Pedal to the Metal

2022

IT'S NOT TOO LATE TO ABATE EMISSIONS FROM THE GLOBAL IRON AND STEEL SECTOR

Caitlin Swalec

ABOUT GLOBAL ENERGY MONITOR

Global Energy Monitor (GEM) develops and shares information on energy projects in support of the worldwide movement for clean energy. Current projects include the Global Steel Plant Tracker, Global Coal Mine Tracker, Global Coal Plant Tracker, Global Fossil Infrastructure Tracker, Europe Gas Tracker, CoalWire newsletter, Global Gas Plant Tracker, Global Registry of Fossil Fuels, Global Solar Power Tracker, Global Wind Power Tracker, Latin America Energy Portal, and GEM.wiki. For more information, visit www.globalenergymonitor.org.

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 five thousand tonnes per year (mtpa) or more of crude iron or steel. The GSPT includes all plants meeting the one mtpa threshold that have been proposed or are under construction since 2016 or retired or mothballed since 2020.

AUTHORS

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ABOUT THE COVER

The cover photo shows the retired Iron Blast Furnace #1 at the ironworks in Ostrava, Czech Republic. The retired furnace is now home to a museum and restaurant. Copyright © Tomáš Píšek, 2021.

EDITING AND PRODUCTION

Edited by James Browning, Global Energy Monitor. Design by Charlene Will and Mimi Heft. Additional design and page layout by David Van Ness.

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FURTHER RESOURCES

For additional data on proposed and existing steel plants, see Summary Data of the Global Steel Plant Tracker (GSPT). For links to reports based on GSPT data, see Reports & Briefings. To obtain primary data from the GSPT, see Download Data.

ACKNOWLEDGEMENTS

This report was made possible with the support of ClimateWorks Foundation. The authors would like to thank Rebecca Dell of ClimateWorks Foundation, Chan Yang of the European Climate Foundation, Tom Hoskyns of Global Strategic Communications Network (GSCC), Margaret Hansbrough of Third Coast Climate Solutions, Ali Hasanbeigi of Global Efficiency Intelligence (GEI), and Matthew Gray and Badr M'barek of Transition Zero for their valuable input to this report.

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EXECUTIVE SUMMARY

Steel is essential for decarbonizing our energy system. We use it to build solar panels, wind turbines, and transmission towers. At the same time, the global iron and steel industry is currently responsible for 11% of global carbon dioxide emissions and 7–9% of global greenhouse gas emissions. In addition to energy projects, we use steel for buildings, bridges, medical devices, and other important applications. As economies develop and build up infrastructure, global demand for steel will continue increasing.

While there is no single "silver bullet" solution for decarbonizing the steel industry, many of the steps that must be taken at iron and steel plants to reduce sector emissions are clear, such as rapidly transitioning from dirtier Blast Furnace-Basic Oxygen Furnace (BF-BOF) steelmaking to cleaner Electric Arc Furnace (EAF) steelmaking. This report serves to provide an assessment of the global iron and steel plant fleet, including capacity that is operating and capacity under development, based on the March 2022 update of the Global Steel Plant Tracker.

Key points:

- **Shift away from BF-BOF capacity is too slow:** Current proposals and steel plants under construction put the global shift from BF-BOF to EAF steelmaking capacity dangerously behind decarbonization targets laid out in the IEA's Net-zero 2050 report. Currently 31% of operating steelmaking capacity uses EAF technology, but only 28% of capacity currently under construction will use EAF technology. By 2030, at least 37% of steelmaking capacity should use EAF technology, and 53% by 2050.

- **Asia is the steel capacity development hotspot:** 80% of the BF-BOF steelmaking capacity under development is planned in China (158 mtpa) and India (123 mtpa). An additional 14% is planned in Indonesia (24 mtpa), Vietnam (16 mtpa), and Malaysia (12 mtpa).

- **Stranded asset risk is much higher than previously thought:** Stranded asset risk is as much as 518 billion USD, approximately seven times the amount previously thought ($47–70 billion). New pledges to lower national emissions and improved tracking of steel plant projects under development reveal significantly greater stranded asset risk if efforts are not made to cancel or change current steel capacity development plans.

- **Clear standards, definitions, policies needed:** The transition from BF-BOF technology to EAF technology will be driven by market demand, policy interventions, and producer incentives for lower emissions steel. In order to create green steel demand and to develop policies and incentives for lower emissions steel production, clear, emissions-based definitions of low-emissions vs. near-zero emissions vs. net-zero emissions are critical.

- **Underreported emissions from coal mining:** The full emissions footprint of steelmaking may be drastically greater than reported when coal mine methane emissions are considered. The steel industry currently emits approximately 2.6 Gt direct CO_2 emissions and 1.1 Gt indirect CO_2 emissions from the power sector and combustion of steel off-gases. Methane emissions from metallurgical coal mining could add an additional 1 Gt CO_2-e20 to this footprint, a 27% increase.

ABOUT THE GLOBAL STEEL PLANT TRACKER

Since 2021, GEM has provided a publicly-accessible database that identifies, maps, and records plant-level details such as plant ownership, production capacity, production process/technology, and geolocation for all crude iron and steel plants with capacity of 0.5 million tonnes per annum (mtpa) or greater, covering over 90% of global capacity. GEM's dataset provides a robust view of the current and developing global iron and steel plant fleet, and the opportunity to examine the status of the iron and steel sector compared to global decarbonization roadmaps and corporate and country level net-zero pledges.

The majority of operating steelmaking capacity relies on conventional, coal-based steelmaking processes. In order to align with mid-century net-zero emissions goals, new investments and reinvestments in coal-based steelmaking must be stopped and steelmaking capacity must be transitioned to lower emissions steelmaking technology. Recent publications of steel decarbonization pathways show that it is not too late to abate the steel sector and align with mid-century global energy net-zero carbon emission plans through the use of material efficiency and novel low-emissions and net-zero steelmaking technologies. However, based on current steel capacity development plans, the steel industry is not on track to meet goals to shift the fleet away from coal-based blast furnace-basic oxygen furnace steelmaking and immediate action must be taken.

