

Pedal to the Metal

**BUILDING MOMENTUM FOR
IRON AND STEEL DECARBONIZATION**





GLOBAL ENERGY MONITOR

Global Energy Monitor (GEM) develops and shares information 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. Follow us at www.globalenergymonitor.org and on Twitter [@GlobalEnergyMon](https://twitter.com/GlobalEnergyMon).

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 at a capacity of 0.5 million tonnes per year (mtpa) or more of crude iron or steel. The GSPT also includes all plants meeting the 0.5 mtpa threshold that have been proposed or are under construction since 2017 or retired or mothballed since 2020.

ABOUT THE GLOBAL BLAST FURNACE TRACKER

The Global Blast Furnace Tracker (GBFT) is a worldwide dataset of blast furnace units. It tracks each of the furnaces at iron and steel plants in GEM's Global Steel Plant Tracker (GSPT) and includes unit-level capacities, key dates, and statuses for each furnace. Relining data, including dates and costs, is also tracked for each furnace where available.

AUTHORS

Marie Armbruster, Astrid Grigsby-Schulte, and Caitlin Swalec.

EDITING AND PRODUCTION

Design and page layout by David Van Ness. Figures led by Nassos Stylianou. Editing contributions provided by Stefani Cox and David Hoffman. Copy edits by Amanda DeBord.

ABOUT THE COVER

Rail workers cutting and laying new tracks at night. Photo by Peter Devlin / Alamy Stock Photo (2017). Obtained via Climate Outreach's Climate Visuals project.

PERMISSIONS/COPYRIGHT

Copyright © Global Energy Monitor. Distributed under a Creative Commons Attribution 4.0 International License.

FURTHER RESOURCES

For additional data on proposed and existing steel plants see the [GSPT Summary Data](#) and for data on blast furnaces see the [GBFT Summary Data](#). For links to more reports based on this data, see [Reports & Briefings](#).

See the [GSPT Download Data](#) page to obtain primary data from the Global Steel Plant Tracker.

See the [GBFT Download Data](#) page to obtain primary data from the Global Blast Furnace Tracker.

ACKNOWLEDGEMENTS

Researchers: Henna Khadeeja, Ziwei Zhang, Jessie Zhi, Gregor Clark, Norah Elmagraby, Hanna Fralikhina, Natalia Fretz, Zhanaïym Kozybay.

Reviewers: John Cooney (Industrious Labs), Caroline Ashley (SteelWatch), Romain Su (SteelWatch), Katinka Waagsaether (SteelWatch), Cynthia Rocamora (Reclaim Finance), Valentin Vogl (ARIA), Martin Kueppers (International Energy Agency).

MEDIA CONTACT

Caitlin Swalec

Program Director for Heavy Industry, Global Energy Monitor
caitlin.swalec@globalenergymonitor.org

Pedal to the Metal 2024

BUILDING MOMENTUM FOR IRON AND STEEL DECARBONIZATION

EXECUTIVE SUMMARY

Achieving net zero in the iron and steel industry by 2050 requires a comprehensive and urgent shift away from coal-based technologies toward low emissions production. Global Energy Monitor's 2024 Global Steel Plant Tracker and Global Blast Furnace Tracker data indicate that, while there has been a notable move toward the lower-emissions direct reduced iron (DRI) and electric arc furnace (EAF) production, blast furnace (BF) development is ongoing and presents a distinct risk for the climate and as stranded assets for top developers. On the country level, China maintains its enormous share of global operating capacity, but India has forged ahead as the largest developer of all upcoming iron and steel plants, particularly coal-based blast furnace-basic oxygen furnace (BF-BOF) capacity. With these trends in mind, the industry must continue its push toward greener steel, and transition plans must translate into concrete actions.

- **Nearly half of steelmaking capacity under development is EAF, putting the International Energy Agency's (IEA) net zero aligned goal of 37% EAF by 2030 within reach:** This year, 49% of capacity under development in the GSPT is set to use the EAF production route, up from 43% in 2023 and 33% in 2022. Further, of steelmaking capacity under development announced since 2023, 93% of capacity with a known production route is EAF, indicating a strong boost in electric arc furnace steelmaking in the years to come. Considering all planned capacity and retirements, the global steel fleet is set to reach over 36% EAF in 2030. This is still not sufficient to meet the IEA NZ climate target, but with heightened momentum the goal is increasingly attainable.
- **While EAF steelmaking is being announced at record rates, less than 14% of this potential capacity has moved to the "construction" phase:** Of all projects that have actually begun construction, nearly 46% are still BOF-based. The transition toward electric arc furnace

steelmaking is underway, but pressure must be maintained all the way through to project completion if real progress is to be seen.

- **India has replaced China as the top steel developer with 258 mtpa of steelmaking capacity in the pipeline, 177 mtpa of which is BOF-based:** Last year, India became the largest developer of BOF-based steel but remained second to China in overall developments. This year, India has not only maintained its leading position in BOF-based steel development but has also surpassed China to become the top overall steel developer.
- **Over one-third of ironmaking under development is DRI-based, but DRI must be operated with a green hydrogen reducing agent to meet net zero goals:** DRI made with green hydrogen is a critical piece of the transition as secondary, scrap-based steelmaking via EAF alone is not enough to meet global needs for steel. DRI makes up 36% of developing global ironmaking capacity with a known production route, compared to only 9% of global operating ironmaking capacity, a notable shift away from coal-based blast furnaces in new capacity.
- **Carbon lock-in concern continues, with 308 mtpa of new coal-based blast furnace ironmaking capacity under development globally:** While DRI development is on the rise, the majority of operating and developing ironmaking is still blast furnace-based. As carbon-capture and storage fails to perform in the iron and steel industry, new coal-based BF development is increasingly out of alignment with a net zero future. Sixteen countries have new blast furnace capacity under development.

ACRONYMS

BF	blast furnace
BOF	basic oxygen furnace
DRI	direct reduced iron
EAF	electric arc furnace
GEM	Global Energy Monitor
GBFT	Global Blast Furnace Tracker
GSPT	Global Steel Plant Tracker
IF	induction furnace
Mt	million metric tonnes
MTPA	million tonnes per annum
OHF	open hearth furnace
TTPA	thousand tonnes per annum

INTRODUCTION

In 2023, the global iron and steel industry saw progress toward net zero goals, with more electric arc furnace steelmaking coming online and entering the development pipeline than ever before. However, new emissions-intensive, coal-based blast furnace construction threatens to further entrench the industry in fossil fuels. We are at a critical juncture: With a net zero future within reach, the industry must capitalize on growing momentum. Decarbonization plans need increased ambition and must progress to actions, and no further investments should be made in coal-based technologies if a sustainable steelmaking industry is to be realized.

The iron and steel industry is a critical pillar of the world economy and will continue to play an important role in the energy transition. Steel production has been estimated to add a value of 2.9 trillion USD, or 3.8% of GDP to the global economy, according to the World Steel Association. Particularly because steel is one of the fundamental materials for building out clean energy transition infrastructure, production is expected to continue rising in the coming years. At

the same time, the iron and steel industry is responsible for over 3.6 Gt¹ of CO₂ emissions annually. This is approximately 7% of greenhouse gas emissions and 11% of carbon dioxide emissions globally — more than total emissions from all cars and vans in the world. The iron and steel sector therefore presents enormous potential for decarbonization and must shift to low-emissions production methods if the world is to build a net zero future.

For the past four years, Global Energy Monitor (GEM) has published an annual report on the global iron and steel sector with the aim of offering a comprehensive overview of both current and emerging technologies and capacities. This year's report adds to that analysis with data from the April 2024 updates of the Global Steel Plant Tracker (GSPT) and Global Blast Furnace Tracker (GBFT). This year GEM has added analysis of the global blast furnace fleet, illuminating key trends in the net zero transition and highlighting this emissions-intensive aspect of the steelmaking process in more detail.

IRON AND STEEL PRODUCTION PATHWAYS

The first publication of Pedal to the Metal 2021 includes a detailed overview of the main iron and steelmaking processes. Briefly, steelmaking from raw materials, or primary steel production, begins with the reduction of iron ore to yield crude metallic iron, which is further processed into steel. Steelmaking from recycled materials, or secondary steel production, remelts scrap steel into new steel products, typically in an electric arc furnace. Some amount of scrap is generally incorporated into primary steelmaking processes as well. In primary steel production, ironmaking is most commonly completed in a blast furnace (BF) using metallurgical coal, or in a direct reduced iron (DRI) furnace using gas, syngas, coal, or hydrogen. Steelmaking is most commonly completed in a basic oxygen furnace (BOF) or electric arc furnace (EAF).

While these units are typically found in BF-BOF and DRI-EAF configurations, other combinations such as DRI-BOF (with an intermediate smelting furnace) and BF-EAF can be used for primary production. The vast majority (92%) of plants with BOF steelmaking capacity in the GSPT use blast furnace technology, meaning that BOF capacity is often used as a metric of coal-based steelmaking.

Additional ironmaking technologies (Corex, HIsarna, Tecored, electrowinning, and others) and steelmaking technologies (open hearth furnace, induction furnace, and others) exist in various levels of commercial use and readiness. Please see Appendix A for an overview of the main production processes.

1. This 2019 3.6 Gt figure includes 2.6 Gt of direct CO₂ emissions per year and nearly 1.1 Gt of indirect CO₂ emissions from the power sector and combustion of steel off-gasses. Production has risen since 2019, possibly raising the overall emissions of the industry in recent years.

SECTOR EMISSIONS

In primary steelmaking, the coal-based BF-BOF route has high emissions intensities, while DRI-EAF is capable of achieving low to near zero emissions steel. However, the DRI-EAF process encompasses a range of emissions intensities, depending on how the units are operated (i.e., the source of electricity and reductant).²

Coal is the primary driver of emissions in the steel industry — used both in power generation (thermal coal) and as a reducing agent in producing metallic iron from iron ore (metallurgical coal). Past publications of this report have highlighted the significant unaccounted upstream emissions of the sector created by methane leaks in coal mining.

While power generation for iron and steel units can be decarbonized as clean energy and industrial heating develop, blast furnaces cannot be operated without metallurgical coal, even when partially replaced with hydrogen injection, as coal plays a critical physical and chemical role in the blast furnace that can never be fully substituted by gas reducing agents. The most commercially viable option for near zero emissions primary steelmaking is currently reduction of iron ore in a DRI furnace using 100% green hydrogen as the reducing agent, followed by steelmaking in an electric arc furnace, with power for the entire process sourced through renewable energy. Coal-based DRI units typically achieve an emissions intensity of 1.4 to 2.0 tonnes CO₂/tonne steel produced, while green

hydrogen-based DRI units can achieve near zero emissions iron production.

The direct emissions of specific production technologies can also vary significantly depending on the inputs. An EAF that uses close to 100% scrap will generally produce fewer emissions than one that incorporates feedstocks produced from raw iron, like DRI or pig iron. For instance, many EAFs in China use hot metal from blast furnaces as a primary input, which makes the emissions intensity of EAFs in China significantly higher than the global average. Likewise, BOF production can achieve steel production with lower emissions intensities by trading the conventional blast furnace pig iron input for other inputs such as green hydrogen-based DRI that has been processed through a smelting furnace.

Secondary steelmaking routes almost always achieve lower emissions intensities than primary steelmaking routes, but steel recycling is limited by scrap availability, and the world has a continued need for primary steelmaking to meet growing demand and produce particular grades of steel. In secondary steelmaking (using scrap in an EAF), the electricity sourced to power the furnace has the largest impact on the route's emissions intensity. Thus there is not only a need to shift to lower-emissions production methods, but also to focus on robust renewable energy infrastructure to support net zero production.

GLOBAL STATE OF OPERATING IRON AND STEEL

Global steelmaking capacity

The 2024 Global Steel Plant Tracker (GSPT) tracks 2,207 mtpa of operating steelmaking capacity and an additional 774 mtpa of steelmaking capacity under development³ globally.⁴ The data includes 1,163 individual plants located in 89 different countries.

Of the operating capacity with a known production route,⁵ 1,483 mtpa (68%) uses BOF technology, 701 mtpa (32%) uses EAF, and just over 2 mtpa (<1%) uses OHF, indicating no substantial shift from 2023 GSPT data.

2. See [Appendix B](#) for specific information on the emissions intensities of various production processes.

3. “Under development” includes all capacity with an operating status of “announced” or “construction” in the GSPT and GBFT.

4. See appendices [C](#) and [E](#) for country-by-country breakdowns of operating and developing steelmaking capacity, respectively.

5. <1% of operating steelmaking capacity tracked in the GSPT has unspecified production technology.

