Global Energy Monitor

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In China, a small boost to low-emissions steelmaking can mean big cuts to its carbon footprint

Introduction

China finds itself poised in an opportunity to achieve significant climate gains through changes to its iron and steel industry. The country's industry is currently dominated by the emissions-intensive, coal-based blast furnace-basic oxygen furnace (BF-BOF) steelmaking route, with only smaller amounts of steel produced through the lower-emissions electric arc furnace (EAF) route.

In China, the emissions intensity of BF-BOF steel is approximately 2.1 tonnes CO_2 per tonne steel, while the emissions intensity of EAF steel is approximately 1.3 tonnes CO_2 per tonne steel. In 2022, BF-BOF production in China was responsible for almost 94% of the industry's emissions (Table 2). Shifting the industry toward EAF production is critical for emissions reductions.

In 2020, China's Ministry of Industry and Information Technology (MIIT) released the draft version of a report which set a target to achieve at least 15% crude steel production by EAF by 2025 in order to reduce the industry's emissions.

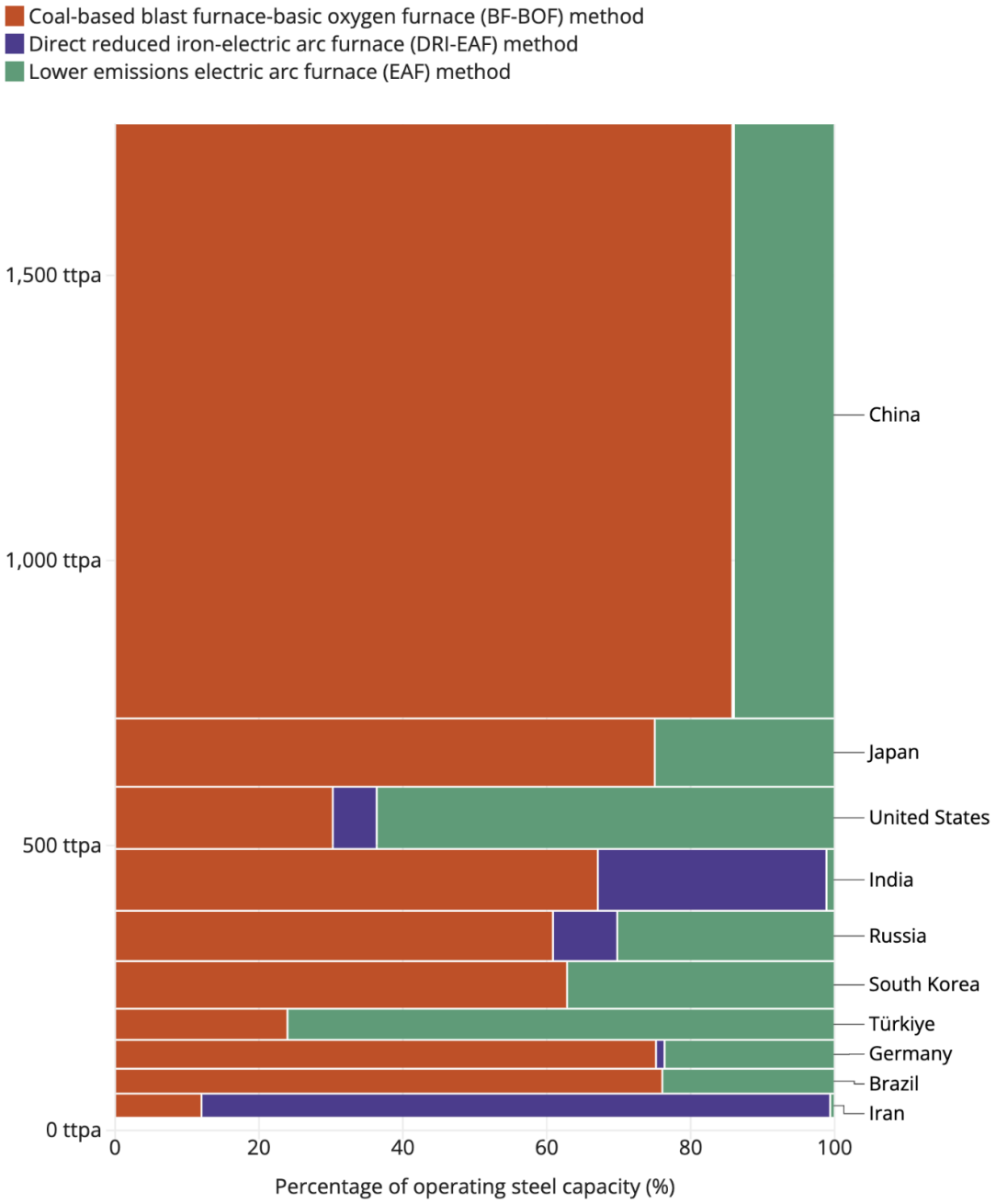
This plan initially included a more ambitious goal of reaching 20% EAF production by 2025, which would further reduce emissions. However, in the final, updated 2022 version of the report, MIIT backtracked and removed mention of the 20% EAF production goal.

