Trading

In the net-zero scenario, the steel industry will have almost entirely shifted to low-carbon production by 2050. Decarbonization will be achieved with the adoption of technologies such as CCUS, short-process EAF steelmaking, and H_2-DRI, coupled with the use of green energy sources, including renewables such as wind and solar, which are called green power, and green hydrogen.

According to RMI, short-process EAF steelmaking is expected to gradually expand to 60% of China's total production by 2050, up from the current level of 10%.[16] Using short-process EAF, electricity is the main source of energy, consuming around 300 kilowatt-hours per ton of steel. If green power can be used at scale, iron and steel companies can accelerate their emissions reduction. Green hydrogen for direct hydrogen reduction can also be sourced through green power procurement plus in-plant hydrogen production from electrolytic water. This means of decarbonization is in practice internationally, for example, by Steel Dynamics and H_2 Green Steel.

Case 1: EAF Steelmaking + Green Power Pathway of Steel Dynamics

As one of the largest steel producers and recyclers in the United States, Steel Dynamics produces 13 million tons of steel annually using EAF steelmaking technology. It has plants throughout the United States and Mexico. In 2023, the company signed a renewable power purchase agreement with the world's largest wind and renewable energy generator, NextEra Energy Resources, and purchased 308 megawatts (MW) of power from its new wind farm in Scurry County, Texas. When put into operation, the wind farm is expected to produce 1.1 terawatt-hours (TWh) of power annually, which is approximately 16% of the company's total power consumption of steel plants. This purchase agreement is by far the largest green power purchase agreement to date in the iron and steel industry in North America.[19]

Case 2: Green Power–Based Hydrogen Production + DRI Pathway of H2 Green Steel

H_2 Green Steel, a Swedish start-up, is building the world's first near-zero-emissions steel plant based on renewable hydrogen in Boden, Sweden. The plant is expected to emit 95% less CO_2 than conventional steel production and is planned to start operation by 2025. It will use hydrogen for direct reduction of iron and produce 2.5 million tons of steel per year in the first phase. The renewable hydrogen used will be produced in the 800 MW electrolyzer of the plant, which will be one of the largest electrolyzers in the world.[20]

To meet the demand for power for renewable hydrogen production, H_2 Green Steel has signed long-term power purchase agreements with leading Nordic energy producers Statkraft and Fortum. Statkraft will supply 2 TWh/year of renewable electricity to the steel plant between 2026 and 2032, and Fortum will supply a total of 2.3 TWh/year of renewable electricity to the plant.[21] These include a fixed-price agreement of 1 TWh per year for nine years from 2027 and an index-based agreement of 1.3 TWh per year with a five-year hedging period from 2026.[22]

Access to economically viable green power is key to implementing this pathway. In recent years, China has been increasingly promoting the market-based trading of green power and green certificates, expanding access to green power for all energy consumers, including iron and steel companies.

- **Green power trading:** A trading mechanism for both electricity and the environmental attributes of green power. In September 2021, China introduced a green power trading model through which energy consumers and renewable energy power producers can enter into direct power purchase agreements. Under these contracts, the green power and the environmental attributes represented by the green certificate are delivered to the energy consumer in a bundled transaction.

- **Green certificate trading:** A trading mechanism solely for the environmental attributes of green power. Consumers purchase the power they need separately through other contractual modes.

Although the trading mechanism has been established, the economic viability of green power cannot be guaranteed as the market is still in its infancy and the relationship between supply and demand is unstable. For example, the purchase of green certificates is an additional operating cost for iron and steel companies.

Green power trading generally follows market-based trading principles, where buyers and sellers can negotiate directly based on market supply and demand, the ability to bear a premium, and other factors. However, some in the market believe the environmental attributes of green power should be recognized, and thus traded at a "premium." That would present another challenge to the iron and steel industry, which is already operating with narrow margins. To make better use of green power and green certificate trading mechanisms, iron and steel companies may try leveraging their scale — that is, significant and predictable power consumption — to explore options such as signing long-term agreements on the purchase of green power. This will allow them to lock in the green electricity they require at a fixed price and reduce risk.