ACRONYMS

BAT	best available technology
BF	blast furnace
BOF	basic oxygen furnace
DRI	direct reduced iron
EAF	electric arc furnace
Mt	million metric tonnes
$MtCO_2e$	metric tonnes carbon dioxide equivalent
MTPA	million tonnes per annum
NZE	IEA's Net-zero by 2050 scenario (1.5°C by 2050)
OHF	open hearth furnace
SDS	IEA's Sustainable Development Scenario (1.5°C by 2070)
TTPA	thousand tonnes per annum

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BACKGROUND

Steel is one of the most important manufactured resources in the world. Every year over 500 lbs., or nearly a quarter tonne of steel is produced per person in the world. In addition to countless applications in engineering, construction, medicine, and technology, steel is essential for decarbonizing our energy system—we use it to build solar panels, wind turbines, and transmission towers. At the same time, the global iron and steel industry is currently responsible for 11% of global carbon dioxide emissions and 7–9% of global greenhouse gas emissions. As economies develop and build up infrastructure, global demand for steel will continue increasing. In the recovery from the global Covid-19 pandemic, steel demand grew by 2.7% in 2021 after declining 0.2% in 2020.[1] According to the World Steel Association, steel demand is forecasted to grow 0.4% in 2022 and a further 2.2% in 2023.

Given our dependence on steel, we must address the climate impact of this sector, which means we must mitigate the carbon footprint of the global iron and steel industry. In order to meet global climate and energy goals, the current dominance of carbon-intensive steelmaking processes in operating and developing plants must be challenged and emissions reduced through a combination of strategies including material efficiency to lessen demand, increased reuse and recycling, and production decarbonization through retrofits and advanced technology.

This report provides an assessment of the global iron and steel plant fleet, including capacity that is operating and capacity under development, based on the March 2022 update of the Global Steel Plant Tracker. GEM's original report, 2021 Pedal to the Metal: No Time to Delay Decarbonizing the Global Steel Sector, provided an overview of the global steel fleet as well as a detailed assessment of steel decarbonization roadmaps at the global and national (for major steel producers) level. For an overview of the main steelmaking processes, see Appendix A.

1. Although preliminary reports of global crude steel production estimated a 0.9% decline in 2020, final production data from the World Steel Association show that the annual average global crude steel output actually held steady from about 1,875 mtpa in 2019 to 1,880 mtpa in 2020.

STEEL INDUSTRY DECARBONIZATION OPTIONS

There is no silver bullet solution for decarbonizing the iron and steel industry. However, it is time to challenge the classification of the steel industry as "hard-to-abate." It is true that each steel plant has a unique configuration of production technologies, raw material and energy sources, capacities and yields, regulatory requirements, and more. But it is also true that the array of technologies and tools for decarbonizing steel have advanced to a stage where there is a growing number of well-established pathways laid out for decarbonizing the steel sector by 2050.[2]

The main solutions are clear (see Appendix B). We need to reduce, reuse, and recycle as much steel as possible (i.e., enhance material efficiency). We need to continue investing in, developing, and bringing to market key decarbonization technologies, especially green hydrogen-based DRI technology, which means that we need to both decarbonize the energy grid and build out hydrogen electrolyzer capacity. We need to shift the capacity of the global steel industry from coal-based blast furnace basic oxygen furnace steelmaking to low-to-zero emissions steelmaking technologies.

These key changes in the iron and steel industry will be driven by policies and economic tools that incentivize steelmakers to use less raw materials and lower emissions. Consumers, investors, and policymakers at every level of government must strive for these changes. Current international efforts to decarbonize the steel industry include the Clean Energy Ministerial's Industrial Deep Decarbonization Initiative (IDDI), which aims to develop a global strategy to decarbonize the steel industry by 2050 through public procurement policies, SteelZero, a net-zero steel procurement pledge organization, and ResponsibleSteel, a steel standard and certification initiative.

Nearly half the global steel fleet (49%) is located in China, including 60% of production that uses higher emissions, coal-based BF-BOF technology. A successful global decarbonization of the iron and steel sector depends on a successful decarbonization of China's iron and steel industry. China must raise ambition and accelerate its transition away from BF-BOF steelmaking; however, in February 2022 three government ministries advocated for pushing China's deadline for achieving peak emissions in the iron and steel sector from "before 2025" to "by 2030." The international community must support and incentivize steelmakers in China and around the world to transition to lower emissions steel production through trade measures, green steel demand, and other policy measures.

One major challenge for effective decarbonization policies and trade agreements in the steel sector is the development of clear definitions, certifications, and standards around "green" steel terminology. The ambition for green steel certifications and standards must be raised to increase transparency in the raw materials and emissions associated with steel products or else the industry risks labeling high-emissions, coal-based steel products as "green" based on a broad definition of "responsible" or "green" steel production. Furthermore, we must establish a clear, internationally agreed upon distinction between low-emissions steel technologies that can serve as intermediate mitigation tactics and near-zero steel technologies that offer long-term solutions for steel decarbonization.