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

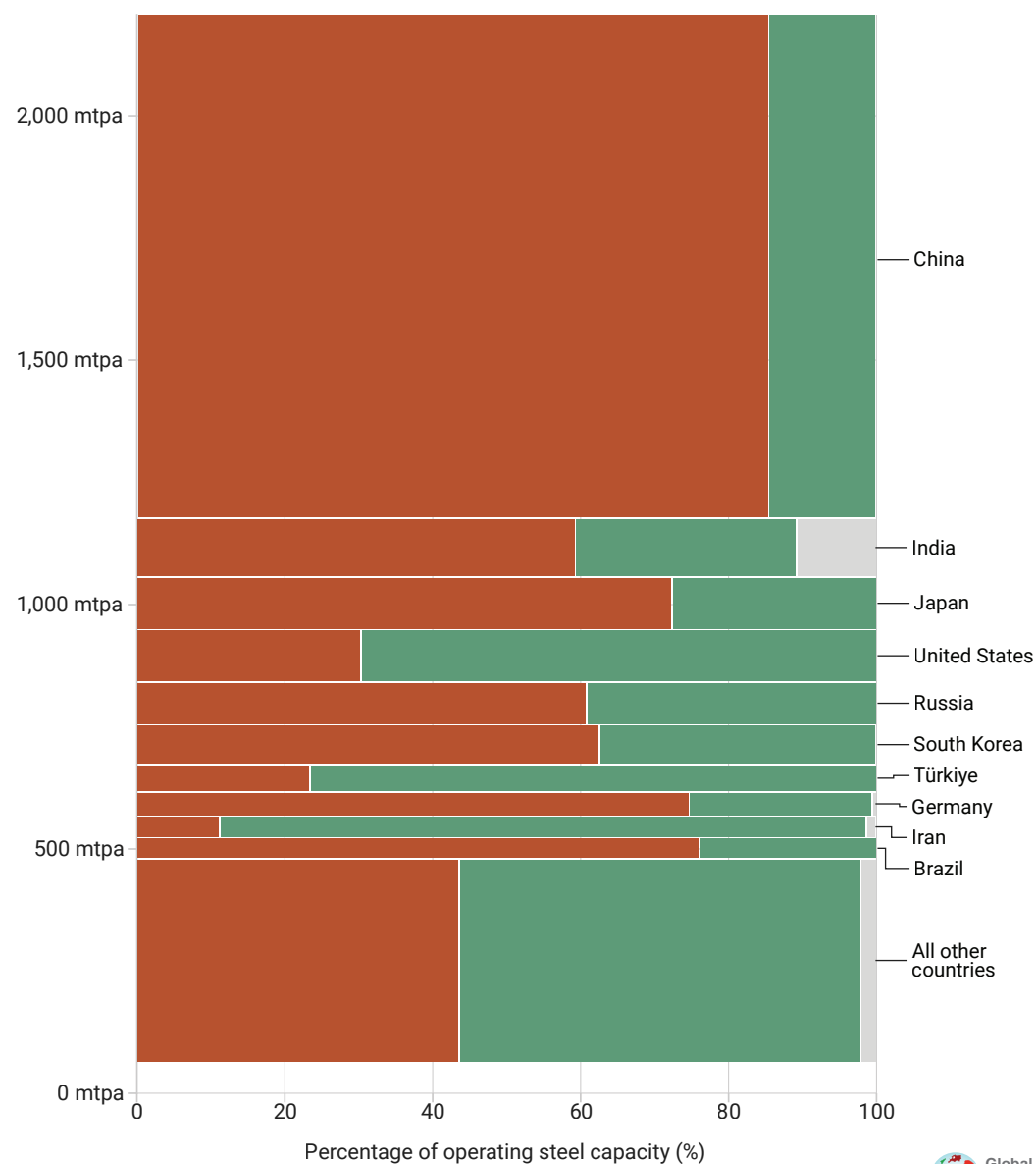
Proportion of operating steel capacity by technology type

How to read this chart:

→ % of operating steel capacity by technology type

↓ height of bars = total operating steel capacity in million tonnes per year (mtpa)

- Higher-emissions basic oxygen furnace (BOF) technology
- Lower-emissions electric arc furnace (EAF) technology
- Other/unspecified technology



Source: Global Steel Plant Tracker, Global Blast Furnace Tracker, Global Energy Monitor



Asia operates over two-thirds (68%) of all steelmaking capacity (1,508 mtpa), the majority of which is in China (1,075 mtpa) and India (123 mtpa), followed by Japan (109 mtpa). The United States also has 109 mtpa in steelmaking capacity.

When looking only at the emissions-intensive, coal-based BOF production route, Asia's share of total operating capacity grows to 80% or 1,181 mtpa, with 918 mtpa located in China. Other top BOF producers are Japan (79 mtpa), India (73 mtpa), Russia (54 mtpa), and South Korea (52 mtpa).

Global ironmaking capacity

In addition to steelmaking capacity, the 2024 GSPT also tracks over 1611 mtpa of operating ironmaking capacity and another 493 mtpa of ironmaking capacity under development.⁶ Out of 1,163 plants in the GSPT, 582 have ironmaking capacity and 81 produce exclusively iron. Of global operating ironmaking capacity

While EAF capacity is more evenly distributed, China still leads with 157 mtpa (22% of global operating capacity), followed by the United States (76 mtpa), Türkiye (43 mtpa), Iran (40 mtpa), and India (37 mtpa).

Nearly 45 mtpa of steelmaking capacity joined the operating fleet in 2023, 26 mtpa (59%) of which is located in China, 5.3 mtpa in India and Türkiye each, 3 mtpa in Indonesia, 2.3 mtpa in Malaysia, 0.8 mtpa in the Philippines, and 0.5 mtpa in the United States. Notably, this incoming operating capacity is more heavily EAF-based than ever before, with nearly 23 mtpa—just over half of 2023 additions—using electric arc furnace steelmaking technology.

with a known production route,⁷ 91% is blast furnace (BF) and 9% is direct reduced iron (DRI).

Asia continues to lead in operating BF capacity, with 61% (885 mtpa) of global operating BF capacity found in China, and India a distant second with 7% (104 mtpa) of global operating blast furnace capacity.

DECARBONIZATION CHALLENGES: BIG AND YOUNG BLAST FURNACES

Since the 2023 release of the GBFT, the average size of operating blast furnaces has increased. The average size of operating blast furnaces in GEM's 2023 data release was 1,590 m³ compared to 1,750 m³ in GEM's 2024 data release. The average size of retired blast furnaces tracked by GEM is 840 m³ while the average size of blast furnaces under development is 1,900 m³, indicating that the industry is trending towards building larger blast furnaces and retiring smaller blast furnaces. The implications of this trend have yet to be seen, but it seems likely that coal-based production will become more geographically concentrated and that the decarbonization movement will face fewer, but larger, targets for technology transitions.

The average age of operating blast furnaces in the GBFT with known start years is 23 years,⁸ with many older furnaces having experienced extensive maintenance and relining throughout their lifetimes. Of the top ten countries with the most operating BF capacity, the United States has the oldest operating fleet with an average age of 73 years, and China has the youngest operating fleet with an average age of twelve years. The average campaign life for all blast furnaces tracked by GEM⁹ is fourteen years when considering relines of all types and 20 years when considering only relining events known to be full relines. Aging blast furnaces and those reaching the end of a campaign present crucial opportunities for phasing out coal-based ironmaking technology.

6. See appendices [D](#) and [F](#) for country-by-country breakdowns of operating and developing ironmaking capacity, respectively.

7. <1% of operating ironmaking capacity tracked in the GSPT has unspecified production technology.

8. GEM tracks the original construction of the furnace as the starting year of operation.

9. Includes furnaces with a known age that have experienced at least one reline.

China has most global iron production capacity, with almost all from emissions-intensive, coal-based technologies

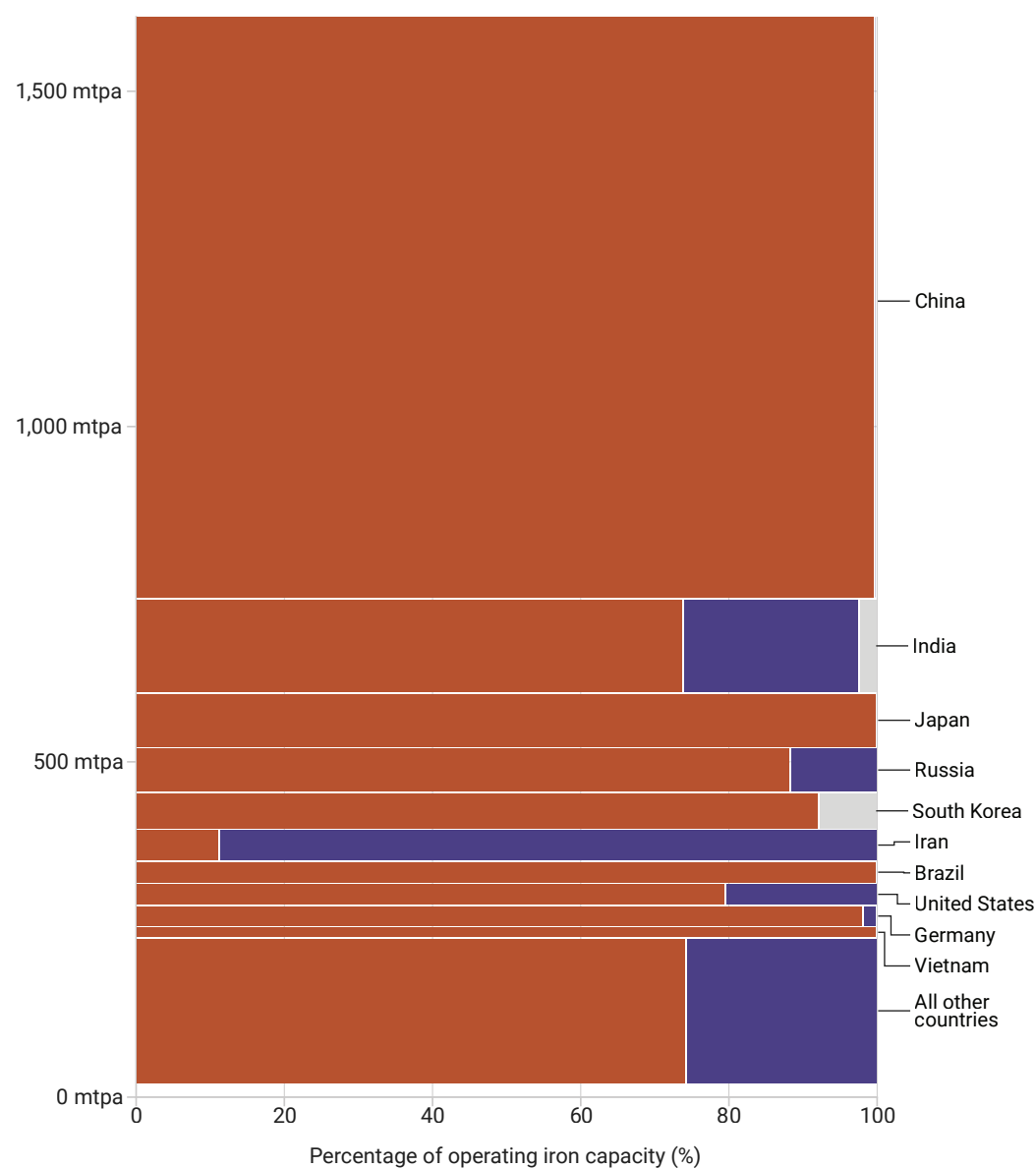
Proportion of operating iron capacity by technology type

How to read this chart:

→ % of operating iron capacity by technology type

↓ height of bars = total operating iron capacity in million tonnes per year (mtpa)

- Coal-based blast furnace (BF) technology
- Direct reduced iron (DRI) technology
- Other/unspecified technology



Source: Global Steel Plant Tracker, Global Blast Furnace Tracker, Global Energy Monitor



Since the 2023 release of the GSPT, global operating DRI capacity has increased by 5 mtpa, indicating potential progress in the green steel transition. Iran operates 28% (42 mtpa) of global DRI capacity, with India close behind at 22% (33 mtpa). However, the reducing agent used in these furnaces is critical to understanding their emissions intensity,¹⁰ with hydrogen-based DRI being the most commercially viable low-emissions ironmaking technology. Unfortunately, much of the DRI capacity operated in the Middle East is methane-based due to the abundance of cheap

methane in the region, and India is known to operate a large number of coal-based rotary kiln DRI furnaces that cannot be readily transitioned to a hydrogen reduction process. Additionally, there are many small coal-based DRI furnaces in India with capacities between 10–30 ttpa that fall below the threshold for inclusion in GEM's trackers but add even more coal-based DRI capacity in India. The DRI fleets in these top two operating countries pose distinct decarbonization challenges to align with net zero goals.

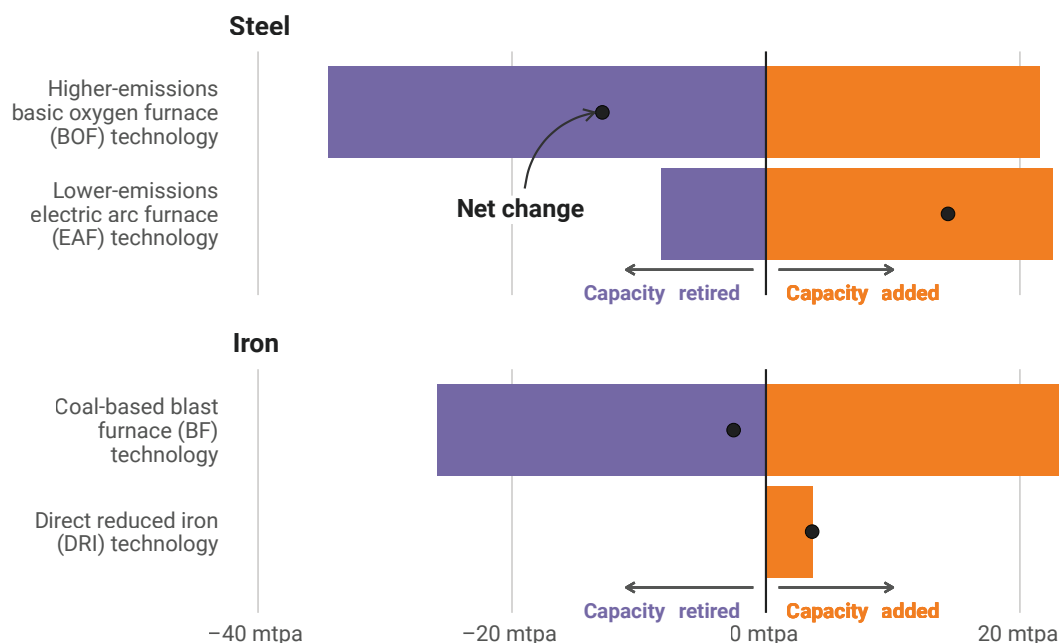
UPDATES ON THE NET ZERO TRANSITION

The shift toward a carbon neutral iron and steel industry is multi-pronged and generally involves the replacement of coal-based BF-BOF capacity with hydrogen-DRI or scrap-based EAF production.

Understanding developing and retiring iron and steel technologies is a critical measure of the industry transition, and GEM's tracking illuminates distinct differences between countries in the pace of their transition.

Progress in iron and steelmaking capacity with lower-emissions technologies, but new coal-based capacity poses decarbonization concern

Changes in operating capacity in 2023 by technology type, in million tonnes per year (mtpa)



Source: Global Steel Plant Tracker, Global Blast Furnace Tracker, Global Energy Monitor



10. The IEA's updated [2023 roadmap](#) requires a rapid buildout of green hydrogen-based DRI capacity from 2030 to 2050, with the electrolytic hydrogen-based share of ironmaking capacity growing from 5% in 2030 to 44% in 2050.

While the common BF-BOF and EAF (both scrap-based and DRI-based) routes are often used as overall indicators of the transition, this analysis considers the industry transition of steelmaking and ironmaking both independently and in combination. By isolating each technology for a more detailed look, GEM is able to see which elements of the transition are succeeding

or falling behind targets and how that might shift as more flexibility is introduced to the operating configurations of these units in the quest for low-emissions steel (for example through DRI-smelt-BOF processes or the decoupling of DRI ironmaking and EAF steel-making at separate sites).