Carbon Emissions Trading

Although China's carbon market currently covers only the power generation sector, iron and steel companies will inevitably be included in the future, given the dual-carbon goals and international trading trends. There are clear signs that this change is in the works. In 2021, the Ministry of Ecology and Environment (MEE) commissioned the China Iron and Steel Association to develop a carbon quota allocation scheme for the industry. In July 2023, China convened two high-level "working meetings" to consider a preliminary proposal for inclusion of the iron and steel industry in the market.

In October 2023, MEE issued the "Notice on the Reporting and Verification of Greenhouse Gas Emissions by Enterprises in Selected Key Industries for 2023–2025," setting more stringent carbon-emissions verification requirements for iron and steel, cement, and electrolytic aluminum.[23] It substantially modified the carbon-emissions accounting and reporting methods for these industries — a change in policy that helps pave the way for including the iron and steel industry in the carbon market.

Including the iron and steel industry in the carbon market will effectively control total emissions of the industry and promote decarbonization actions. For individual companies, the carbon market gives them greater incentive for low-carbon transition by providing a firm price signal for emissions reduction, allowing them to determine the optimal amount of emissions reduction depending on their technological pathways and emission levels. It would allow iron and steel companies to buy and sell emissions reductions and share the cost of reductions, thereby maximizing the benefits in the market. Therefore, companies lacking emissions reduction capacity can have a new compliance option that gives them time to gradually build up their capacity rather than shutting down immediately, while corporations with strong emissions reduction capacity can gain incentives for deeper emissions reductions.

Iron and steel companies should pay close attention to national policies and make plans for participation in the carbon market. For example, they can incorporate carbon market–related work in their development plans, build carbon-accounting mechanisms and capacity in advance, and actively participate in the development of carbon standards. In addition, these companies should also pay attention to global trends in the industry, including international carbon prices, and the impact of carbon tariffs on their exports, such as the EU Carbon Border Adjustment Mechanism.

Raise funding through financing-based mechanisms.

Due to certain characteristics of the low-carbon transition for iron and steel companies, such as perceived high risks and the requirement for long-term commitment, these projects are often not the top preference for financiers. Such projects frequently face intense competition for capital against other projects that are considered more financially rewarding, often placing them at a disadvantage.

Green finance and transition finance are key innovative market mechanisms to help iron and steel companies out of their predicament. Once certified as green or transition projects, potential investors interested in climate change mitigation will be more inclined to provide funding, sometime at lower interest rates and with longer maturities. Although debates still exist in terms of the definition of the two terms, there are some general differences between green finance and transition finance.

Green finance, in definition, is designed to finance pure green projects with zero or near-zero emissions, while in practice, other project types such as energy efficiency improvemnts or synergy with air pollution control are also included. For example, In the *Green Bond Endorsed Projects Catalogue* (2021 Edition), "ultra-low emissions transition of iron and steel companies" projects are explicitly supported.[24] However, due to the high-emissions nature of the iron and steel industry, only a limited number of projects can be covered, causing corresponding restrictions on green finance for the steel industry.

Transition finance, complementing green finance by supporting high-carbon projects to make progress in reducing carbon emissions, offers more potential to finance the transition of iron and steel companies. Currently, transition finance is still in its infancy but is gradually growing and receiving increased attention. The People's Bank of China launched a study on transition finance in 2021 and organized research on transition finance standards in four key areas, including the iron and steel industry, coal and electricity, construction and building materials, and agriculture. In the future, more specific standards should be set for transition finance to ensure that it can support sufficiently ambitious actions that align with the decarbonization roadmap.

Under green finance and transition finance frameworks, iron and steel companies can raise funds for their emissions-reduction initiatives through financing instruments including debt financing, equity financing, and other innovative financing instruments. These financing mechanisms will vary depending on the different transition technology pathways and the features of the transition finance required by iron and steel companies.

Scenario 1: Debt financing is the preferred option when adopting mature technologies