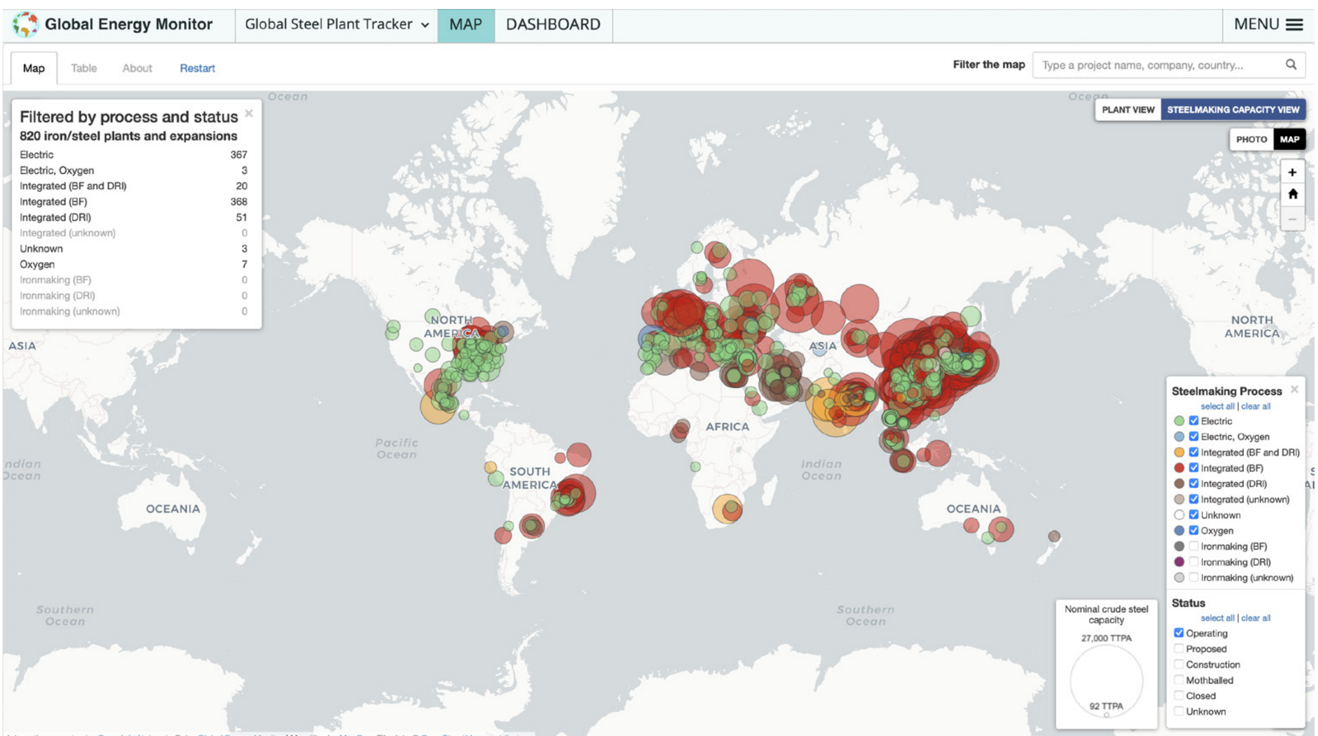
2. Recently published steel sector decarbonization roadmaps include IDDRI's Net Zero Steel project; the IEA's Iron and Steel Technology Roadmap and Net-Zero by 2050 report; McKinsey & Company's Decarbonization challenge for steel and The net-zero transition, The future of the European steel industry, and Tackling the challenge of decarbonizing steelmaking reports; OECD's Low and Zero emissions in the steel and cement industries issue paper; Mission Possible Partnership's Net-Zero Steel Initiative; World Steel Association's Climate change and the production of iron and steel policy paper; and various scientific journal articles.

CURRENT STATUS OF GLOBAL STEEL PLANT FLEET

The Global Steel Plant Tracker (GSPT) documents all crude iron and steel plants around the world with crude iron or steelmaking capacity of at least 0.5 million tonnes per annum (0.5 mtpa). The GSPT serves to provide current and accurate data on the status of the global steel plant fleet. Providing such data supports efforts to track and analyze steel sector decarbonization, which is essential in order to meet the Paris Agreement 1.5°C pathway.

The GSPT covers 2,208 mtpa operating crude steelmaking capacity, approximately 90% of global capacity according to OECD estimates.[3] The GSPT also covers 1,417 mtpa operating blast furnace capacity and 123 mtpa operating DRI capacity, approximately 89% and 90% of global capacity, respectively.[4] Additionally, the GSPT covers all crude iron and steel plants under development as of March 1, 2022, making this the most up-to-date comprehensive tracker of global steel capacity developments.[5]

Figure 1: Global operating steelmaking capacity by type



Source: Global Steel Plant Tracker, Global Energy Monitor, March 2022.
Note: includes steel plants with capacity of at least 0.5 mtpa.

3. GEM Global Steel Plant Tracker, March 2022. The OECD reported 2,454 mtpa crude steelmaking capacity in 2021.

4. Global estimates of operating blast furnace capacity are limited and lacking transparency, but recent estimates based on a combination of private and public sources estimate 1,600 mtpa. Global estimates of operating DRI capacity are also limited and difficult to find because of the high number of small rotary kiln operations, but recent estimates are approximately 138 mtpa.

5. Plants "under development" include iron and steel plants that have been proposed or are in any stage of planning or construction prior to beginning crude iron/steel production. Only plants under development meeting our tracker criteria (at least 0.5 mtpa crude iron or steel capacity) were considered. Proposals or plants under construction that have not made any reported or physically observable advancement towards operations in the past five years were considered to be "cancelled."

According to the GSPT, approximately 61.1% (1,349 mtpa) of global crude steel capacity currently uses the basic oxygen furnace (BOF) route, 27.3% (603 mtpa) uses electric arc furnace (EAF) steelmaking, and 0.4% (10 mtpa) uses open hearth furnace (OHF) steelmaking. The remaining 11.2% (248 mtpa) of capacity has not been distinguished between BOF, EAF, and OHF.[6] From the steelmaking capacity of known technologies, 69% is BOF, 31% is EAF, and less than 1% is OHF.