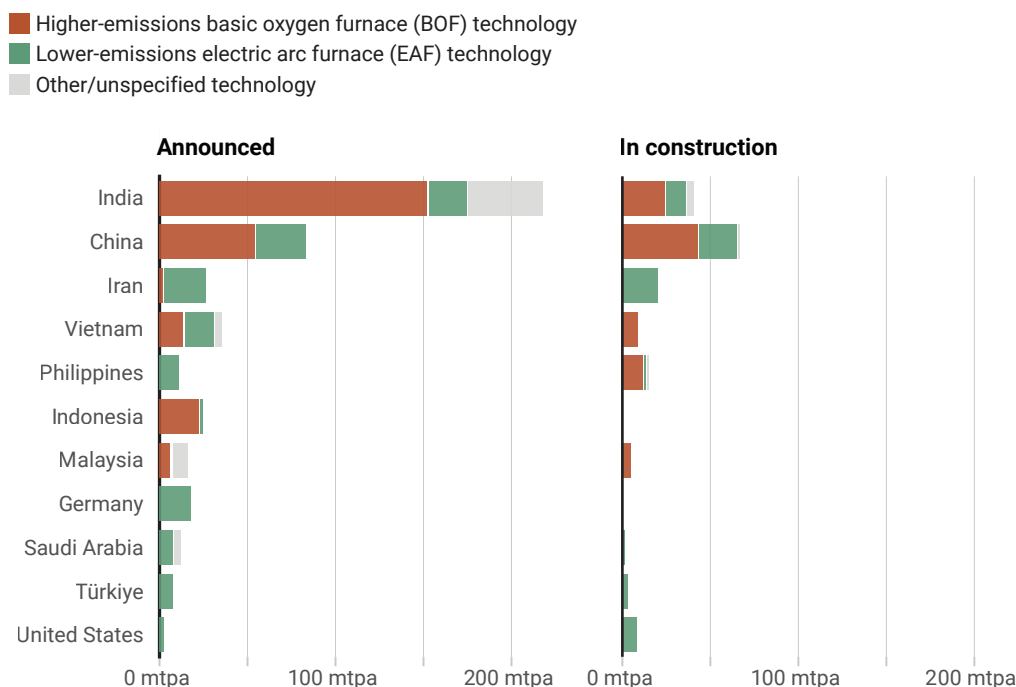
Steelmaking capacity developments

There is currently 774 mtpa of steelmaking capacity under development, 223 mtpa of which has advanced to the construction phase.¹¹ Together China and India are responsible for 53% of all developments. India emerged as the top developer of coal-based BOF capacity last year. This year, India's buildout of BOF capacity has grown so large that it has also replaced China as the top developer of overall steel capacity even as

China remains the top developer of EAF capacity. India is responsible for one-third of total global steelmaking capacity that is announced or under construction (258 mtpa). China now comes in second with 20% of capacity under development (150 mtpa). Following India and China are Iran (46 mtpa), Vietnam (45 mtpa), the Philippines (26 mtpa), and Indonesia (25 mtpa).

India has more steel capacity in development, but China currently building more

Steel capacity in development by technology type and status, million tonnes per year (mtpa)



Source: Global Steel Plant Tracker, Global Blast Furnace Tracker, Global Energy Monitor



11. In the GSPT, projects are moved from “announced” to “construction” status once work on the physical facility has begun.

While India has the most steel in development, 84% of this has not yet moved to the construction phase, leaving a greater opportunity to change these plans. 45% of China's total developments have progressed to the construction phase, and China is still responsible for the most new steel capacity under construction (67 mtpa). While proposals provide a good indication of the steel industry's goals for the future, there's a big step between proposal and construction, meaning there is more space for adjustment in Indian development plans because they are still in this initial announcement stage.

All 357 mtpa of BOF steelmaking under development in the GSPT is taking place in just a dozen countries. While China has historically been the largest developer of BOF capacity, [last year](#) India moved into the lead. India's lead as the largest developer of coal-based BOF has surged this year to approximately half of global capacity, with China coming in a more distant second at 28%. As with overall steelmaking, most

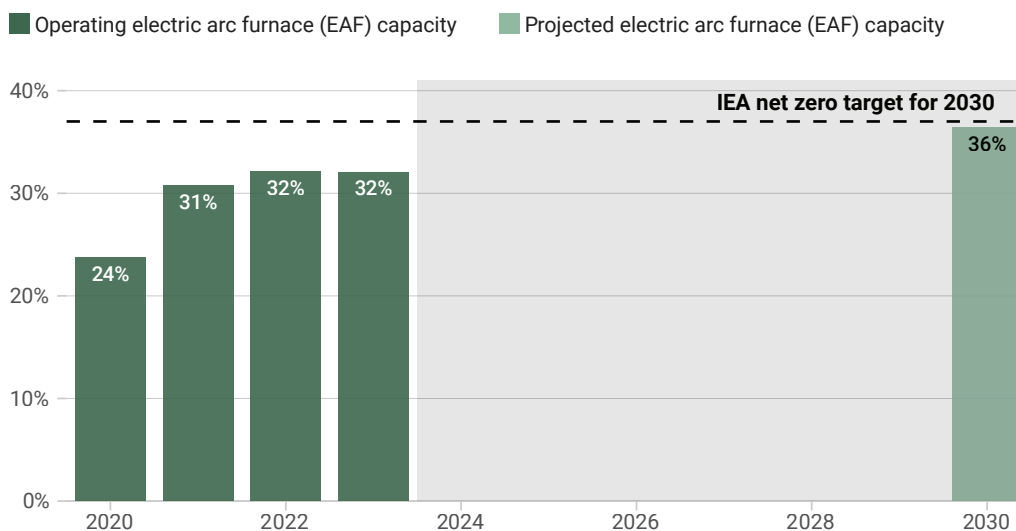
of this capacity has yet to progress to construction work in India (only 14%), while a much more substantial 44% of Chinese BOF developments have started construction. Nearly all (>99%) BOF development is located in Asia with the remainder in Iran, Nigeria, and Kazakhstan (each holding less than 1%).

While BF-BOF capacity is concentrated in a few critical countries, EAF development is more distributed around the world; 50 countries are currently developing EAF capacity, led by China (15% of global share), Iran (13%), and India (10%).

GEM's [Pedal to the Metal 2023 report](#) noted a shift toward a higher percentage of EAF production, and this trend is strengthening. Based on the April 2024 update of the GSPT, nearly half (49%) of capacity under development — 337 mtpa — is EAF, up from 43% in 2023 and 33% in 2022. This puts the IEA's net zero aligned goal of [37% EAF](#) by 2030 within reach for the first time since the launch of the GSPT.

Net zero target for steelmaking could be within reach

Proportion of steelmaking production capacity using lower-emissions electric arc furnace (EAF) steel technology, with projection for 2030 based on current capacity development plans



Source: Global Steel Plant Tracker, Global Blast Furnace Tracker, Global Energy Monitor; International Energy Agency (IEA)



Further, only 36% of steelmaking capacity announced in 2020 with a known production route planned to use EAF, but that number has grown each year to reach 92% in 2023. This indicates a significant shift toward electric arc furnace steelmaking in the years to come.

However, of these recent EAF announcements, less than 14% have moved to the construction phase, and of all projects that have actually begun construction, nearly 46% are still BOF-based. This highlights the fact that, while we may be within reach of net zero targets based on proposed electric arc furnace capacity, actually achieving these goals requires follow-through.

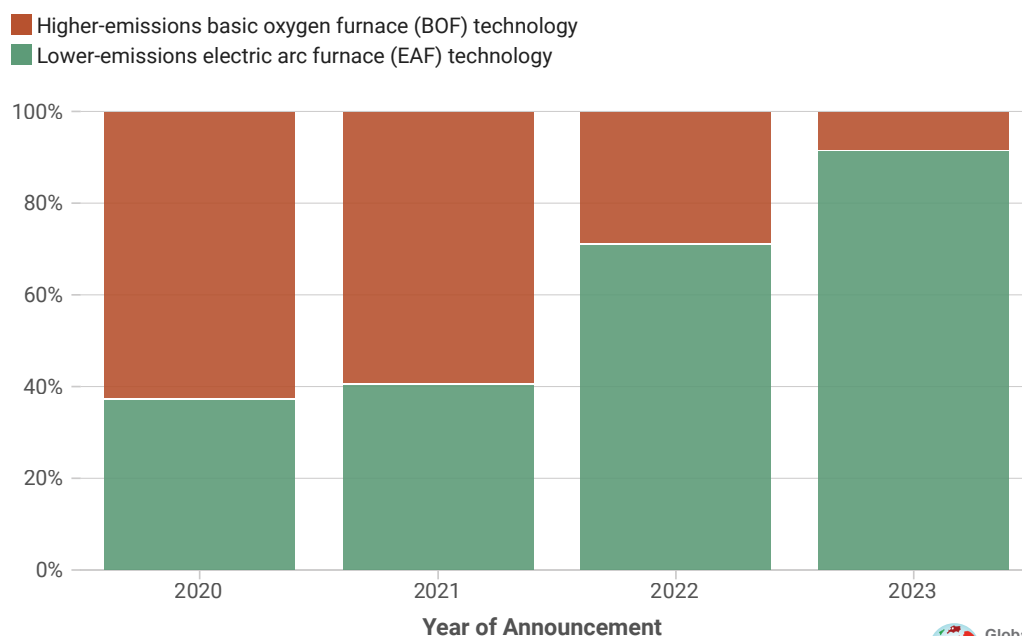
This impending transition away from coal-based steel is also seen in capacity retirements. Of the 212 mtpa

of steelmaking capacity slated for retirement,¹² 88% is BOF-based. However, there is still projected to be a net growth of BOF capacity with current development plans. In total, if all planned developments and retirements take effect, an additional 171 mtpa of BOF capacity, 310 mtpa of EAF capacity, and 80 mtpa of capacity with unknown technology will be added to the global fleet.

All of these factors indicate that the global transition toward EAF steelmaking is underway, but that progress is neither uniform nor guaranteed. The push for new, clean developments must continue, and developers must see projects through to completion if tangible progress is to be made on a global scale.

Sharp rise in share of new steelmaking plans with lower-emissions technologies

Proportion of new planned steelmaking capacity by type and announcement year



Source: Global Steel Plant Tracker, Global Blast Furnace Tracker, Global Energy Monitor



12. Includes all pre-retirement steelmaking capacity tracked in the GSPT.

Ironmaking capacity developments

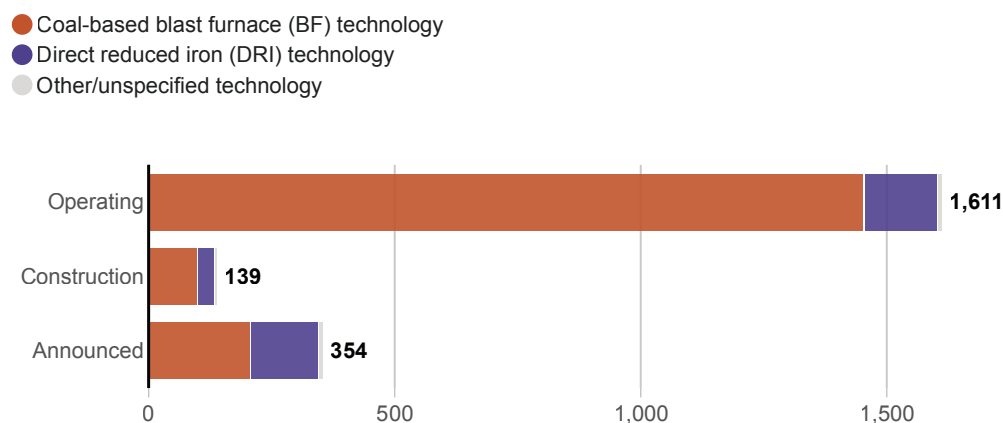
Coal-based blast furnaces account for 64% of developing global ironmaking capacity with a known production method. Blast furnaces currently account for 91% of operating iron production with a known technology, meaning that ironmaking capacity is beginning to shift towards direct reduced iron globally. However, the reducing agent planned in these DRI units is critical for emissions reduction, and the pace of green hydrogen-based DRI development and BF retirements must increase to align with net zero goals for primary steel production.

Carbon capture, utilization, and storage (CCS/CCUS) methods have proven costly and unreliable for mitigating emissions from coal-based blast furnaces, and net zero roadmaps now call for an increased share of green hydrogen-based DRI in primary steel production. The IEA [Net Zero Scenario](#) published in 2021 required hydrogen-based DRI to reach 29% of primary steel production by 2050. This scenario relied heavily

on CCS/CCUS technology for mitigating emissions from coal-based blast furnaces, technology that has failed to deliver since the publication of this scenario, recently highlighted by [IEEFA](#) and [others](#). The IEA updated this [Net Zero Scenario](#) in 2023, accounting for an increased share of hydrogen-DRI in primary steel production (5% by 2030 and 44% by 2050), and recognizing the lack of development of CCS/CCUS, although this scenario still relies on CCS/CCUS-mitigated processes for 37% of primary iron production by 2050. Industry think tank Agora published a [more recent and specific plan](#) for the iron and steel industry, calling for a quicker phaseout of currently operating blast furnaces and increased reliance on low-carbon hydrogen-DRI over CCS/CCUS-mitigated BF production. Agora modeled a “Global Green Iron” scenario with a 90% share of low-carbon hydrogen-DRI in primary steel production by 2050 and a “Technology Mix” scenario with a 79% share of low-carbon hydrogen-DRI in primary steel production by 2050.

The majority of ironmaking capacity, both operating and in-development, uses emissions-intensive technologies

Ironmaking capacity by status and technology type, in million tonnes per year (mtpa)



Source: Global Blast Furnace Tracker, Global Steel Plant Tracker, Global Energy Monitor



While DRI development is on the rise, it is critical that gas-based DRI units have clear plans for operating with green hydrogen reducing agents. Should all BF and DRI capacity currently operating continue, and all BF and DRI capacity developments and retirements move forward as planned, DRI would reach a 16% share of ironmaking capacity by 2030. However, the emissions implications of this shift and alignment with net zero goals depends on how much of this DRI will use a green hydrogen reducing agent as opposed to methane or coal.

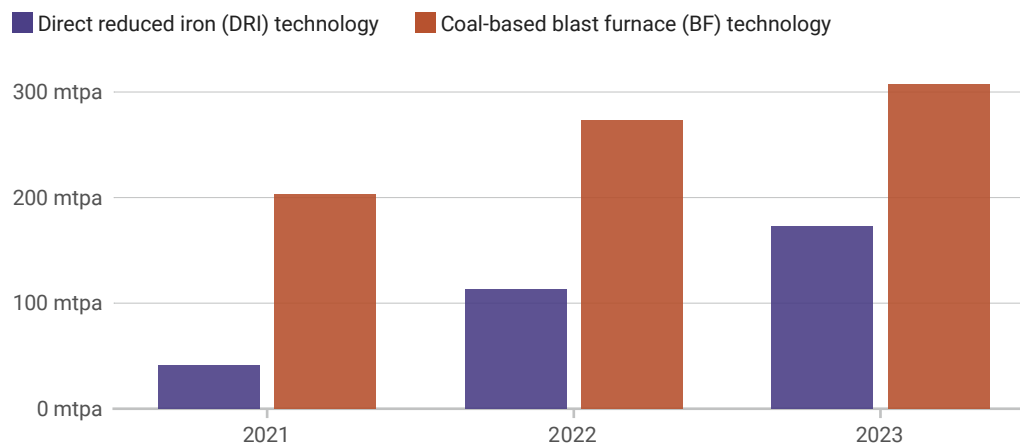
Asia, particularly in coastal areas, is the largest regional developer of DRI capacity, with 31% of developing DRI capacity in the Asia Pacific region. However, there is much less total DRI capacity under development (54 mtpa) in the region than BF capacity (295 mtpa). Globally, 30 countries are developing DRI capacity, with the top ten countries holding 73%

of developing DRI capacity. India and Iran lead with 34 mtpa and 29 mtpa under development, respectively. Oman, Germany, Russia, Saudi Arabia, Sweden, South Korea, France, and the Netherlands follow with 6–10 mtpa of DRI capacity under development in each country.