When iron and steel companies plan to adopt mature emissions-reduction technologies such as energy-efficiency improvements, large-scale retrofitting, and recycling, they may apply for debt financing to support project construction and production. Bank credit and bond issuance are two primary instruments for debt financing. In the Chinese sustainable financing market, bank credit is more mainstream, while corporate bond issuance volumes have been increasing over the years. By the end of 2022, the balance of green loans in China reached 22.03 trillion yuan, and the stock of green bonds was 1.4 trillion yuan.[25] As these two financing instruments have different characteristics, iron and steel companies can choose between these two instruments according to their capital demands. First, the preparation period for credit is shorter than that for bonds. For a sustainable loan, the company needs only submit materials to the financial institution, which, upon approval, can directly disburse the funds required for the project. Bond issuance requires companies go through more complicated and time-consuming procedures with higher

transaction costs. Secondly, the tenor of credit is commonly shorter than that of bonds. For instance, loans directed toward energy-efficient improvements typically exhibit a tenor of less than three years within the Chinese market, while in 2022, the weighted average maturity of green bonds in China was 5.5 years.[26] Thirdly, bond interest rates are generally lower than credit interest rates. According to institutional estimates, the weighted average interest rate of green loans is 4.1%, while the average issuance rate of green bonds in 2022 was 3.1%.[27] Considering the above factors, bank credit is more suitable for small projects that require rapid financing, while bonds are more suitable for large-scale projects that require large upfront investment. It should be noted that in the financing practices of individual enterprises, the characteristics of bonds and credit may change due to various factors such as the market environment, enterprise risk ratings, project types, etc.

Case 3: Chinese iron and steel company issues green bonds

HBIS Group is one of the largest steel material manufacturers and integrated service providers in China. In recent years, due to rising raw material prices and China's progressively stricter requirements for environmental protection, its production cost and environmental protection expenses have continued to increase. To make a green transition, HBIS Group needed to update its production equipment, but it did not have the funds to make the large capital investment required to upgrade to low-carbon green technology. Its debt ratio of 60%–70% also made external financing difficult. So, in March 2018, HBIS Group issued China's first green bond to raise funds for its upgrade. The bond raised 700 million yuan with a five-year maturity and a coupon rate of 5.42%. Half of the funds raised were invested in energy-saving technology transition projects, while the other half supplemented the group's daily operations. HBIS Group subsequently issued its second green bond in December 2018, raising a total of 3.5 billion yuan. This issuance was the first green renewable bond in the Chinese green bond market.[28]

Scenario 2: Equity financing is better suited to the deployment of emerging technologies

To realize their long-term strategic plans, iron and steel companies will also need to apply some immature technologies such as hydrogen energy and CCUS in pilot projects. With high up-front costs and high associated uncertainty, these technologies make it difficult to ensure a stable return on investment. For these types of projects, the lack of repayment flexibility of instruments such as loans and bonds may pose a significant risk to both the borrower and the lender. Equity financing, characterized by a higher risk appetite, whereby partial ownership of the company is sold to investors willing to share the risks and returns of the project, is the preferred financing option for the deployment of emerging technologies. However, the green or transition labeling of equity investment is still in its early stages worldwide. The concepts, related standards, and financing forms of green stocks and transition stocks have not been clearly defined in China. Building this financing tool could provide Chinese iron and steel companies with a lower-cost, longer-term, and more flexible financing option to decarbonize.

Scenario 3: Other innovative instruments

Other innovative financial instruments can be used. For example, insurance mechanisms can be effective in sharing the transition risks posed to iron and steel companies. Some typical transition insurance allows steel companies to hedge against the risk of not achieving the projected energy efficiency gains in their retrofit projects. If the project fails to meet the predetermined energy-saving targets during the operation