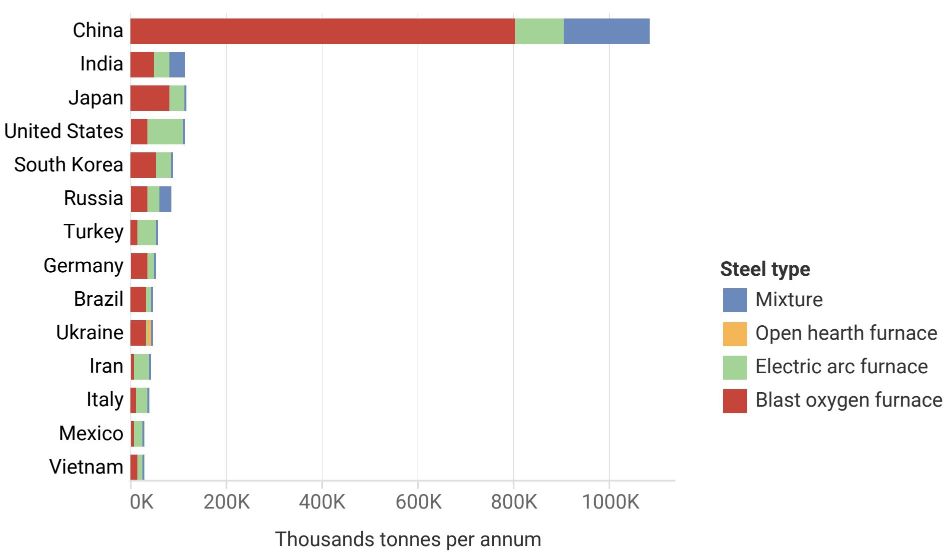
Crude steel capacity is largely concentrated in Asia, with a significant share in the United States as well. China accounts for 49% (1083 mtpa) of the operating steelmaking capacity in the GSPT, followed by India (114 mtpa), Japan (113 mtpa), and the United States (109 mtpa). However, when only BOF steelmaking is considered, China accounts for 60% (804 mtpa) of global capacity. (see Appendix C for full list of operating steelmaking capacity by type and country). (Figure 2a.)

According to the GSPT, 91.2% (1,417 mtpa) of global crude iron capacity currently uses the blast furnace technology and 7.9% (123 mtpa) uses DRI technology. Only 0.9% (14 mtpa) of iron capacity in the GSPT could not be distinguished as blast furnace or DRI technology.

Like steel, iron capacity is largely concentrated in Asia. China accounts for 56% (875 mtpa), followed by Japan (98 mtpa), India (85 mtpa), Russia (63 mtpa), and Ukraine (43 mtpa). Iran also has a notable iron industry with 26 mtpa DRI capacity, second only to India's DRI industry (28 mtpa DRI capacity). Together, India and Iran account for 44% of the operating DRI capacity in the GSPT. (see Appendix D for full list of operating ironmaking capacity by type and country). (Figure 2b, on the next page.)

The average age of the existing global fleet of BF and direct reduced iron (DRI) furnaces is 13 years and 14 years, respectively. Over half the world's global iron

Figure 2a: Steelmaking capacity by technology type



Source: Global Steel Plant Tracker, Global Energy Monitor, March 2022.
Note: includes iron and steel plants with capacity of at least 0.5 mtpa.

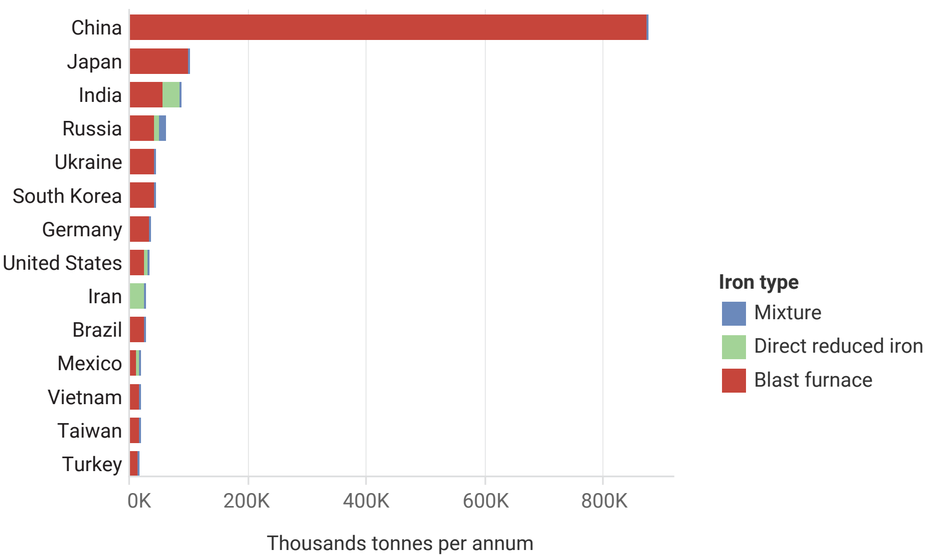
6. Open hearth furnace steelmaking combusts fuel to convert steel scrap and/or pig iron to crude steel. OHF steelmaking has been almost completely replaced by BOF and EAF steelmaking.

fleet is BF based capacity in China, where the average age for BFs is 12 years. BF and DRI furnaces are typically operated for around 40 years with investment cycles of 15–20 years for BFs and 20 or more years for DRI plants,[7] though refurbishments may extend their overall lifetime by several decades.

By 2030, 1090 Mt of existing coal-based blast furnaces (77% of the BF fleet in the GSPT) will reach the end of their working life and the start of their next reinvestment cycle. China accounts for 730 Mt of this BF capacity facing reinvestment. This means that over the next decade, plant owners will need to decide whether to spend hundreds of millions of dollars refurbishing these BFs or shut them down. Refurbishing a typical BF costs around one-third to one-half of a new blast furnace (approximately $0.3 billion USD) and results in substantial revenue loss during the maintenance period for refurbishment (estimated around $1 billion USD over 3 months). With each reinvestment in a BF unit, the plant operator commits to operating the unit until they recoup their investment costs and losses or until an economically favorable opportunity to switch operations arises.

Thus, each BF reinvestment cycle is an inflection point at which an integrated steelmaker is most capable of switching to a low-emissions steelmaking technology. As each BF unit comes up against its reinvestment cycle, a plan must be made for switching the unit to low-emissions steelmaking technology, whether that means an immediate, full retirement/replacement of BF capacity, or a limited maintenance plan to prolong the lifetime of the asset by no more than 2–5 years until it can be fully retired/replaced by low-emissions processes. By 2025, there should be no further reinvestments in BFs, in order to minimize long-term carbon lock-in and additional stranded asset risk.