Developing BF capacity is more geographically condensed than DRI, with new coal-based blast furnace capacity under development in only sixteen countries and 96% percent of new BF capacity under development in the Asia Pacific region. Of 308 mtpa BF capacity under development globally, 128 mtpa are in China, 122 mtpa are in India, 16 mtpa are in Vietnam, and 12 mtpa are in Malaysia; Indonesia, Zimbabwe, Cambodia, Myanmar, Russia, the Philippines, Nigeria, Brazil, Kazakhstan, Angola, Pakistan, and Japan each hold less than 2% (6 mtpa) of global developing BF capacity.

New coal-based blast furnace development continues alongside growing development of direct reduced iron capacity

Ironmaking capacity of known technology types in development globally by year and technology type, million tonnes per year (mtpa)



Source: Global Steel Plant Tracker, Global Blast Furnace Tracker, Global Energy Monitor

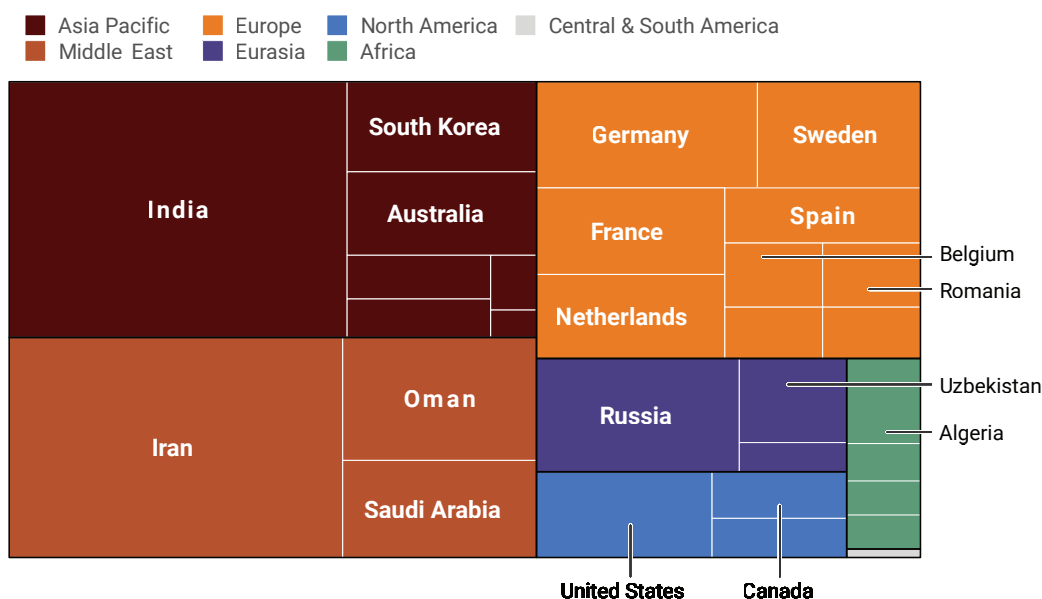


As with steelmaking, India is the largest developer of ironmaking capacity when considering all technology routes. China is the largest developer of BF technology (127 mtpa), followed by India (121 mtpa), together accounting for 81% of global developing BF capacity.¹³ India is the largest developer of DRI capacity (34 mtpa), followed by Iran (29 mtpa), together accounting for 37% of global developing DRI capacity. Despite being the largest developer of DRI capacity, India still has nearly four times as much BF capacity under development as DRI.

As the largest operators and developers of coal-based BF capacity, understanding BF operations and development in China and India is critical to understanding global iron and steel production in a net zero future. Despite little change in total operating and construction BF capacity in China since GEM's 2023 data release, a closer look at announcement and construction dates shows that new blast furnace development is still strong in China, with 32 mtpa of BF capacity entering construction in 2023. While India has more BF capacity announced, China has more BF capacity that has progressed into the construction stage.

Developing direct reduced iron capacity is broadly distributed across 30 countries

Ironmaking capacity in development using direct reduced iron technology; each segment represents share of capacity in development by country



Note: Countries not labelled, ordered by region and capacity in development, include: Malaysia, Bangladesh, China, Myanmar (Asia Pacific); Finland, Italy (Europe); Azerbaijan (Eurasia); Mexico (North America); Mozambique, Nigeria, Namibia (Africa) and Bolivia (Central and South America)

Source: Global Steel Plant Tracker, Global Blast Furnace Tracker, Global Energy Monitor



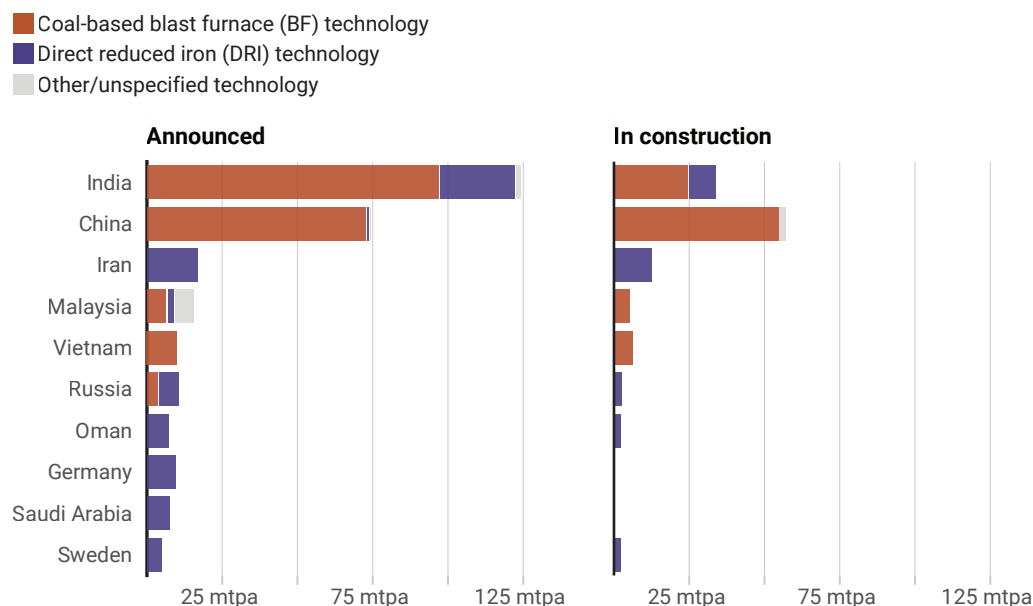
13. India outpaces China in BOF development, but China outpaces India in BF development. This discrepancy is in part due to the fact that many BOF announcements in India do not include information about the ironmaking source and can't be confirmed as integrated mills. If one assumes that all new BOF capacity in India was planned as an integrated mill with adequate BF capacity, India would also be the top developer of BF capacity.

BF retirements in China slightly outpaced new operating capacity in 2023 (20 mtpa began operating and 25 mtpa retired) unlike in 2022 (63 mtpa began operating, compared to 57 mtpa retired). There are also 19 mtpa of BF projects under development in China that were

initially planned to enter operation in 2023 but remain in the development stage. Thus it seems unlikely that retirement will outpace BF development in China in the near future without a significant course correction by the industry.

Majority of ironmaking capacity in development in China and India uses emissions-intensive, coal-based technologies

Ironmaking capacity in development by tech type and status, million tonnes per year (mtpa)



Source: Global Steel Furnace Tracker, Global Blast Furnace Tracker, Global Energy Monitor



Overcapacity

Capacity utilization rates have historically been calculated using OECD global capacity figures, which include a share of idled plants, many of which are unlikely to resume operations again. Using operating capacity only, global capacity utilization rates fall around 80–86%.¹⁴ Typically, capacity utilization rates of **80% to 90%** are required for a steel plant to remain profitable. Although excess capacity has been a major concern to steel producers for the past decade, the industry appears to have a healthy level of capacity at the global scale.

However, problems with overcapacity persist when viewed at the country level, with certain countries producing below 80%. Among the top ten global producers, China, India, Japan, Russia, and South Korea all fall within the desirable range of 80–90% capacity utilization, while Brazil, Germany, Iran, Türkiye, and the United States suffer from lower capacity utilization rates than desirable.

Though overcapacity is no longer pervasive in all steel-making economies, it continues to challenge producers in many countries. In countries facing low capacity utilization rates, dormant blast furnaces are able to

14. The Global Steel Plant Tracker includes plants with at least 0.5 mtpa crude iron and/or steel capacity. Countries including China and India have significant shares of production using small induction furnaces, which add approximately 150 mtpa crude steel capacity to the global steel industry.

linger in the fleet in mothballed states — extending the amount of time they may need to be operated for iron and steelmakers to recuperate their investments. Overcapacity also contributes to volatility of iron and steel prices and challenges the profitability of iron and steelmakers by reducing the cash flow they need to transition production to all new low-emissions process technologies.

While overcapacity hinders industrial transition to greener technologies, it also presents a window of opportunity for this inevitable industrial transition.

Stranded asset risk

Blast furnaces are becoming riskier investments with limited options to mitigate emissions from the furnace and upstream emissions from metallurgical coal mining.¹⁵ Due to the long operational lifetime of blast furnaces, these investments are becoming particularly risky in countries with net zero targets where carbon pricing and other climate-aligned policies may challenge BF production. GEM uses developing BOF capacity as a proxy to estimate the stranded asset risk posed by newly developing BF-BOF steelmaking based on an estimated investment of \$1–1.5 billion per 1 million tonnes per annum of capacity at an integrated BF-BOF site. With less integrated BOF capacity under development than in past editions of this report, future stranded asset risk has dropped slightly, from an upper estimate of 554 billion USD in 2023 to 400 billion USD in 2024. As the largest developers of new

With proper planning and management, this overcapacity presents an opportunity for a staged transition of production to lower-emissions technologies. GEM's iron and steel trackers show new development of lower-emissions iron and steel technology, and a global shift towards lower-emissions production, albeit not fast enough to reach mid-century net zero goals. As overcapacity continues to challenge the industry, DRI-based ironmaking offers the additional advantage that shifting these furnaces between active and inactive states is cheaper than the same demand-response operational shift for BF-based production.

BF-BOF capacity, China and India have the potential to face large stranded asset risks.

In Southeast Asia, increasing BF-BOF development carries carbon lock-in concerns. The region has been highlighted by SEAISI as “de-greening” their iron and steel industry. While global stranded asset risk has decreased since Pedal to the Metal 2023, stranded asset risk has increased in Malaysia and Cambodia due to increased development of BF-BOF capacity. Additionally, Africa — though home to much less total capacity than Asia — poses an increasing risk of stranded assets due to BF buildout in Nigeria, Angola, and Zimbabwe. Regionally, Africa is set to more than double operating BF capacity from 5 mtpa (<1% of global capacity) to 12 mtpa if all developing BF capacity goes into operation.

Country/area	Carbon commitment	BOF steel under development in integrated process development	Stranded asset risk (US\$ billion)	
			Low range	High range
India	Net Zero 2070	124,364	124	187
China	Net Zero 2060	80,803	81	121
Vietnam	Net Zero 2050	22,900	23	34
Indonesia	Net Zero 2060	17,000	17	26
Malaysia	Net Zero 2050	11,600	12	17
Cambodia	Net Zero 2050	4,100	4	6
Myanmar	Net Zero 2050	4,000	4	6
Nigeria	Net Zero 2060	1,300	1	2
Kazakhstan	Net Zero 2060	665	1	1
Total		266,732	267	400

15. See [Sector emissions](#) for more information.

COUNTRY PROFILES

China

Operating iron and steel: China's operating capacity primarily follows the BF-BOF route, with 918 mtpa of BOF capacity, 885 mtpa of BF capacity, 157 mtpa of EAF capacity, and just 2 mtpa of DRI capacity. It is among the [most emissions-intensive](#) steel producers globally, producing over two tonnes of CO₂ per tonne of steel on average.

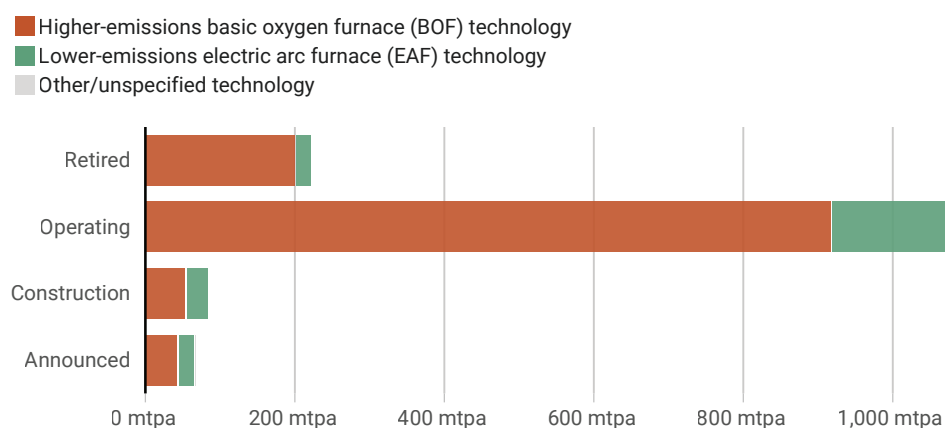
Transition updates and key policies: China has a net zero 2060 goal. The Chinese government has facilitated some decarbonization plans within the steel sector, including setting a goal of [15% EAF production](#) by 2025¹⁶ (lowered from the original goal of 20%) as well as pushing retrofitting, assessment, and monitoring of

most production facilities. However, with over 85% of China's steel capacity relying on BF-BOF technology, and 60% of the world's operating BF capacity situated in China, emphasis on retrofitting programs rather than extensive replacement of coal-based capacity presents a significant threat to decarbonization goals in China and globally.