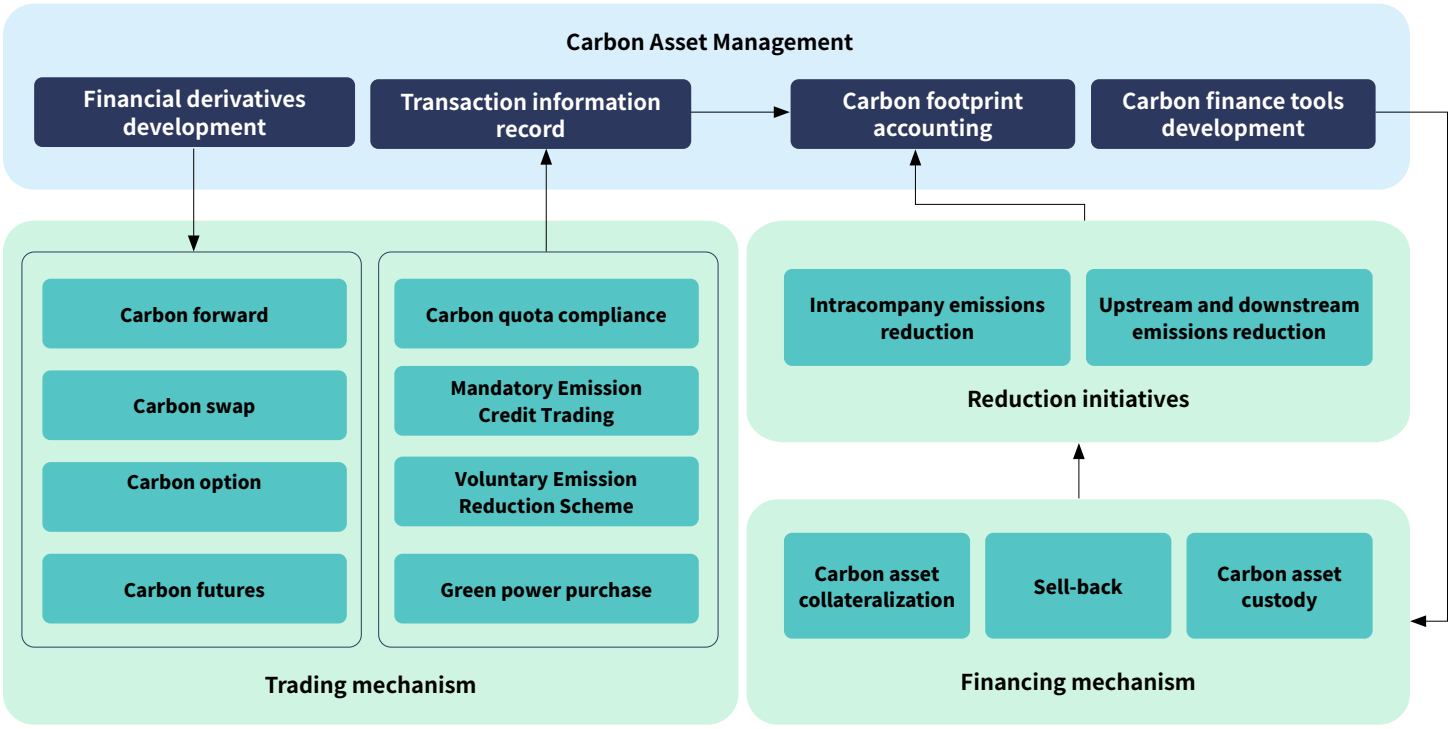
period, the insurance company will be responsible for paying out part of the energy-saving retrofit costs. Additionally, for asset-heavy projects, steel companies can try financial leasing, whereby financial institutions purchase the required equipment and then lease it to the steel company. In this way, steel companies can avoid investing a large amount of capital in the early stages of the project, and instead spread the capital investment over the project period, thus preventing the short-term increase in gearing and operational pressures. With the market recognizing the potential of financial innovation, numerous financing mechanisms using carbon assets as leverage have emerged. The report will introduce more details of the carbon asset-based financing solutions in the next section.

Enable data transparency and carbon derivatives through carbon asset management-based mechanisms.

Traditionally, iron and steel companies view their carbon emissions as an environmental consequence of production processes and thus focus solely on compliance. As carbon-neutrality targets become clearer and carbon pricing mechanisms improve, these companies are facing increasing compliance costs that will erode their competitiveness and profitability in the long term. However, these companies can optimize their resources and achieve sustainable development at the lowest possible cost if they take a different perspective: By regarding carbon emissions reduction as part of their assets (their carbon assets), they can actively reduce compliance cost or even generate revenue through emissions reduction and use financial instruments to manage their carbon assets and sinks.

Carbon asset management can help iron and steel companies reach their climate targets in several ways. These companies can quantify their total carbon emissions through carbon asset management and begin mitigation actions on that basis. They can also apply it to communicate with upstream and downstream companies in the supply chain for collaborative emissions reduction. In addition, carbon asset management can create synergies with trading and financial mechanisms, raising capital, reducing costs, and mitigating risks. Exhibit 12 summarizes the ways that carbon asset management empowers corporate emissions reduction activities.