Figure 2b: Ironmaking capacity by technology type



Source: Global Steel Plant Tracker, Global Energy Monitor, March 2022.
Note: includes iron and steel plants with capacity of at least 0.5 mtpa.

7. DRI investment cycles are estimated at 20 to 25 years, though some estimates are longer due to the relatively low operating temperatures of some DRI plants. Blast furnace investment cycles are estimated at around 15 to 20 years, though lengths vary significantly depending on the unit configuration, intensity of production, and level of maintenance performed on the unit. Some sources estimate investment cycles as low as 10 to 15 years or approaching 30 years, though most sources cite approximately 15 to 20 years under typical operation and maintenance. A recent study found that the length of reinvestment cycles for blast furnaces decreases with each subsequent relining, from approximately 19 years to 10.5 years. The IEA estimates a combined average investment cycle for BF and DRI at 25 years.

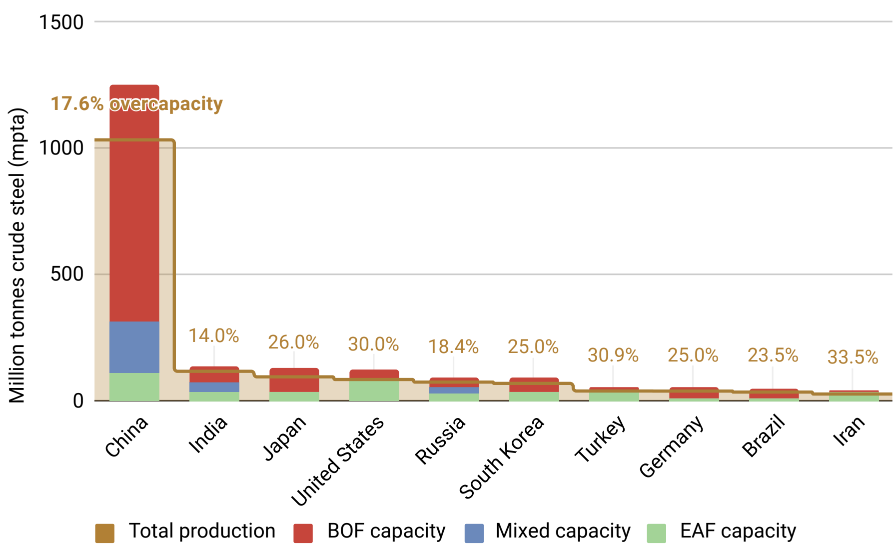
STEELMAKING CAPACITY UNDER DEVELOPMENT

Global overcapacity and utilization trends

The OECD reported a global excess capacity of 544 million tonnes of crude steel in 2021. While this represents a decrease of overcapacity from the 625 Mt reported in 2020, global excess capacity has persisted around 25% since 2018.[8] Additionally, current development plans and investments in crude steel capacity indicate that the global trend of overcapacity will continue unless expansion plans are cancelled or scaled back. While overcapacity presents serious profitability challenges for steelmakers as they struggle to operate with lower capacity utilization rates,[9] strategic decisions to switch production technology at operating plants, close higher emissions steel plants, and/or cancel planned capacity expansions create an opportunity to move the global steel industry toward lower emissions steelmaking. The top ten steel producers in 2021 averaged 75% capacity utilization (see Figure 3).

Global crude steel capacity was essentially unchanged from 2020 (2453 Mt) to 2021 (2454 Mt). According to the GSPT, over 16 Mt crude steel capacity was closed in 2021 while 14 Mt was added.[10] All 16 Mt of capacity closed in 2021 was BOF production in China while the new steel capacity was split between BOF technology (7.5 Mt all located in China) and EAF technology (2 Mt each at two plants in China, and the remaining split between a plant in Peru and a plant in Iran). Another 38 Mt crude steel capacity (22 Mt BOF, 12 Mt EAF, and 4 Mt unspecified technology) was under development with an intended start date of 2021. By the end

Figure 3: 2021 overcapacity in top steel producers



Source: Production data from World Steel Association (2021). Capacity data from Global Energy Monitor's Global Steel Plant Tracker (2022), CarbonBrief (2020), and the OECD (2022).
Note: includes steel plants with capacity of at least 0.5 mtpa.

8. Global overcapacity in the steel industry has challenged the steel industry since the global financial crisis of 2008, leading to the creation of the Global Forum on Steel Excess Capacity (GFSEC) in 2016.

9. Typically capacity utilization rates of 80% to 90% are required for a steel plant to remain profitable. Steel capacity exceeding more than 90% of demand is considered to be overcapacity.

10. The OECD published their latest capacity development data in September 2021, which may account for the slight discrepancy between GEM's reported net loss of 2 Mt crude steel capacity and the OECD's reported net gain of 1 Mt crude steel capacity.

of 2021, 30 Mt of this capacity (18 Mt BOF, 11 Mt EAF, 1 Mt unspecified technology) had reached the construction phase, while the remaining had not shown further signs of advancement beyond the proposal stage. Delays in plant operation and changes to construction/proposal plans may be due to the ongoing impacts of the Covid-19 pandemic, shifting pressures on the global supply chain, change capacity restriction policies, and general construction delays.

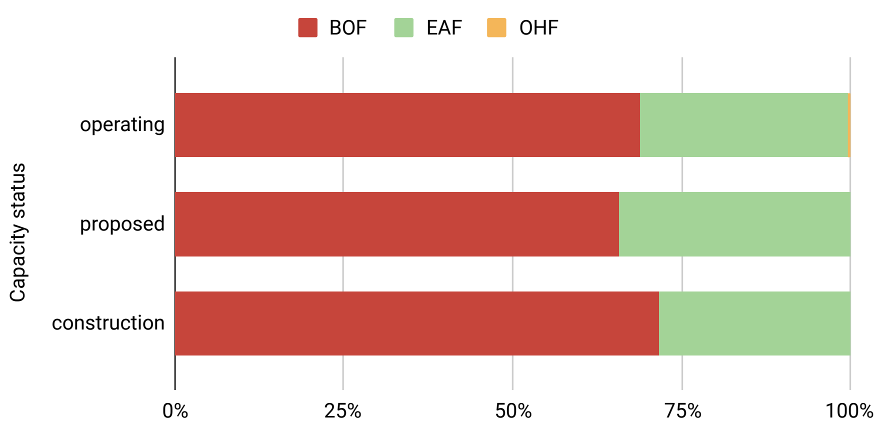
Behind target on shift away from BF-BOF steelmaking