Coal-based production summary: China's blast furnaces are young, with an average age of twelve years for operating furnaces with known ages. China continues to invest in new blast furnaces, with 128 mtpa of new blast furnace capacity currently under development.

Majority of operating steelmaking capacity in China uses emissions-intensive, coal-based technologies

Steelmaking capacity by status and technology type, million tonnes per year (mtpa)



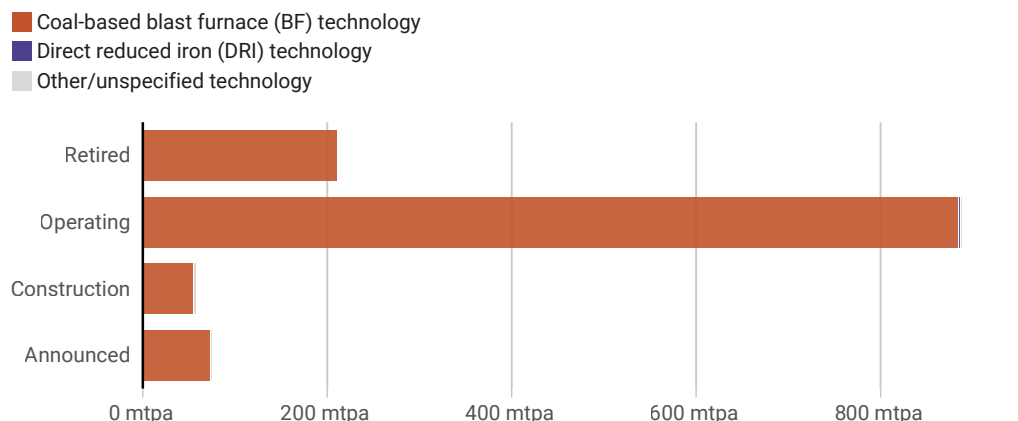
Source: Global Steel Plant Tracker, Global Blast Furnace Tracker, Global Energy Monitor



16. Note that while China's operating capacity is approximately 15% EAF, [less than 10%](#) of actual production uses the EAF route.

Almost all operating ironmaking capacity in China uses emissions-intensive, coal-based technologies

Ironmaking capacity by status and technology type, million tonnes per year (mtpa)



Source: Global Steel Plant Tracker, Global Blast Furnace Tracker, Global Energy Monitor



India

Operating iron and steel: India has the [highest emissions intensity](#) across all production routes globally. India operates 73 mtpa of BOF capacity, 104 mtpa of BF capacity, 37 mtpa of EAF capacity, and 33 mtpa of DRI capacity. India also has a very high level of induction furnace (IF)¹⁷ capacity, with IFs producing around [31%](#) of India's total steel.

Transition updates and key policies: India has a net zero 2070 target and is aiming for 50% renewable electricity by 2030. India's Green Hydrogen Mission aims to achieve a green hydrogen capacity of 5 mtpa by 2030. However, the ready availability of coal and

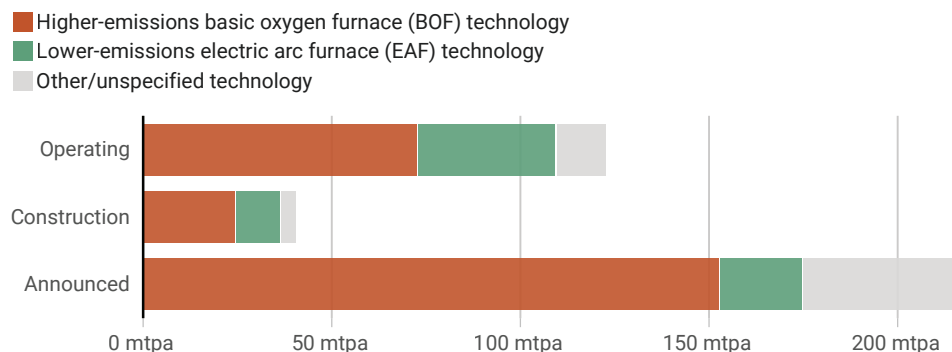
limited availability of gas in India tends to [restrict](#) the early adoption of hydrogen-capable DRI. Achieving higher utilization rates, increasing the share of scrap in the feedstock, and switching to cleaner energy sources for EAF and IF technologies could help achieve lower emissions intensity in the Indian steel industry overall.

Coal-based production summary: The relatively young blast furnace fleet in India (average operating BF age of 23 years) poses a challenge in phasing out existing BFs. India has 122 mtpa of new BF capacity under development.

17. [Induction furnaces](#) use electromagnetic induction to heat and melt iron and scrap metal, unlike EAFs, which use electric arcs between electrodes to generate the heat necessary for melting.

Majority of operating and developing steelmaking in India uses emissions-intensive, coal-based technologies

Steelmaking capacity by status and technology type, million tonnes per year (mtpa)

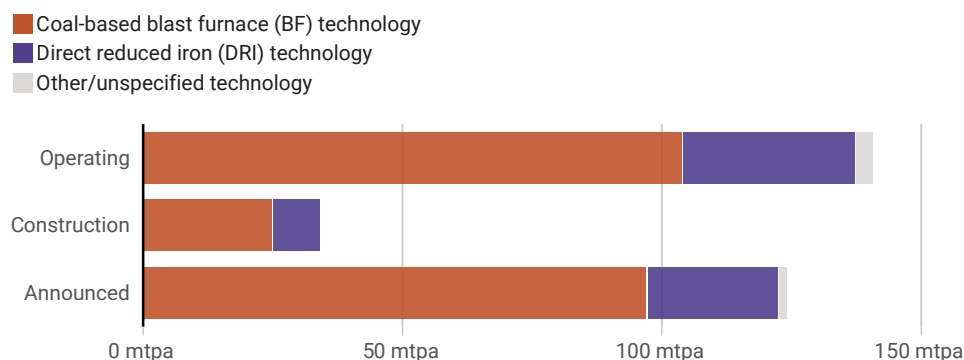


Source: Global Steel Plant Tracker, Global Blast Furnace Tracker, Global Energy Monitor



Majority of operating and developing ironmaking in India uses emissions-intensive, coal-based technologies

Ironmaking capacity by status and technology type, million tonnes per year (mtpa)



Source: Global Steel Plant Tracker, Global Blast Furnace Tracker, Global Energy Monitor



Japan

Operating iron and steel: Steelmaking in Japan is heavily BF-BOF based. Japan operates 79 mtpa of BOF capacity, 30 mtpa of EAF capacity, 81 mtpa of BF capacity, and there is no DRI capacity tracked by GEM. Less than 28% of steel in Japan is produced via EAF; if all announced closures and new projects are realized, this percentage will only move up to 33% over the next few years.

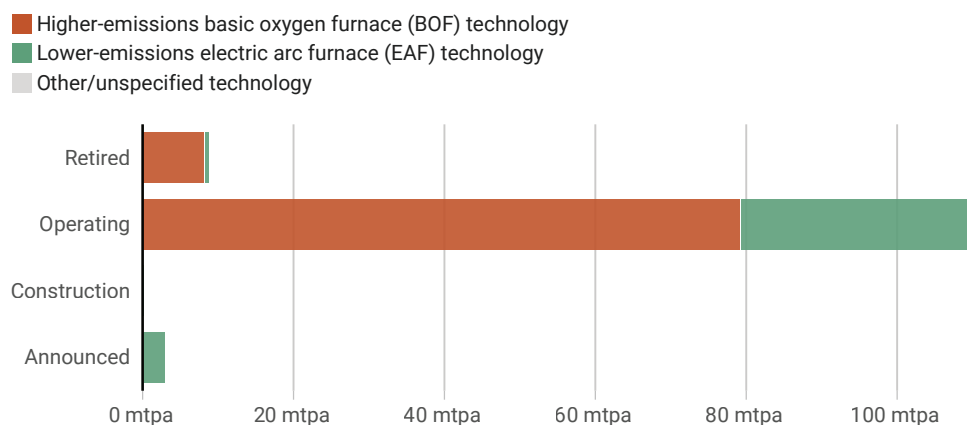
Transition updates and key policies: Japan has a net zero 2050 target. The Japanese government is aiming for a [30% reduction](#) in total emissions compared to 2013 baseline by 2030. Kobe Steel's "[Kobenable](#)" and JFE Steel's [JGreeX](#), marketed as decarbonizing strategies, are mass balance approaches to show emission reductions per tonne of steel and are not considered

meaningful approaches to decarbonizing their production processes. Further, Japanese companies are focusing on blast furnace retrofitting through [COURSE50](#) projects, which only target a [30–50%](#) carbon reduction, are high cost, and are not expected to be in commercial operation until 2030.¹⁸

Coal-based production: Operating Japanese blast furnaces have an average age of 50 years, presenting an opportunity to accelerate the transition as older units approach the end of their campaigns. Currently, less than 11% of operating blast furnace capacity in Japan is slated for retirement, and there is no DRI under development tracked by GEM in Japan.

All developing steelmaking in Japan uses lower-emissions technologies, but operating capacity is still heavily coal-based

Steelmaking capacity by status and technology type, million tonnes per year (mtpa)



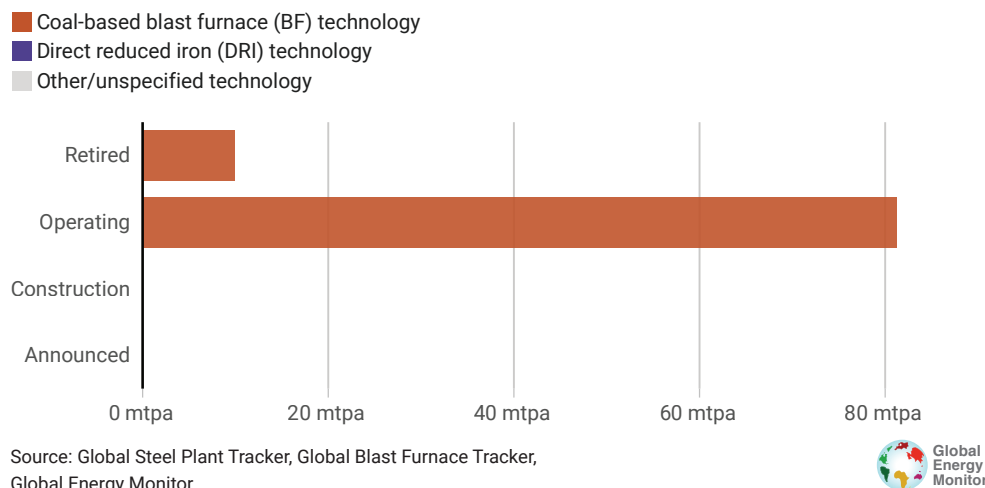
Source: Global Steel Plant Tracker, Global Blast Furnace Tracker, Global Energy Monitor



18. Summarized from TransitionZero's [Process, Not Product: Why Southeast Asia's Energy Transition Mechanisms need time to evolve](#).

All operating ironmaking in Japan uses emissions-intensive, coal-based technologies

Ironmaking capacity by status and technology type, million tonnes per year (mtpa)



United States

Operating iron and steel: Of top producing countries, the United States has a relatively [low](#) average emissions intensity for steelmaking. This is primarily due to the high percentage of electric arc furnace steelmaking (approximately 70%) and the dominant use of scrap in production (around [82%](#) of all EAF feedstock in the country). The U.S. operates 33 mtpa of BOF capacity, 76 mtpa of EAF capacity, 26 mtpa of BF capacity, and 7 mtpa of DRI capacity.

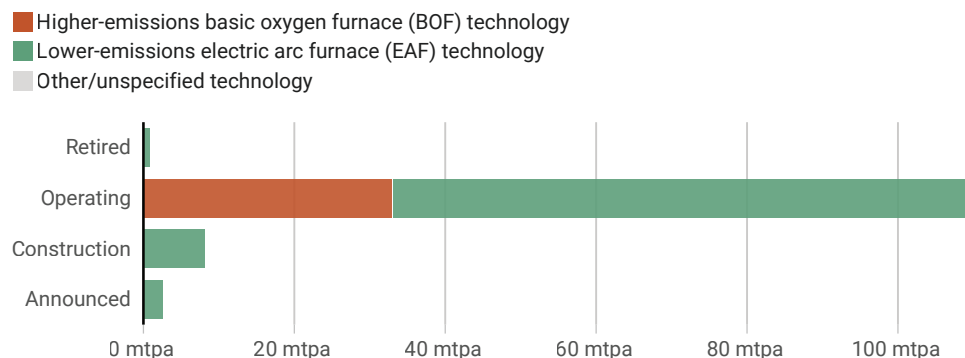
Transition updates and key policies: The United States has set a net zero 2050 target. The U.S. has seen substantial legislative support for domestic steel decarbonization in recent years. The [Energy Act of 2020](#), the [2021 Infrastructure Investment and Jobs Act](#), the [2022 Inflation Reduction Act \(IRA\)](#), and the [2022](#)

[CHIPS and Science Act](#) have all facilitated investments in transition technologies and clean electricity that will further EAF decarbonization. Recent government support has also looked to accelerate DRI construction and other developing ironmaking technologies, with the [DOE awarding billions](#) to both nascent and commercial-ready technologies. However, concerns remain about the reducing agent these DRI facilities will use and whether they will truly achieve green steel production.

Coal-based production: The U.S. blast furnace fleet is the oldest in the world, with an average operating age of 73 years. There is still 26 mtpa of operating blast furnace capacity, the majority of which has no announced plans for retirement.

All developing steelmaking in the United States uses electric arc furnace, but little coal-based capacity is being retired

Steelmaking capacity by status and technology type, million tonnes per year (mtpa)

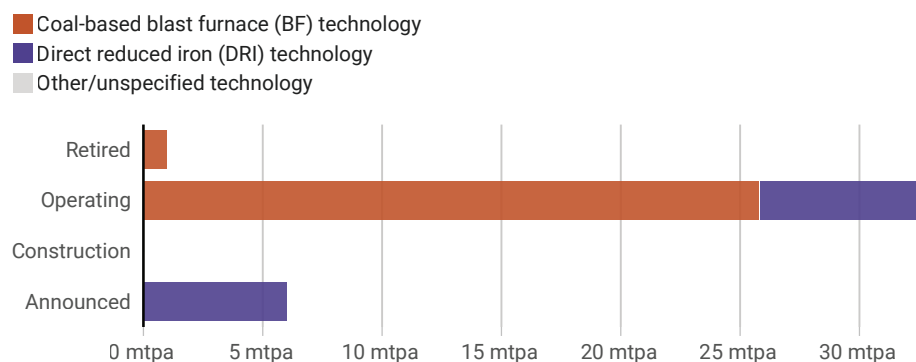


Source: Global Steel Plant Tracker, Global Blast Furnace Tracker, Global Energy Monitor



All developing ironmaking in the United States is direct reduced iron, but plans have not moved into construction yet

Ironmaking capacity by status and technology type, million tonnes per year (mtpa)



Source: Global Steel Plant Tracker, Global Blast Furnace Tracker, Global Energy Monitor



Russia

Operating iron and steel: The Russian steel industry is heavily reliant on BF-BOF production, with 59 mtpa of BF capacity, 54 mtpa of BOF capacity, 8 mtpa of DRI capacity, and 35 mtpa of EAF capacity.