Exhibit 12 **Purposes of Carbon Asset Management**



RMI Graphic. Source: RMI

Scenario 1: Supply chain carbon management

Collaborative emissions reduction in the supply chain can incur high communication and coordination costs due to differences in how upstream and downstream companies set climate targets and take climate actions. To address this problem, iron and steel companies can assist upstream and downstream peers in building capacity and promoting the use of a common carbon asset management system. The system should be able to unify the climate targets of all companies into a single indicator of carbon emissions and assess the effectiveness of climate actions by amount of emissions reduction. With the system in place, iron and steel companies can access information on upstream carbon emissions and set appropriate upstream emissions requirements to reduce their Scope 2 and Scope 3 emissions. The system also allows iron and steel companies to provide first-hand, real-time, trusted information to downstream companies without going through complex reporting.

Scenario 2: Synergies with trading mechanisms

As new market trading mechanisms related to environmental attributes continue to improve, iron and steel companies will increase their transactions in various markets, including the sale and purchase of commodities containing environmental attributes, solely environmental attributes, and carbon emissions reductions. As the transactions increase, it is difficult for companies to understand how much each transaction contributes to their climate targets without sound management tools. Carbon asset management helps them systematize transactions in various markets, counting all types of transactions as outflows and inflows in their carbon accounts to better account for and manage transactions related to environmental rights and interests.

In addition, iron and steel companies can develop carbon financial derivatives based on their carbon assets, such as carbon forwards, carbon swaps, carbon options, and carbon futures. By trading carbon financial derivatives, companies mitigate the risks of participating in carbon market transactions or obtain higher returns. For example, iron and steel companies that require emissions credits can hedge their carbon emissions by purchasing carbon futures to lock the carbon price of a future date. In this way, they can avoid paying a higher price for carbon emissions if the market price increases.

Case 4: Innovative trading mechanism based on carbon asset management

Global certification body DNV has developed the Green Steel Assurance, which allows downstream companies to share the cost of emissions reduction by iron and steel companies. Under this framework, iron and steel companies account for the emissions reduction generated by their measures through carbon asset management; DNV verifies the reduction and grants third-party certification of the reduction; and downstream companies may purchase the certified reduction to reduce their own Scope 3 emissions while sharing the emissions reduction cost of iron and steel companies. DNV has established partnerships with several major European steel manufacturers, including Arcelor Mittal, Thyssenkrupp, and Tata Steel Europe.[29]

Scenario 3: Synergies with financial mechanisms

Iron and steel companies can leverage their existing carbon assets to raise more funds through a wide range of financing instruments. For example, these companies may collateralize their carbon assets for loans to banks or other lenders or perform a “sell-back” of their carbon assets (i.e., sell carbon assets to a lender and then buy them back at an agreed upon price on the maturity date). In this way, they can improve short-term liquidity by collateralizing their carbon assets. To reduce the operating costs of managing carbon assets, iron and steel companies may turn to carbon asset custodianship, where their carbon assets are entrusted to a custodian who handles the registration, certification, trading, and settlement of the assets on their behalf.

Suggestions for Improving Iron and Steel Companies' Climate Actions in China

Reducing carbon emissions in the iron and steel industry is important and urgent both for global low-carbon development and the promotion of carbon-peaking and carbon-neutrality goals in China. This report analyzes the feasible measures and market mechanisms for iron and steel companies to reduce carbon emissions by considering the existing guidelines on setting climate targets for the iron and steel industry and companies, as well as current corporate targets and practical actions. To accelerate the implementation of carbon-reduction initiatives, this report offers **five** suggestions:

1 **At the industry level, carbon reduction targets and roadmaps in line with China specific features can help set the scene for companies.** A carbon budget model meeting China's dual carbon goals can be developed to formulate an industry-specific carbon budget, taking into account the national development plan for high-emission industries and the feasibility of emissions-reduction technologies. Developing emissions reduction pathways for various industries allows for the determination of emissions capacity and reduction targets specific to the iron and steel sector, thereby providing a baseline for setting goals within enterprises. Target setting should also take into account the differences between short and long processes. Explore specific issues such as whether different carbon targets should be set for short and long processes to avoid targets that are unachievable.

2 **At company level, iron and steel companies are suggested to improve clarity and comprehensiveness of carbon targets, for example, setting feasible interim targets to monitor carbon reduction progress, specifying the boundary and scope of emissions, including actions plans behind commitments, etc.** Ideally, interim targets contain a base year, base-year emissions performance, a target year, and target-year emissions performance, so that they are transparent, traceable, and comparable. These targets help companies break down their ultimate carbon targets into more specific milestones to ensure they achieve carbon neutrality by stages. They also help assess the effectiveness of carbon-reduction measures so companies make timely adjustments and minimize total emissions.