Over 598 mtpa steelmaking capacity is currently under development of which 59% (352 mtpa) uses the BOF route and 28% (170 mtpa) uses EAF steelmaking, according to the GSPT. The share of BOF and EAF steelmaking for the remaining 13% (76 mtpa) of capacity is unknown. Of the steelmaking capacity under development with known steelmaking processes, 67% uses the BOF route and only 33% uses EAF steelmaking, compared to 69% and 31%, respectively, of operating steelmaking capacity (see Figure 4). However, of the most advanced steel projects under development (having entered the "construction" phase), 72% of capacity is BOF and only 28% is EAF. Not only are we behind in the shift from BOF to EAF steelmaking capacity, but under current development plans, the situation is actually getting worse.

This might indicate that proposed plants using BOF technology are more likely to reach operation than plants using EAF or that newly proposed steel plant developments are shifting towards more EAF projects. More information is needed to confirm either of these possibilities. However, it is clear that we are not only behind in the shift from BOF to EAF steelmaking capacity, but that the situation is actually going to get worse (i.e. 72% of steelmaking capacity under construction is BOF, compared to 69% of operating capacity) without intervention. In order to shift the majority share of global steelmaking capacity from BOF to EAF, some of the BOF capacity under development must be canceled and/or more operating BOF capacity must be retired.

With the current proposals and plants under construction, the global steelmaking capacity in the GSPT could potentially grow from 2,208 mtpa in 2022 to 2,488 mtpa in 2030 and 2,620 mtpa in 2050 if the lives of currently operating assets are extended through reinvestment. However, shares of capacity by steelmaking technology would only shift from 69% BOF and 31% EAF in 2022 to 68% BOF and 32% EAF in 2030, and remain the same through to 2050. Thus, shifting the balance in steelmaking production technology from BOF to EAF will only be possible if action is

Figure 4: Share of steel capacity operating and under development by technology



Source: Global Steel Plant Tracker, Global Energy Monitor, March 2022.
Note: includes steel plants with capacity of at least 0.5 mtpa.

taken to retire currently operating BOF capacity, cancel BOF capacity under development, and increase the share of EAF capacity under development.

According to the IEA's Net-zero by 2050 scenario, the share of EAF steelmaking capacity should reach 37% by 2030 and 53% by 2050. In order to reach the goal of 53% EAF steelmaking capacity and meet the projected 12% increase in demand for steel by 2050, an additional 576 mtpa EAF capacity would need to be added while at the same time canceling or retiring 419 mtpa BOF capacity.[11] In summary, the current plans for steelmaking capacity development put the global shift towards EAF steelmaking well behind decarbonization targets (see Figure 5).

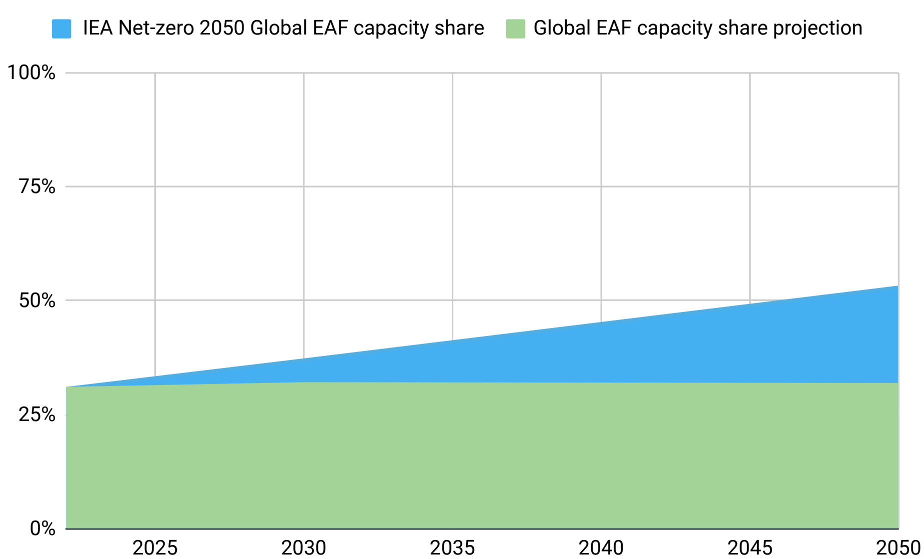
Majority of steel developments concentrated in Asia

Steelmaking plants of at least 0.5 mtpa are under development in 36 countries. If all steel plants proposed and under construction are completed as planned, China and India will account for over 66% of new steelmaking capacity with approximately 36% (216 mtpa) in China and 30% (179 mtpa) in India (see Figure 6, on the next page).

BF-BOF steelmaking capacity under development

While China and India have pledged carbon neutrality by 2060 and 2070, respectively, 80% of the BF-BOF steelmaking capacity under development globally is planned in China (158 mtpa) and India (123 mtpa). An additional 14% of the BF-BOF steelmaking capacity under development is planned for Indonesia (24 mtpa), Vietnam (16 mtpa), Malaysia (12 mtpa), and eight other countries (see Appendix E for a complete list).