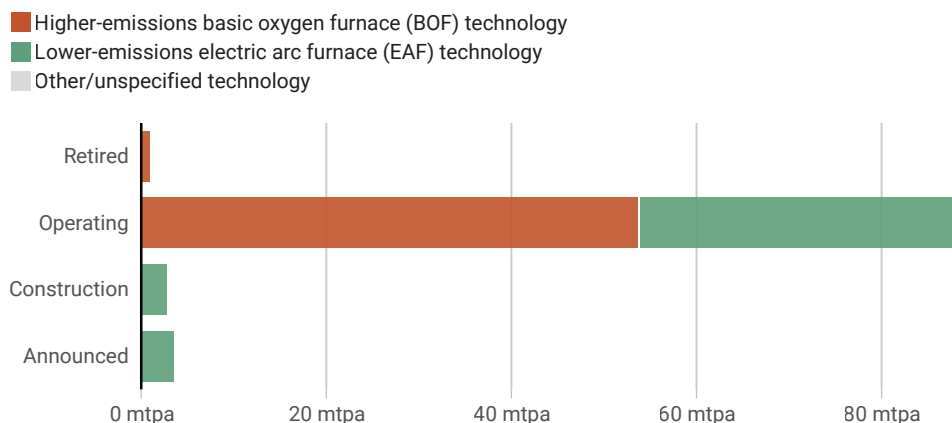
Transition updates and key policies: Russia has set a 2060 net zero target. The Russian steel industry faces decarbonization pressures from the EU's Carbon Border Adjustment Mechanism, mandatory corporate sustainability reporting in the EU and U.S., and carbon pricing, which will make exports to the EU more difficult and expensive by 2026. Many major Russian steel companies have announced decarbonization strategies aiming for carbon neutrality by 2050, but their plans include vague implementation steps,

primarily involving low-level emission reductions and continued use of emissions-intensive methods, falling short of the Paris Agreement goals. In 2023, Russia's steel production increased by 5.6% to 76 million tonnes, despite sanctions affecting exports to the EU. Sanctions are expected to have a stronger impact from 2024 onwards, with companies focusing on increasing domestic consumption and exploring new markets to mitigate reduced overseas demand.

Coal-based production: Russia's blast furnace fleet is old, with an average operating age of 45 years. Russia now has 9 mtpa of DRI capacity under development compared to 4 mtpa of developing BF capacity, starting a shift away from coal-based production.

All developing steelmaking in Russia is lower-emissions electric arc furnace capacity

Steelmaking capacity by status and technology type, million tonnes per year (mtpa)

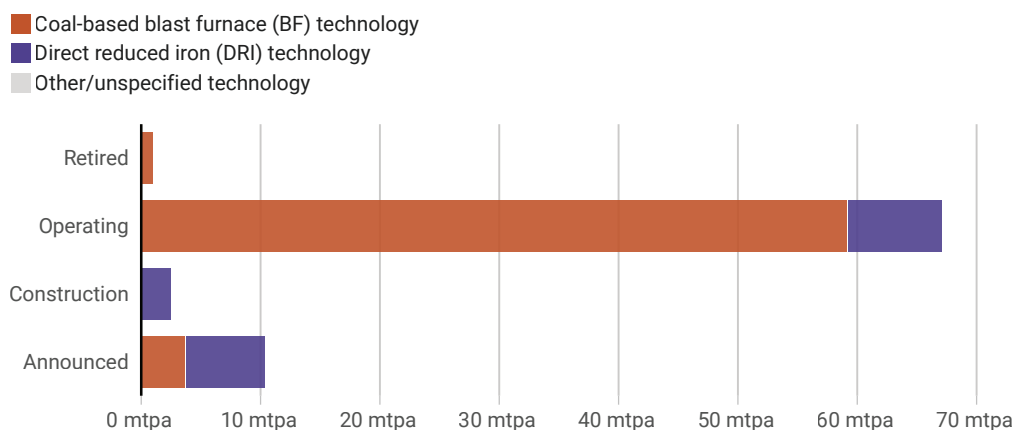


Source: Global Steel Plant Tracker, Global Blast Furnace Tracker, Global Energy Monitor



Developing Russian ironmaking is primarily direct reduced iron, but emissions-intensive, coal-based blast furnace capacity still planned

Ironmaking capacity by status and technology type, million tonnes per year (mtpa)



Source: Global Steel Plant Tracker, Global Blast Furnace Tracker, Global Energy Monitor



South Korea

Operating iron and steel: South Korea's steelmaking capacity is largely high-emissions integrated BF-BOF capacity, with 52 mtpa of BOF capacity, 31 mtpa of EAF capacity, and 50 mtpa of BF capacity.

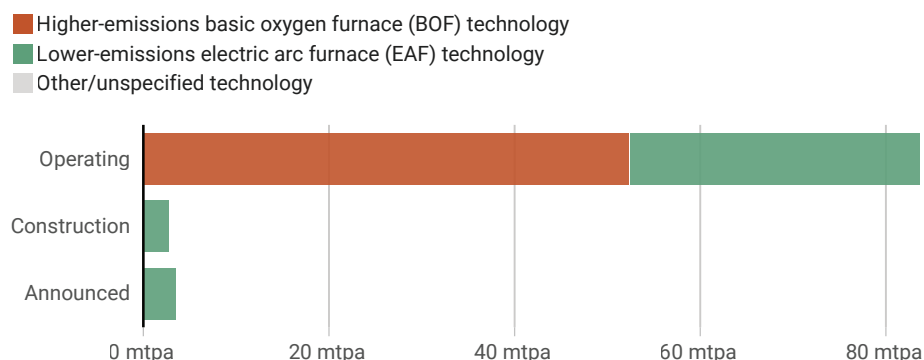
Transition updates and key policies: South Korea has set a net zero target of 2050. In 2023, the Korean government released the [Steel Industry Development Strategy for Transition to Low-Carbon Steel Production](#), which outlines certain investments and support for BF facility conversion, but does not appear to be sufficient to meet transition and decarbonization goals. POSCO, the country's largest steelmaking

company, announced a [plan](#) to complete an H₂-DRI-based green steel R&D project by 2028 and commercialize that technology by 2030. However, POSCO is also one of the companies with the most blast furnace capacity in the world and is [not set](#) to meet near- and mid-term net zero goals based on current plans.

Coal-based production: Operating blast furnaces in South Korea have an average age of 31 years. None of the 52 mtpa of operating BF capacity is currently set to retire, and there are no announced plans for blast furnace developments.

All developing steelmaking in South Korea is electric arc furnace capacity

Steelmaking capacity by status and technology type, million tonnes per year (mtpa)

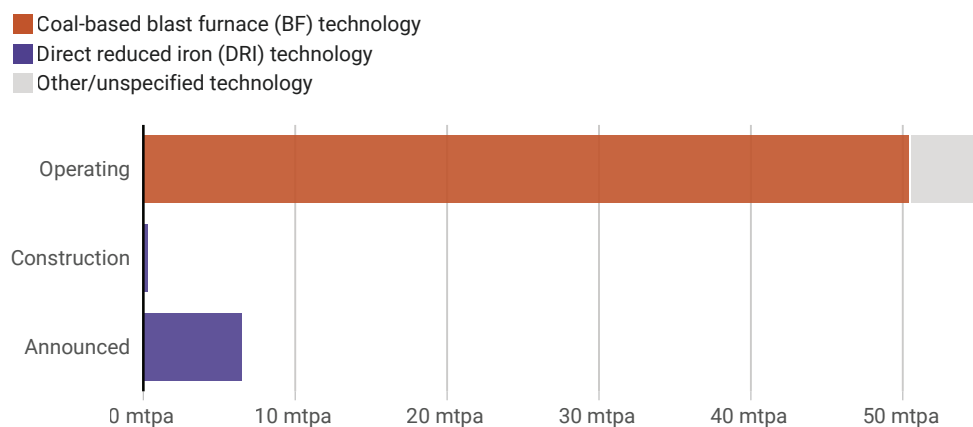


Source: Global Steel Plant Tracker, Global Blast Furnace Tracker, Global Energy Monitor



All planned ironmaking in South Korea is direct reduced iron capacity

Ironmaking capacity by status and technology type, million tonnes per year (mtpa)



Source: Global Steel Plant Tracker, Global Blast Furnace Tracker, Global Energy Monitor



Germany

Operating iron and steel: Germany's operating steel industry is heavily coal based, with 32 mtpa of operating BF capacity, 38 mtpa of operating BOF capacity, <1 mtpa of operating DRI capacity, and 13 mtpa of operating EAF capacity.

Transition updates and key policies: Germany has a net zero goal by 2045. As a member of the G7 and the European Union, Germany is part of some of the most ambitious emissions reduction goals, although plans have not yet moved into action. Germany is also part

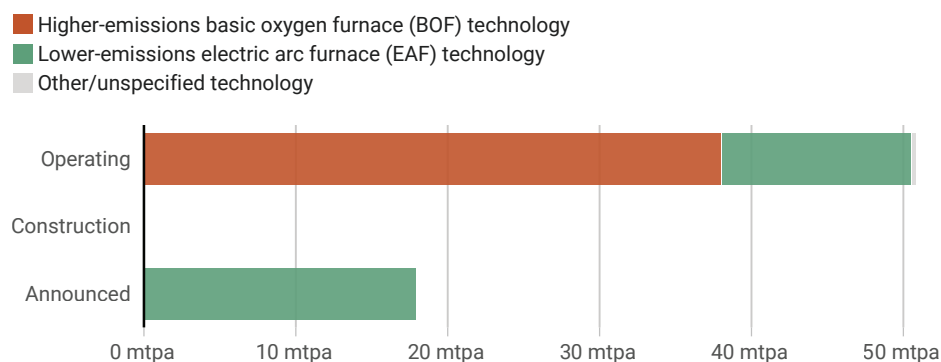
of Europe's carbon border adjustment mechanism, meant to advantage local green industry. Germany is pursuing a national hydrogen strategy that could support industrial decarbonization. However, recent [backpedaling](#) by large steelmakers at the projected costs of hydrogen in Europe could put decarbonization goals at risk if BF retirements are postponed or DRI

plans fail to move into construction or are not operated with green hydrogen.

Coal-based production: Operating German blast furnaces have an average age of 47 years. Germany has plans to retire all blast furnaces except for one at ArcelorMittal Bremen. Germany has 29 mtpa of operating blast furnace capacity planned for retirement and 9 mtpa of DRI capacity under development.

All developing steelmaking in Germany is electric arc furnace capacity, but planned capacity not yet under construction

Steelmaking capacity by status and technology type, million tonnes per year (mtpa)

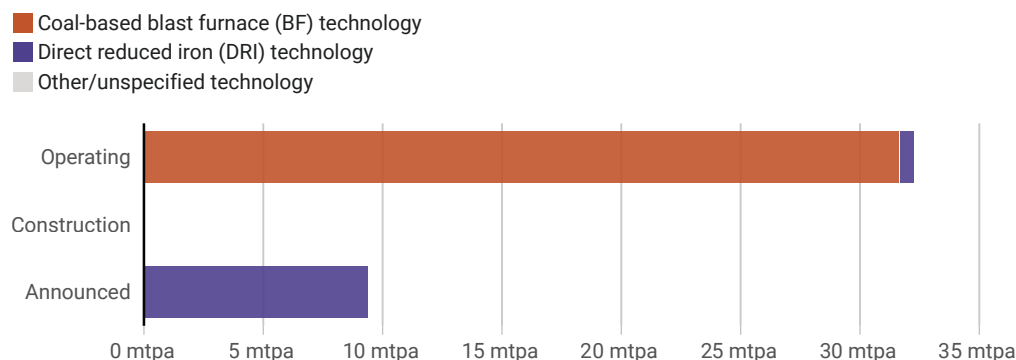


Source: Global Steel Plant Tracker, Global Blast Furnace Tracker, Global Energy Monitor



No new blast furnace capacity developing in Germany, but plans for direct reduced iron not yet in construction

Ironmaking capacity by status and technology type, million tonnes per year (mtpa)



Source: Global Steel Plant Tracker, Global Blast Furnace Tracker, Global Energy Monitor



Türkiye

Operating iron and steel: Türkiye has a relatively high percentage of EAF steelmaking at 77% (13 mtpa of operating BOF capacity and 43 mtpa of EAF). This is the second-most EAF-reliant country in the top ten steelmakers, after Iran.

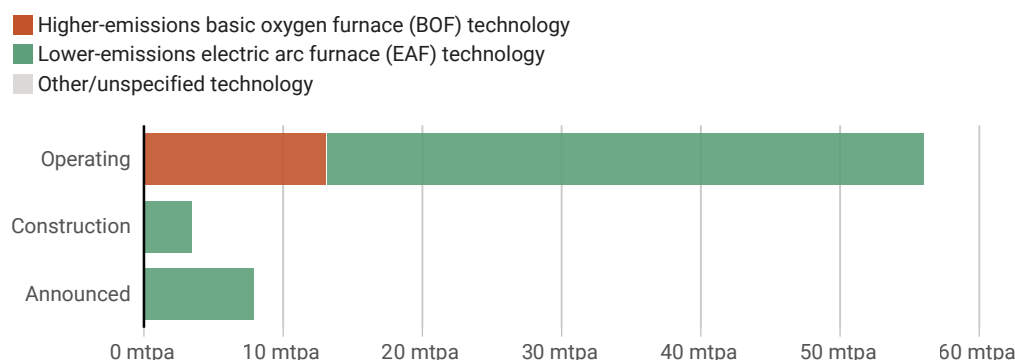
Updates on the transition: Türkiye has set a 2053 net zero target. They are heavily reliant on imported raw materials (primarily scrap), and decreases in exports

in countries like the U.S. have the potential to impact Turkish steel dramatically. They do not have clearly defined reduction targets for high-emissions industries like the steel sector.

Coal-based production: Türkiye has 15 mtpa of blast furnace ironmaking capacity with no plans for retirement and an average operating blast furnace age of sixteen years.