The change in target represents a large missed opportunity, given China's current capacity numbers. As of January 2024, China's 1,064 mtpa of steelmaking capacity is 86% BF-BOF and 14% EAF (Table 1). This means that the 15% production target is already clearly within reach, if China can increase the capacity utilization rate of its EAFs and lower that of its BF-BOFs.

China leads global steel production capacity, with the majority from emissions-intensive, coal-based method

Proportion of operating steel capacity by technology type in top ten steel producers

How to read this chart: → % of operating steel capacity by technology type
↓ height of bars = total operating steel capacity in thousand tonnes per year (ttpa)



Source: Global Steel Plant Tracker, Global Energy Monitor

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Outlook on production and emissions in China

China's crude steel demand is projected at 910 mtpa in 2025, and the country will produce approximately 950 mtpa in 2025. With 1,064 mtpa operating capacity installed currently, the country already has enough steelmaking capacity to meet its demand. Achieving 15% EAF production in 2025 would mean producing 143 mtpa with EAF technology. The country already has 151 mtpa of EAF capacity operating as of January 2024, enough capacity to meet the goal of 15% EAF production by 2025 if EAF capacity utilization rates are raised (Table 3).

In the past, the main factors contributing to China's low EAF capacity utilization rates have been limited scrap and electricity supplies. However, China's scrap supply is projected to grow rapidly in the next decade and China has invested significantly to expand its grid, bringing relief to these pinch points. In fact, these shifts have made EAF production economically competitive with BF-BOF since 2018, in addition to being environmentally favorable.

While achieving the 15% goal will reduce the industry's emissions by 8.7% (179 mtpa CO_2) from 2022 to 2025, China will still be the top BF-BOF producer globally with 913 mtpa of BF-BOF capacity operating and another 97 mtpa under development, according to January 2024 projections. China could strive for more, as BF-BOF production is not consistent with the country's climate targets, nor with recent calls for greener industry from President Xi Jinping.

Table 1: China's steel capacity by technology type

Operating steel capacity (TTPA)	BF-BOF	EAF	Total	Share of BF-BOF	Share of EAF
China	912,966	151,256	1,064,222	86%	14%
Global	1,425,145	645,785	2,070,930	69%	31%

Source: Global Steel Plant Tracker

Table 2: China's steel emissions

China's 2022 emissions from iron and steel	BF-BOF	EAF	Total
Emissions intensity (tonne CO_2/tonne steel)	2.1	1.3	
2022 production (TTPA)	921,290	96,710	1,018,000
Share of 2022 production	90.5%	9.5%	100.0%
2022 emissions (thousand tonnes CO_2)	1,934,709	125,723	2,060,432
Share of industry emissions	93.9%	6.1%	100.0%

Sources: Global Efficiency Intelligence and Berkeley Lab, World Steel Association

Table 3: China's current goals for EAF production

China's 2025 emissions from iron and steel under current 15% goal	BF-BOF	EAF	Total
Emissions intensity (tonne CO_2/tonne steel)	2.1	1.3	
2025 production (TTPA)	807,500	142,500	950,000
Share of 2025 production	85%	15%	100.0%

2025 emissions (thousand tonnes CO_2)	1,695,750	185,250	1,881,000
Share of industry emissions	90.2%	9.8%	100.0%

Sources: Global Efficiency Intelligence and Berkeley Lab, World Steel Association

China's shifting targets for EAF and steel emissions

In 2022, China's EAF production was 9.5% of its total crude steel production, only a small shift from 2020, when EAF accounted for 9.2% of total production, and well below the country's goals of reaching 15% or 20% EAF production within three years.