Figure 5: Current plans for steelmaking capacity development put shift towards EAF production behind decarbonization targets



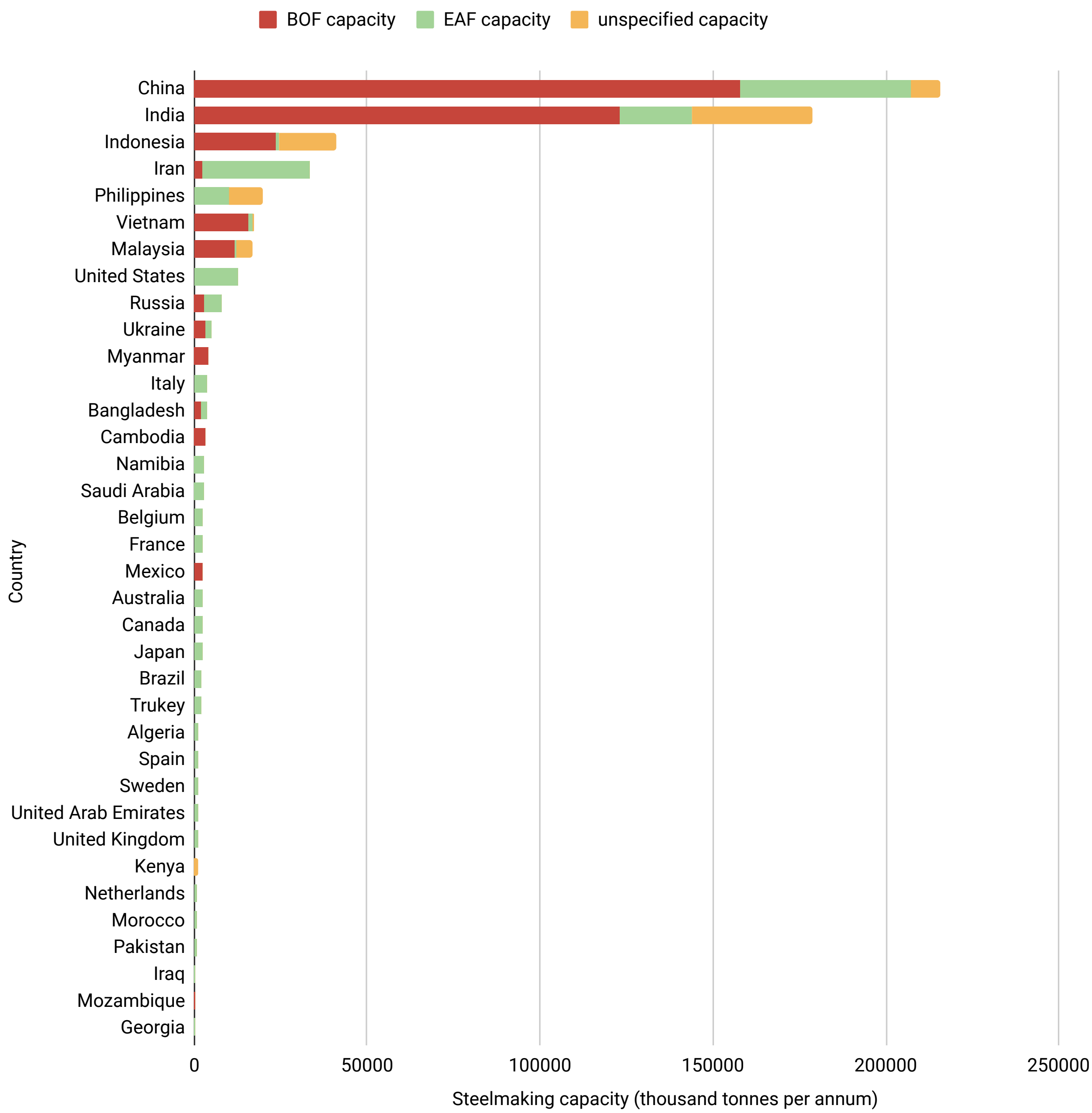
Source: EAF capacity projection data from Global Steel Plant Tracker, Global Energy Monitor, March 2022.
EAF capacity net-zero projection from 1.5C pathway in IEA Net-zero by 2050.

11. These calculations are made assuming that all existing OHF capacity (9 mtpa) is retired by 2050 and current capacity utilization rates remain the same (and thus, current overcapacity rates also remain the same).

EAF steelmaking capacity under development

The EAF steelmaking capacity under development is more spread out than BF-BOF steelmaking capacity under development, with 170 mtpa in 32 countries. China accounts for 29% (49 mtpa) of EAF steelmaking capacity under development, followed by Iran with 18% (31 mtpa), India with 12% (21 mtpa), the United States with 7% (12 mtpa), and the Philippines with 6% (10 mtpa) (see Appendix E for a complete list).

Figure 6: Steelmaking capacity under development by technology type



Source: Global Steel Plant Tracker, Global Energy Monitor, March 2022.
Note: includes steel plants with capacity of at least 0.5 mtpa.