Majority of operating and all developing steelmaking in Türkiye is lower-emissions electric arc furnace capacity

Steelmaking capacity by status and technology type, million tonnes per year (mtpa)

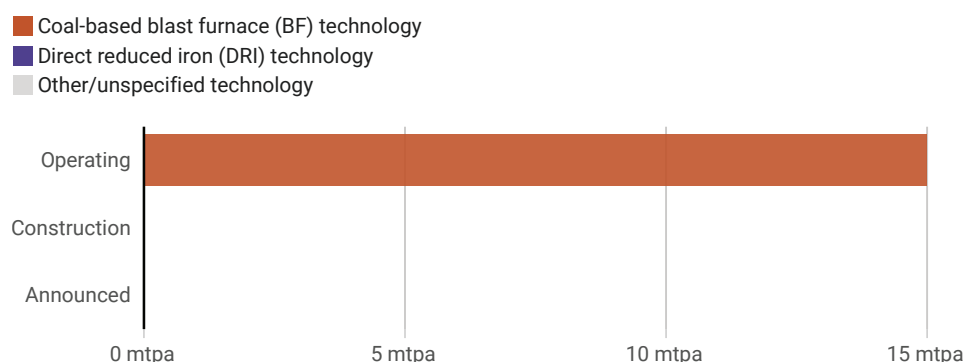


Source: Global Steel Plant Tracker, Global Blast Furnace Tracker, Global Energy Monitor



No developing ironmaking in Türkiye; all operating ironmaking relies on emissions-intensive, coal-based blast furnaces

Ironmaking capacity by status and technology type, million tonnes per year (mtpa)



Source: Global Steel Plant Tracker, Global Blast Furnace Tracker, Global Energy Monitor



Brazil

Operating iron and steel: Brazil is heavily reliant on coal-based iron and steel production, with 34 mtpa of operating BF capacity, 33 mtpa of operating BOF capacity, 11 mtpa of operating EAF capacity, and no DRI capacity.

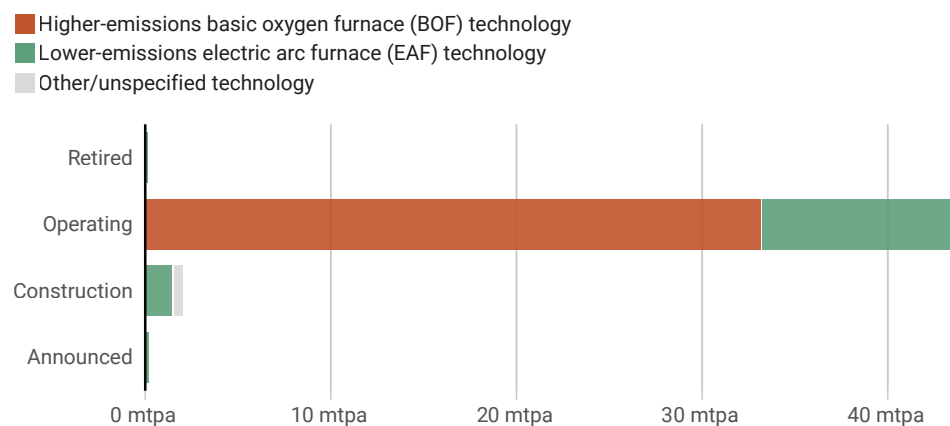
Updates on the transition: Brazil has a net zero by 2050 target, as well as a 2030 50% emissions reduction goal. The mining company Vale has recently been the center of industrial hub [agreements](#) in the country and is set to export feedstock for DRI units to H2 Green Steel in Sweden. Considering the potential for renewable energy and local hydrogen production in Brazil, as well as local iron ore reserves, there is growing interest in looking to Brazil to produce green iron locally by hydrogen-reduced iron ore and export green iron as opposed to iron

ore and hydrogen. However, Brazil currently has no operating or developing DRI capacity. Boston Metal, a U.S.-based iron production start-up, has inaugurated its first [production facility](#) in Brazil, which uses molten-oxide electrolysis (MOE) to recover metallic iron from mining waste. While this technology has not been proven at large industrial scales yet, there is growing interest in electrochemical iron-refining technologies like MOE as potential processes for low-emissions ironmaking.

Coal-based production: Despite its emissions reduction targets, Brazil has no retirement plans for any currently operating coal-based iron and steel production and has just over 1 mtpa of newly announced blast furnace capacity. Brazil's operating blast furnaces have an average age of 31 years.

All developing steelmaking in Brazil uses electric arc furnaces, but operating steelmaking primarily uses basic oxygen furnaces

Steelmaking capacity by status and technology type, million tonnes per year (mtpa)

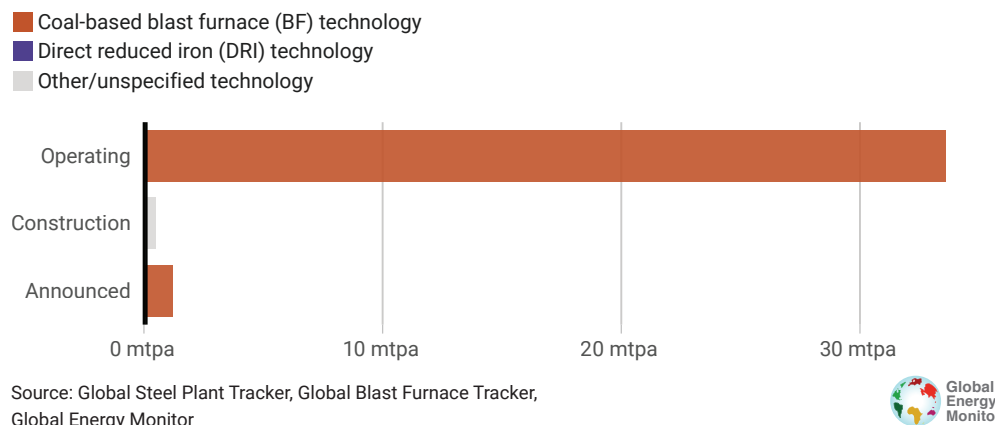


Source: Global Steel Plant Tracker, Global Blast Furnace Tracker, Global Energy Monitor



All operating and announced ironmaking in Brazil relies on emissions-intensive, coal-based blast furnaces

Ironmaking capacity by status and technology type, million tonnes per year (mtpa)



Iran

Operating iron and steel: Iran has a large share of gas-based DRI production, slightly lowering the country's primary steelmaking emissions compared to many other countries that rely heavily on coal-based BF production. Iran has over 5 mtpa of operating BF capacity, 5 mtpa of operating BOF capacity, 42 mtpa of operating DRI, and 40 mtpa of operating EAF capacity.

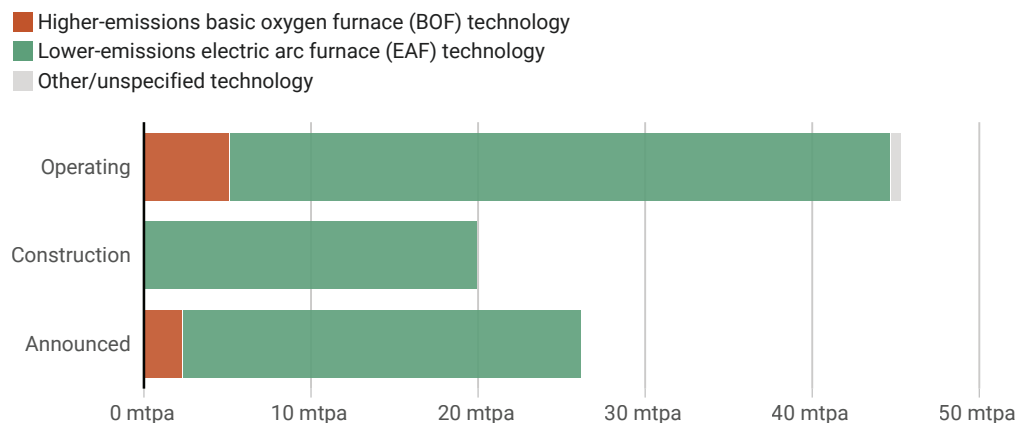
Updates on the transition: Iran has no net zero targets. Iron and steel production in Iran has been dominated by DRI and EAF production methods for many years, due to abundant methane available as a reducing agent for DRI furnaces. Iran has seen large growth in the industry over the past decade due to [goals](#) set over ten years ago by the Iranian Mines & Mining

Industries Development and Renovation Organization (IMIDRO) for approximately 55 mtpa of DRI capacity, 46 mtpa of EAF capacity, and 6 mtpa of BF-BOF capacity by 2025. The country has an estimated [3.8 billion tons](#) of iron ore reserves. The lack of net zero targets in the country and the abundance of cheap methane make it unlikely that the DRI furnace fleet will move towards hydrogen-based reduction.

Coal-based production: While primary steelmaking in Iran is not heavily coal-dependent, the industry's reliance on methane reducing agents in DRI production is expected to continue. Iran has 29 mtpa of DRI capacity under development and 44 mtpa of EAF capacity under development.

Operating and developing steelmaking in Iran primarily uses lower-emissions electric arc furnaces

Steelmaking capacity by status and technology type, million tonnes per year (mtpa)

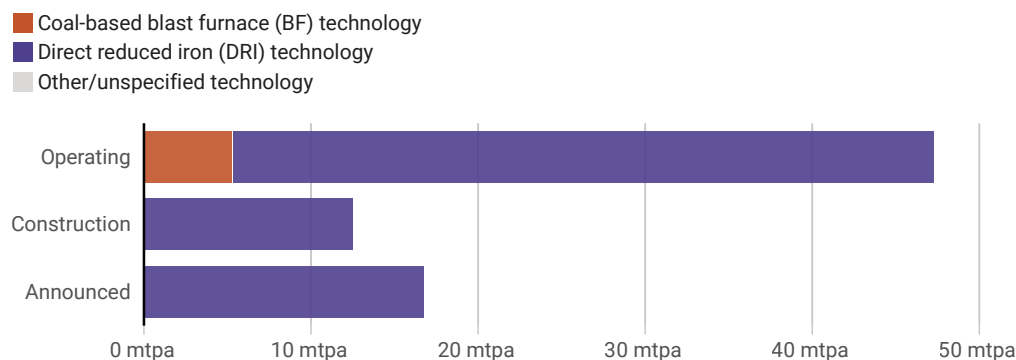


Source: Global Steel Plant Tracker, Global Blast Furnace Tracker, Global Energy Monitor



Operating and developing ironmaking in Iran is primarily direct reduced iron

Ironmaking capacity by status and technology type, million tonnes per year (mtpa)



Source: Global Steel Plant Tracker, Global Blast Furnace Tracker, Global Energy Monitor

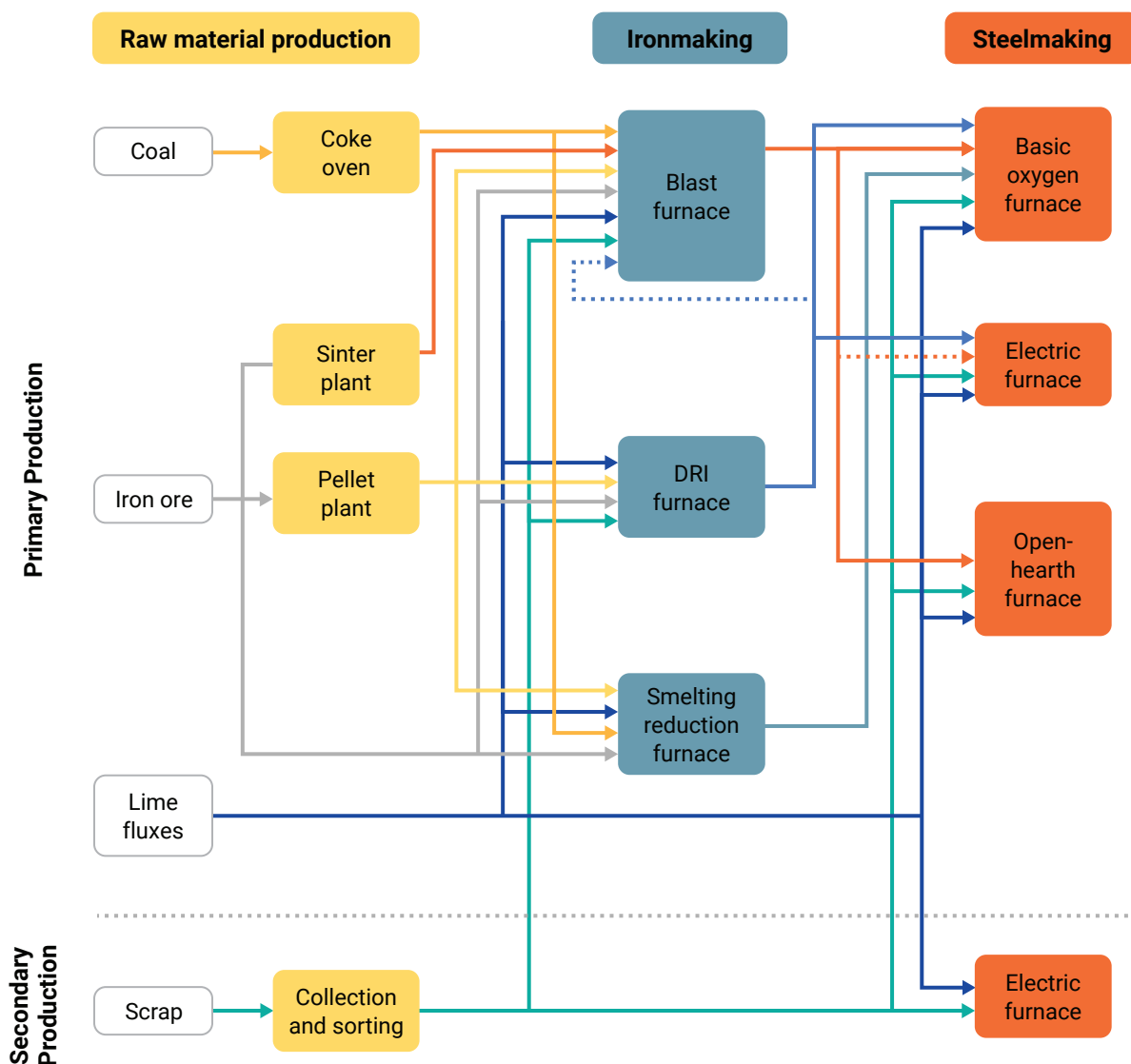


APPENDIX A

Main steel production pathways

Steelmaking currently uses two main production routes: (1) integrated blast furnace-basic oxygen furnace (BF-BOF) and (2) electric arc furnace (EAF) steelmaking, which typically uses a feedmix of direct

reduced iron (DRI) and/or steel scrap. Open-hearth furnaces (OHF) are less commonly used, accounting for <1% of global steel capacity. The figure below displays the main steelmaking pathways.



Source: [Iron and Steel Technology Roadmap](#), IEA, October 2020 as modified by Global Energy Monitor. All rights reserved.