   Carbon targets should be supported by a roadmap of initiatives for emissions reduction. The technologies and pathways that reduce emissions in the iron and steel industry have been identified and reached consensus at the global level. Companies should create roadmaps of emissions-reduction technologies based on their own operating conditions while clarifying feasible pathways for their carbon targets.

3 **Iron and steel companies are encouraged to leverage their key position along the value chain, and closely collaborate with their upstream and downstream players to accelerate the establishment of a comprehensive carbon emissions management mechanism.** The supply chain of the iron and steel industry consists of emitters from multiple industries. Understanding the emissions of each player is essential for the iron and steel industry and its supply chain to further reduce emissions. By accelerating the establishment of a carbon- management mechanism, information on emissions upstream and downstream can be structured to assess and optimize the carbon footprint throughout the chain more accurately. This would provide data to meet the requirements for green finance,

transition finance, and sustainable investment, so that iron and steel companies are more likely to obtain the capital to invest in low-carbon technology innovation and sustainable production.

4 **Iron and steel companies are also encouraged to actively participate in existing market mechanisms to ease financial pressure and even fully capture market opportunities.** Iron and steel companies are already under financial pressure, which will only increase in their low-carbon transition. With the support from market mechanisms, they not only gain incentive for transition, but effectively reduce the pressure on management and finances during the transition. Take the carbon trading mechanism as an example.
Iron and steel companies will inevitably be included in the carbon trading market, so they should closely follow the corresponding policy developments and plan for emissions-reduction initiatives, emissions data, and emissions verification. Once included in the carbon trading market, iron and steel companies that have prepared can seize the opportunity to reduce emissions costs through effective trading strategies, and even make financial gains by trading additional credits to subsidize other climate actions.

5 **Iron and steel companies need to leverage their advantages such high strategic position in China's economy and large asset base to actively engage in mechanism innovations to support their efficient transition.** Several market mechanisms are in place to support iron and steel companies, but in the short term they have limited impact due to varying degrees of development. Take green power trading as an example. Green power is trading at a premium, which makes it generally more expensive than thermal power, and thus not affordable for iron and steel companies with high energy consumption and low margins. Given their industrial advantages, such as strategic importance, large-scale investment, and strong credit, iron and steel companies are positioned to develop innovative financial products on top of carbon assets that support corporate emissions reductions. This will not only ease the transition for iron and steel companies, but also contribute to the low-carbon development of other industries in the supply chain.

Endnotes

1 IPCC, *Climate Change 2021: The Physical Science Basis*, **https://www.ipcc.ch/report/ar6/wg1/**

2 Net Zero Tracker (accessed in September 2023), **https://zerotracker.net/**

3 Global Carbon Project, **https://globalcarbonbudget.org/about/**

4 Global Carbon Project, "About us," **https://globalcarbonbudget.org/about/**

5 IPCC, Climate Change 2021: The Physical Science Basis, **https://www.ipcc.ch/report/ar6/wg1/**

6 University of Technology Sydney (UTS), Sectorial Pathways for Industries-One Earth Climate Model, November 2021, **https://www.uts.edu.au/sites/default/files/2021-11/OECM%20Executive%20Summary_0.pdf**

7 IEA, *Net Zero by 2050*, 2021, **https://www.energy.gov/sites/default/files/2021-12/IEA%2C%20Net%20Zero%20by%202050.pdf**

8 Mission Possible Partnership (MPP), *Making Net-Zero Steel Possible*, 2022, **https://missionpossiblepartnership.org/wp-content/uploads/2022/09/Making-Net-Zero-Steel-possible.pdf**

9 MIIT [2022] No.6, Guiding Opinions on Promoting the High-Quality Development of the Steel Industry, **https://www.gov.cn/zhengce/zhengceku/2022-02/08/content_5672513.htm**

10 MIIT [2022] No.88, Carbon Peaking Action Plan for Industrial Sectors by 2030, **https://www.gov.cn/zhengce/zhengceku/2022-08/01/content_5703910.htm**

11 China Iron and Steel Association, Carbon Neutrality Vision and Low Carbon Technology Roadmap for Iron and Steel Industry, 2022.