In March 2021, the China Steel Association (CSA) announced a plan to achieve peak emissions in the steel industry by 2025 and reduce carbon emissions by 30% from peak in 2030, but CSA softened this goal in 2022, shifting the target for peak emissions from 2025 to 2030. China's shifting targets for EAF production and steel emissions show a pattern of limited ambition. Shifting course would be a great first step to put weight behind President Xi Jinping's latest call to develop green and low-carbon industries.

How China can achieve its initial EAF goals

If China were to achieve the goal of 20% EAF production by 2025, the country would need to produce 190 mtpa using EAF technology, meaning that at least another 39 mtpa of EAF capacity would need to be added to the industry by 2025 (or more than this amount, to accommodate lower capacity utilization rates). China currently has 48 mtpa EAF capacity under development, but 21 mtpa set to close, meaning that the industry is set to add approximately 27 mtpa under current development and closure plans (Table 4).

Based on current projections, China will install enough EAF capacity to make it possible to exceed its goal of 15% EAF production by 2025. If China made modest adjustments to its current capacity development and closure plans to add more EAF capacity and less BF-BOF capacity, or retire more BF-BOF capacity and less EAF capacity, the country could install enough EAF capacity to make its initial ambition of reaching 20% EAF production by 2025 possible, provided utilization rates are raised.

Reaching 20% EAF production by 2025 would reduce the industry's emissions by another 38 mtpa CO_2, lowering the industry's emissions by a total of 217 mtpa CO_2, nearly 11% of 2022 levels by 2025. China would still have one of the lowest rates of EAF production globally (Table 1), but would be much closer to a net zero aligned iron and steel industry, which will require approximately 85% EAF production by 2050.

Of course, installing enough capacity to reach 15 or 20% EAF production only achieves these emissions reductions if China operates its EAFs at high capacity utilization rates like those of its BF-BOFs.

Table 4: China's steel development and closure plans

Status	Operating		In-development		Pre-retirement	
Technology	BF-BOF	EAF	BF-BOF	EAF	BF-BOF	EAF
Capacity (ttpa)	912,966	151,256	96,969	48,376	84,841	20,880
% total	86%	14%	67%	33%	80%	20%

Source: Global Steel Plant Tracker

Table 5: Examples of Chinese steel plants transitioning from BF-BOF to EAF steelmaking with approximately equal capacities

Steel plant name	Transition announced	Status	Old units	New units
Tangshan Xinglong Iron and Steel Co Ltd	Feb 14, 2022	Construction	2x50 tonne BOFs	1x110 tonne EAF
Shaanxi Longmen Steel Co Ltd	Jan 26, 2022	Announced	1x94 tonne BOF; 1x1280 m3 BF	1x135 tonne EAF
Tianjin Rockcheck Steel Group Co Ltd	Nov 18, 2021	Announced	1x120 BOF	1x70 tonne & 1x100 tonne EAFs
Shijiazhuang Iron and Steel Co Ltd (Special Steel Branch)	Oct 31, 2018	Operating (October 2020)	2x60 tonne BOFs; 1x60 tonne EAF; 1x480 m3 & 1x580 m3 & 1x1800 m3 BFs	2x130 tonne EAFs
Yunnan Tiangao Nickel Alloy Co Ltd	Dec 1, 2017	Announced	1x110 tonne BOF	1x70 tonne & 1x75 tonne EAFs

Source: Global Steel Plant Tracker

Obstacles and opportunities for China's growing EAF production share

China faces several potential challenges to growing EAF capacity and raising the capacity utilization rates of its EAFs: the availability of scrap supply, the development of hydrogen-based direct reduced iron (DRI) capacity, and the layout of power resources. However, China has the opportunity to overcome these obstacles with strategic planning.