APPENDIX B

Average emissions and energy intensities of main steelmaking pathways

Production route ¹⁹	Average emissions intensity (tonnes CO ₂ per tonne of steel; indirect + direct)	Average energy intensity (GJ per tonne of steel)	Source/notes
BF-BOF	2.2 ^a	20.8 ^{b,20}	^a IEA Iron and Steel Technology Roadmap; ^b Hasanbeigi, A. and Springer, C. 2019
EAF (average)		9.0 ²¹	Hasanbeigi, A. and Springer, C. 2019
EAF (scrap-based)	0.3 ²²	2.1	IEA Iron and Steel Technology Roadmap
EAF (natural gas-based DRI)	1.4	17.1	IEA Iron and Steel Technology Roadmap
EAF (natural gas-based DRI with CCUS)	0.57		IEA Iron and Steel Technology Roadmap
EAF (coal-based DRI; rotary kiln) ²³	3.2		Sohn (2019)
EAF (coal-based DRI; COREX/FINEX) ²⁴	1.3–1.8		Sohn (2019)
EAF (hydrogen-based DRI)	0.71 ²⁵		IEA Iron and Steel Technology Roadmap

19. Open hearth furnace (OHF) steelmaking emissions intensity is not included because it accounts for <1% global steelmaking capacity.

20. Weighted average final energy intensity from top fifteen steel producing countries in 2016.

21. Ibid.

22. Embodied emissions of scrap not included in estimate. [Fan, Z. and Friedmann, J. 2021](#) offers an estimate of 0.8 t CO₂ / t crude steel when considering embodied emissions of scrap steel.

23. Emissions from coal-based DRI range widely based on the production process used. Rotary kilns, which provide continuous DRI production from a cylindrical rotating vessel, result in 3.2 t CO₂ / t crude steel while the COREX/FINEX process, which produces DRI in batches from a series of fluidized bed reactors, results in 1.3–1.8 t CO₂ / t crude steel. The majority of coal-based DRI occurs in India where both rotary kiln and COREX/FINEX processes are used, giving India a blended national carbon intensity of [2.1 t CO₂ / t crude steel](#) for coal-based DRI steel production. [Fan, Z. and Friedmann, J. 2021](#) also offers an estimate of 2.0 t CO₂ / t crude steel.

24. Ibid.

25. The CO₂ intensity for hydrogen-based DRI-EAF steelmaking varies widely based on electricity source. This estimate uses an electricity CO₂ intensity of 144 g CO₂ / kWh, which is the global average CO₂ intensity assumed under the IEA's Sustainable Development Scenario in 2035. This average is roughly 60% [below](#) the 2020 CO₂ intensity of the U.S. power sector (366 g CO₂ / kWh). Using variable renewable energy (VRE) could potentially eliminate CO₂ emissions in steelmaking.

APPENDIX C

Operating steelmaking capacity by country/area and production process

Country/area	Total Capacity	BOF	EAF	Other/unspecified
China	1,074,979	918,223	156,756	0
India	122,560	72,681	36,677	13,202
Japan	109,426	79,223	30,203	0
United States	109,120	33,021	76,099	0
Russia	88,400	53,799	34,601	0
South Korea	83,710	52,400	31,310	0
Türkiye	55,980	13,100	42,880	0
Germany	50,850	38,000	12,550	300
Iran	45,300	5,100	39,600	600
Brazil	43,666	33,210	10,456	0
Italy	30,936	7,800	23,136	0
Vietnam	25,260	16,100	9,160	0
Taiwan	23,600	15,000	8,600	0
Mexico	21,840	2,400	19,440	0
Indonesia	19,700	11,480	8,220	0
Spain	19,440	5,400	14,040	0
France	19,145	11,850	7,295	0
Canada	15,700	9,000	6,700	0
Ukraine	14,575	12,255	2,320	0
Egypt	14,500	0	14,500	0
Malaysia	13,470	6,500	6,170	800
Saudi Arabia	12,330	1,180	10,800	350
United Kingdom	11,120	8,200	2,920	0
North Korea	10,250	4,000	4,000	2,250
Poland	9,690	5,000	4,690	0
Thailand	8,965	0	8,235	730
Algeria	8,050	350	7,700	0
Belgium	8,000	5,000	3,000	0
South Africa	7,850	6,400	1,450	0
Austria	7,570	7,570	0	0
Netherlands	7,500	7,500	0	0
Argentina	7,450	3,500	3,950	0
Kazakhstan	6,800	6,000	800	0
Czech Republic	6,400	6,200	200	0
Australia	5,930	4,400	1,530	0
Bangladesh	5,922	0	3,040	2,882
Romania	5,335	3,200	2,135	0
Sweden	4,813	3,800	1,013	0
Slovakia	4,500	4,500	0	0
Finland	4,375	2,600	1,775	0
Oman	4,300	0	4,300	0
United Arab Emirates	4,000	0	3,600	400
Morocco	3,520	0	3,520	0

Continues on next page

Operating steelmaking capacity by country/area and production process – *continued*

Country/area	Total Capacity	BOF	EAF	Other/unspecified
Belarus	3,000	0	3,000	0
Luxembourg	3,000	0	3,000	0
Greece	2,850	0	2,850	0
Serbia	2,700	2,200	500	0
Iraq	2,600	0	2,600	0
Qatar	2,575	0	2,575	0
Syria	2,200	0	2,200	0
Hungary	2,150	1,600	550	0
Peru	2,000	0	2,000	0
Chile	1,970	1,450	520	0
Pakistan	1,950	0	850	1,100
Bosnia and Herzegovina	1,940	1,140	800	0
Portugal	1,700	0	1,700	0
Libya	1,611	0	1,611	0
Bulgaria	1,400	0	1,400	0
Switzerland	1,370	0	1,370	0
Philippines	1,300	0	1,300	0
Kuwait	1,200	0	1,200	0
Bahrain	1,100	0	1,100	0
Venezuela	1,020	0	1,020	0
Azerbaijan	1,000	0	1,000	0
Kenya	1,000	0	1,000	0
Moldova	1,000	0	1,000	0
Uzbekistan	1,000	0	1,000	0
Ghana	800	0	800	0
Singapore	800	0	800	0
Norway	770	0	770	0
Slovenia	726	0	726	0
Albania	700	0	700	0
New Zealand	650	650	0	0
North Macedonia	550	0	550	0
Angola	500	0	0	500
Guatemala	500	0	500	0
Uganda	450	0	450	0
World	2,206,909	1,482,982	700,813	23,114

Note: Includes steel plants with capacity of at least 0.5 mtpa.

Source: Global Steel Plant Tracker, Global Energy Monitor, April 2024.

APPENDIX D

Operating ironmaking capacity by country/area and production process

Country/area	Total Capacity	BF	DRI	Other/ unspecified
China	887,640	884,803	2,410	427
India	140,725	103,935	33,391	3,400
Japan	81,238	81,238	0	0
Russia	67,047	59,167	7,880	0
South Korea	54,790	50,490	0	4,300
Iran	47,259	5,300	41,959	0
Brazil	33,591	33,591	0	0
United States	32,486	25,826	6,660	0
Germany	32,247	31,647	600	0
Vietnam	16,220	16,220	0	0
Taiwan	16,020	16,020	0	0
Türkiye	14,988	14,988	0	0
Ukraine	12,599	12,599	0	0
France	10,900	10,900	0	0
Indonesia	10,560	10,560	0	0
Algeria	9,500	1,500	8,000	0
Canada	9,048	7,398	1,650	0
Egypt	8,120	0	8,120	0
United Kingdom	7,770	7,770	0	0
Mexico	7,512	1,452	6,060	0
Malaysia	7,300	6,400	900	0
Venezuela	6,800	0	6,800	0
Austria	6,650	6,650	0	0
Saudi Arabia	6,450	0	6,450	0
Netherlands	6,310	6,310	0	0
Argentina	5,575	4,015	1,560	0
Kazakhstan	5,400	5,400	0	0
Belgium	5,000	5,000	0	0
Slovakia	5,000	5,000	0	0
Spain	4,700	4,700	0	0
South Africa	4,603	3,200	1,403	0
Poland	4,500	4,500	0	0
Australia	4,200	4,200	0	0
Czech Republic	4,200	4,200	0	0
Sweden	4,114	4,105	9	0
United Arab Emirates	4,000	0	4,000	0
North Korea	3,550	3,550	0	0
Finland	2,600	2,600	0	0
Romania	2,100	2,100	0	0
Italy	2,000	2,000	0	0
Trinidad and Tobago	2,000	0	2,000	0
Oman	1,820	0	1,820	0
Libya	1,750	0	1,750	0

Continues on next page

Operating ironmaking capacity by country/area and production process – *continued*

Country/area	Total Capacity	BF	DRI	Other/ unspecified
Bahrain	1,600	0	1,600	0
Qatar	1,600	0	1,600	0
Chile	1,482	1,482	0	0
Uganda	1,200	0	1,200	0
Bosnia and Herzegovina	1,100	1,100	0	0
Serbia	1,000	1,000	0	0
Hungary	660	660	0	0
New Zealand	650	0	650	0
Kenya	500	0	500	0
Syria	300	300	0	0
Angola	96	96	0	0
Peru	80	0	80	0
World	1,611,150	1,453,972	149,052	8,127

Note: Includes plants with capacity of at least 0.5 mtpa.

Sources: Global Steel Plant Tracker, Global Energy Monitor, April 2024.

Global Blast Furnace Tracker, Global Energy Monitor, April 2024.

APPENDIX E

Steel capacity under development by technology type

Basic Oxygen Furnace			
Country/area	Announced BOF capacity (ttpa)	BOF capacity under construction (ttpa)	Total BOF capacity under development (ttpa)
India	152,658	24,420	177,078
China	54,655	43,464	98,119
Vietnam	14,000	8,900	22,900
Indonesia	22,750	0	22,750
Philippines	0	12,000	12,000
Malaysia	6,600	5,000	11,600
Cambodia	4,100	0	4,100
Myanmar	4,000	0	4,000
Iran	2,280	0	2,280
Nigeria	0	1,300	1,300
Kazakhstan	665	0	665
Sri Lanka	0	600	600
World	261,708	95,684	357,392

Electric Arc Furnace			
Country/area	Announced EAF capacity (ttpa)	EAF capacity under construction (ttpa)	Total EAF capacity under development (ttpa)
China	28,770	22,106	50,876
Iran	23,850	19,900	43,750
India	22,194	11,910	34,104
Germany	17,900	0	17,900
Vietnam	17,180	0	17,180
Philippines	11,000	1,800	12,800
Türkiye	7,900	3,400	11,300
United States	2,590	8,088	10,678
Saudi Arabia	8,000	1,540	9,540
Sweden	5,000	4,000	9,000
Netherlands	8,080	0	8,080
France	6,500	0	6,500
Russia	3,550	2,800	6,350
South Korea	3,500	2,800	6,300
Canada	2,400	3,700	6,100
United Kingdom	5,680	0	5,680
Italy	3,000	2,500	5,500
Finland	5,100	0	5,100
Oman	0	5,100	5,100
Mexico	1,200	3,600	4,800
Romania	4,100	500	4,600
Namibia	0	4,500	4,500
Algeria	3,800	0	3,800

continues on next page

Steel capacity under development by technology type – *continued*

Electric Arc Furnace – <i>continued</i>			
Country/area	Announced EAF capacity (ttpa)	EAF capacity under construction (ttpa)	Total EAF capacity under development (ttpa)
Spain	3,700	0	3,700
South Africa	3,600	0	3,600
Czech Republic	0	3,500	3,500
Austria	0	3,300	3,300
Japan	3,000	115	3,115
Nigeria	3,000	0	3,000
Uzbekistan	0	2,800	2,800
Belgium	2,500	0	2,500
Australia	2,000	0	2,000
Thailand	2,000	0	2,000
Brazil	200	1,500	1,700
Indonesia	1,700	0	1,700
Egypt	0	1,600	1,600
Hungary	1,600	0	1,600
Taiwan	1,500	0	1,500
Azerbaijan	1,250	0	1,250
Bangladesh	0	1,250	1,250
Luxembourg	1,250	0	1,250
Poland	1,000	0	1,000
Argentina	950	0	950
Bolivia	500	200	700
Hong Kong	700	0	700
New Zealand	0	650	650
Iraq	0	500	500
Malaysia	500	0	500
Mozambique	0	500	500
Myanmar	0	500	500
World	222,244	114,659	336,903

APPENDIX F

Iron capacity under development by technology type

Blast Furnace			
Country/area	Announced BF capacity (ttpa)	BF capacity under construction (ttpa)	Total BF capacity under development (ttpa)
China	73,006	54,811	127,817
India	97,122	24,860	121,982
Vietnam	10,000	6,180	16,180
Malaysia	6,600	5,000	11,600
Indonesia	3,000	2,800	5,800
Zimbabwe	3,800	1,200	5,000
Cambodia	4,100	0	4,100
Myanmar	4,000	0	4,000
Russia	3,700	0	3,700
Philippines	0	3,580	3,580
Nigeria	0	1,355	1,355
Brazil	1,200	0	1,200
Kazakhstan	728	0	728
Angola	424	0	424
Japan	0	50	50
Pakistan	50	0	50
World	207,730	99,836	307,566

Direct Reduced Iron			
Country/area	Announced DRI capacity (ttpa)	DRI capacity under construction (ttpa)	Total DRI capacity under development (ttpa)
India	25,387	9,060	34,447
Iran	16,750	12,510	29,260
Oman	7,250	2,250	9,500
Germany	9,350	0	9,350
Russia	6,660	2,500	9,160
Saudi Arabia	7,500	0	7,500
Sweden	4,800	2,100	6,900
South Korea	6,500	300	6,800
France	6,500	0	6,500
Netherlands	6,310	0	6,310
Australia	6,300	0	6,300
United States	6,000	0	6,000
Spain	4,300	0	4,300
Uzbekistan	3,600	0	3,600
Algeria	2,500	0	2,500
Belgium	2,500	0	2,500
Canada	2,500	0	2,500
Malaysia	2,500	0	2,500
Romania	2,500	0	2,500

continues on next page

Iron capacity under development by technology type – continued

Direct Reduced Iron – continued			
Country/area	Announced DRI capacity (ttpa)	DRI capacity under construction (ttpa)	Total DRI capacity under development (ttpa)
Bangladesh	2,200	0	2,200
Mexico	0	2,100	2,100
Finland	2,000	0	2,000
Italy	2,000	0	2,000
Azerbaijan	1,250	0	1,250
Mozambique	0	1,100	1,100
China	1,000	0	1,000
Namibia	0	1,000	1,000
Nigeria	0	1,000	1,000
Myanmar	0	500	500
Bolivia	0	250	250
World	138,157	34,670	172,827