12 SBTi, Steel Science-Based Target-Setting Guidance, July 2023, **https://sciencebasedtargets.org/resources/files/SBTi-Steel-Guidance.pdf**

13 Global Steel Climate Council (GSCC), The Steel Climate Standard, August 2023, **http://globalsteelclimatecouncil.org/wp-content/uploads/2023/08/GSCC-Standard-August2023.pdf**

14 World Steel Association, "Top Steel-Producing Companies 2022/2021," **https://worldsteel.org/steel-topics/statistics/top-producers/**.

15 RMI, *Pursuing Zero-Carbon Steel in China*, 2021, **https://rmi.org/wp-content/uploads/dlm_uploads/2021/09/Pursuing_Zero_Carbon_Steel_in_China.pdf**.

16 China Iron and Steel Industry Association, Report on the Economic Operation of the Iron and Steel Industry in 2022, 2022, **http://lwzb.stats.gov.cn/pub/lwzb/bztt/202306/W020230605413586261007.pdf**.

17 World Steel Association, *Climate Change and the Production of Iron and Steel*, 2021, **https://worldsteel.org/publications/policy-papers/climate-change-policy-paper/**.

18 *Lianhe Ratings, Summary and Outlook on Credit Risks for Iron and Steel Industry 2022*, 2022, **https://pdf.dfcfw.com/pdf/H3_AP202212161581134926_1.pdf?1671183494000.pdf**.

19 "Steel Dynamics Signs PPA With NextEra Energy," *Renewable Energy Magazine*, 2023, **https://www.renewableenergymagazine.com/wind/steel-dynamics-signs-ppa-with-nextera-energy-20230808**.

20 Bodenxt, "One of the World's Largest Hydrogen Plants Is Planned Here," 2023, **https://bodenxt.se/en/one-of-the-worlds-largest-hydrogen-plants-is-planned-here/**.

21 Statkraft, "H2 Green Steel Partners with Statkraft for 14 TWh of Renewable Electricity," 2022, **https://www.statkraft.com/newsroom/news-and-stories/2022/statkraft-signs-ppa-with-h2-green-steel/**.

22 Fortum, "Fortum and H2 Green Steel Have Entered into a Long-term Frame Agreement for Electricity Supply," 2023, **https://www.fortum.com/media/2023/03/fortum-and-h2-green-steel-have-entered-long-term-frame-agreement-electricity-supply**.

23 General Office of the Ministry of Ecology and Environment, "Notice on the Reporting and Verification of Greenhouse Gas Emissions by Enterprises in Selected Key Industries for 2023–2025," 2023, **https://www.mee.gov.cn/xxgk2018/xxgk/xxgk06/202310/t20231018_1043427.html**.

24 PBOC, *Green Bond Endorsed Projects Catalogue (2021 Edition)*, 2021, **http://www.pbc.gov.cn/goutongjiaoliu/113456/113469/4342400/2021091617180089879.pdf**
25 IFS&Paulson Institute, *Fintech for Green Finance in China: Cases and Prospects (2023)*, 2023, **https://paulsoninstitute.org.cn/wp-content/uploads/2023/10/2023-Fintech-Report_Full-Report_Final.pdf**
26 Ping An Securities, *2022 Annual Green Finance Development Report*, 2022, **https://pdf.dfcfw.com/pdf/H3_AP202212301581512408_1.pdf?1672392836000.pdf**
27 Zheshang Securities, *Green Finance in the Context of "Double Carbon --The Role and Responsibility of Commercial Banks*, 2022, **https://pdf.dfcfw.com/pdf/H3_AP202202141546915576_1.pdf**
28 Ma Rui Rui, "Green Bonds Financing and Green Transformation of Iron and Steel Enterprises," Dalian University of Technology, 2022, **https://doi.org/10.26991/d.cnki.gdllu.2021.003691.**
29 DNV, "Green Steel Assurance," **https://www.dnv.com/services/green-steel-assurance-232895**.

RMI, *Accelerating Industrial Decarbonization in China: Key Climate Actions for Iron and Steel Companies*, 2024, **https://rmi.org/insight/accelerating-industrial-decarbonization-in-china-key-climate-actions-for-iron-and-steel-companies/**.

RMI Innovation Center
22830 Two Rivers Road
Basalt, CO 81621

www.rmi.org