Steel scrap availability

While steel scrap availability has been frequently cited as a potential limitation for China to grow EAF capacity and share of production, China currently has more scrap steel (260 million tonnes in 2022) available than the iron and steel industry is using. The country has also set goals to bolster scrap resources through improved technologies and equipment in the scrap steel processing industry,

and China's scrap steel resources are projected to increase to 320 million tonnes by 2025, 390 million tonnes by 2030, and 500 million tonnes by 2050. Additionally, most of China's scrap steel supply (68%) is currently used in the BF-BOF steelmaking process to charge BOF units for steelmaking, which means that moving from BF-BOF to EAF steelmaking will make more scrap available to EAF steel producers.

On the other hand, the majority of scrap steel is concentrated in specific regions within China (the Northeast, North China, East China, Central South, and Southwest), which raises questions about whether the distribution of scrap will align with the current layout of steel production capacity.

Because of issues in scrap distribution and pricing, China has developed a unique steel industry that uses a large share of pig iron produced from BFs and/or coal-based DRI instead of scrap steel to feed EAFs, leading to the second-most emissions intensive EAF production in the world. While raising the share of steel produced via EAF is an important step toward lowering the Chinese steel industry's emissions, shifting the feedstock of EAF production to scrap or hydrogen-based DRI is critical to maximize the benefit of this transition.

China's plans for hydrogen-based DRI and energy supply issues

China has seen modest growth in hydrogen-based DRI projects in recent years, with Chinese steel giants including Baowu and HBIS developing new projects. In most parts of the world, hydrogen availability has limited the development of clean DRI plants. However, China has built out such a large share of green hydrogen (hydrogen produced through an electrolyzer operating on renewable power), that Chinese hydrogen facilities are operating at less than 10% capacity on average, even though China is currently the world's largest consumer and producer of hydrogen. Thus, hydrogen availability is not the main limitation for Chinese hydrogen-DRI production.

Instead, China's hydrogen-based DRI industry is challenged by inadequate energy resources. In recent years, the country has faced insufficient power supply and abrupt power cuts (a phenomenon referred to as the "power shortage"), creating unstable energy supplies for industrial users like hydrogen-based DRI and EAF production. In comparison, many BF-BOF plants have captive coal-based power resources directly supplying them, which avoids the uncertainty of power shortages, but also means a higher emissions rate from dirty power sources. In response to recent major outages, China has increased grid flexibility and built storage capacity, making the likelihood of future outages lower and the outlook for an increasingly electrified industry brighter. However, these solutions have mainly relied on increased coal power, which is not consistent with net zero goals.

There is good news though, as China has become a top developer of off-shore wind energy, and most of China's current BF-BOF capacity is located in coastal areas. Relatively easy access to this clean energy source could make the switch from BF-BOF to EAF smoother. With strategic planning and coordination between the power sector and the iron and steel industry, China can increase hydrogen-based DRI and EAF production using renewable energy for near-zero steel production.

About the Global Steel Plant Tracker

The Global Steel Plant Tracker (GSPT) provides information on global crude iron and steel production plants, and includes every plant currently operating with a capacity of five hundred thousand tonnes per year (ttpa) or more of crude iron or steel. The GSPT also includes all plants meeting the five hundred ttpa threshold that have been proposed or under construction since 2017 or retired or mothballed since 2020. Steel plants consist of multiple units, depending on the iron and steel production method used. Iron and steel are typically produced through coal-based methods (blast furnace and basic oxygen furnace or open hearth furnace) or electricity-based production (electric arc furnace charged with scrap metal, pig iron, direct reduced iron, or a combination). Each plant included in the tracker is linked to a wiki page on GEM.wiki, which provides additional details.

Background on Global Energy Monitor

Global Energy Monitor (GEM) develops and shares information on energy projects in support of the worldwide movement for clean energy. By studying the evolving international energy landscape, and creating databases, reports, and interactive tools that enhance understanding, GEM seeks to build an open guide to the world's energy system.

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