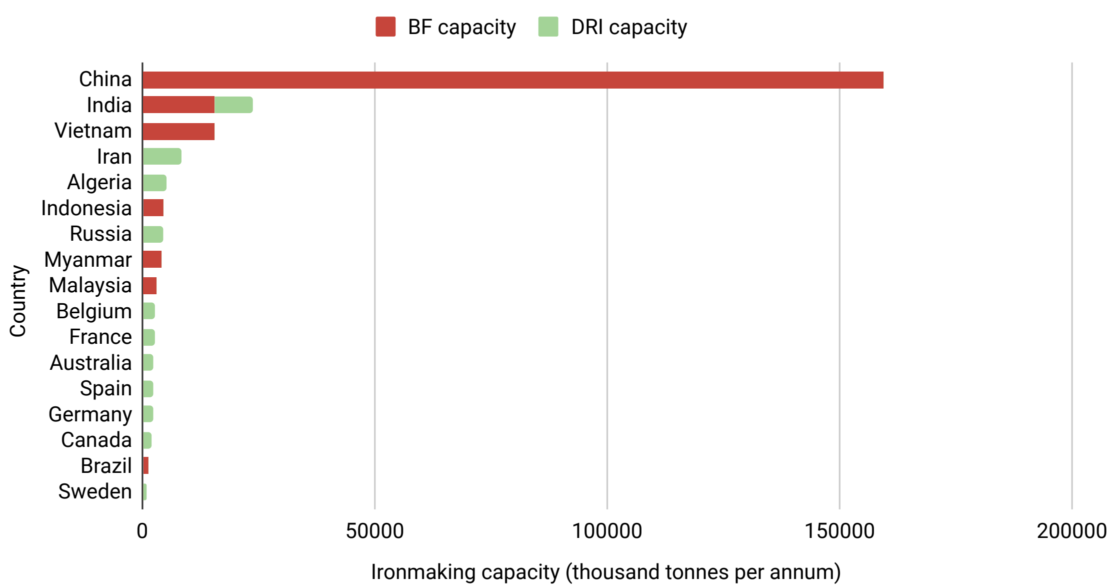
IRONMAKING CAPACITY UNDER DEVELOPMENT

Ironmaking developments are likely under-reported since proposals for integrated steel plants (BF-BOF technology) typically only provide proposed capacities for final products, such as crude steel or finished steel products. Details on production capacity for raw materials processing (i.e., coking ovens, sinter plants, etc.) and ironmaking are often unavailable until the plant begins operating and reveals capital investments and facility upgrades through annual and investor reports.

While it's possible to make rough estimates of the iron capacity required in a new integrated facility of a certain crude steel capacity, predicting how the expansion of crude steel capacity at an existing integrated facility will affect ironmaking capacity proves much more difficult since the facility may already have adequate ironmaking facilities or plans to source iron and/or scrap from other facilities. In order to estimate proposed additions to ironmaking capacity for these projects, iron and steel plant operators must provide more information and increased transparency about steel capacity expansions and the production and sourcing of upstream materials such as iron.

Of known capacities for ironmaking projects under development, 83% (203 mtpa) will use BF technology and 17% (41 mtpa) will use the DRI process (see Figure 7). Compared to the current distribution of operating ironmaking capacity (91% BF, 8% DRI, 1% unspecified), ironmaking capacity is shifting towards a greater share of DRI production. However, the emissions intensity of steel produced from DRI varies significantly depending on the DRI process. Much of the DRI capacity under development is in India (8 mtpa), where coal-based DRI production dominates the industry, resulting in the highest national average CO_2 emissions intensity for EAF steel production.

Figure 7: Ironmaking capacity under development by technology type



Source: Global Steel Plant Tracker, Global Energy Monitor, March 2022.
Note: includes iron plants with capacity of at least 0.5 mtpa.

BF ironmaking capacity under development

While only 7 countries have reported plans for BF capacity development, it is likely that all 13 of the countries with BOF capacity under development will also add BF capacity. Given that BF is the most carbon-intensive portion of steel production with limited, difficult, and high-cost decarbonization options, decisions about the refurbishment, retrofit, and retirement of existing blast furnace capacity and proposals and investments in new BF plants vs DRI plants will determine whether the global steel sector aligns with a 1.5°C pathway or not.

DRI ironmaking capacity under development

Capacity using the Direct Reduced Iron (DRI) process is more dispersed, with projects planned in 11 countries, though many smaller (<0.5 mtpa capacity) DRI projects were noted in our research. By mid-century, DRI must account for a significantly greater share of ironmaking capacity than current developments will deliver. As hydrogen-based DRI reaches commercial scale, DRI proposals will need to ramp up to help us reach the global share of 29% hydrogen-based DRI-EAF production needed for Paris-aligned heavy industry decarbonization pathways. Steel decarbonization strategies point out that DRI development should be strategically planned in countries with ample renewable electricity generation potential and iron ore availability exceeding domestic needs.The Net Zero Steel project identifies Australia, Brazil, Canada, South Africa, and Russia as good candidates for hydrogen-based DRI production based on renewables potential and iron ore resources.

STRANDED ASSET RISK HIGHER THAN PREVIOUSLY ESTIMATED

The steel industry faces significant risk from stranded assets as more countries with major steel industries pledge to reach carbon neutrality but at the same time plan to build numerous large BF-BOF steel plants.

The capital cost of a new integrated BF-BOF steelmaking facility is approximately 1–1.5 billion USD. If all BF-BOF capacity proposed or under construction is fully developed, the steel industry could face 345 to 518 billion USD in stranded asset risk as countries work towards their carbon neutrality commitments (see Table 1, on the next page).

We previously estimated that the global steel industry faced approximately 47–70 billion USD in stranded assets from steel plants under development. However, the past year saw a significant increase in country-level commitments to reach carbon neutrality and many new proposals for steel plant projects. Along with a significant expansion and improvement in our

STRANDED ASSETS IN STEEL INDUSTRY

Stranded assets are assets that have lost anticipated economic value as the result of changes in market conditions and regulations adopted as part of decarbonizing the global economy. Because decarbonization options for BF-BOF steel plants are limited and largely unproven, BF-BOF steel plants will be vulnerable to stranded asset risk if the cost of carbon is realized through carbon pricing (i.e., taxes) or emission standards, and a conventional steel plant may be unable to price competitively with low-carbon steelmaking plants. To avoid stranded asset potential, BF-BOF retrofits for low-carbon steelmaking would need to be developed and brought to market in a fraction of the time predicted in steel decarbonization roadmaps (see 2021 Pedal to the Metal, The risk of stranded assets.)

ability to track proposed steel capacity, we find that the actual stranded asset risk from developing plants in the steel industry is much higher.

In addition to stranded asset risk from developing steel plants, a recent study of TransitionZero's Global Steel Cost Tracker estimated that 132 mtpa capacity at existing BF-BOF facilities will face stranded asset risk by 2030 and 514 mtpa by 2050 if we are to achieve net zero emissions by 2050.[12] While the complexity of the steel industry leaves some uncertainty in how market and regulatory response to climate change will actually impact the production of steel in coming years, it is clear that building new BF-BOF plants and extending the life of existing BF-BOF plants carries serious financial risk.

Table 1: BF-BOF capacity under development in countries with net-zero carbon commitments

Country	Carbon commitment	BF-BOF steel capacity under development (ttpa)	Stranded asset risk (billion USD)	
			Low range	High range
China	Net Zero 2060	157,918	158	237
India	Net Zero 2070	122,994	123	184
Indonesia	Net Zero 2060	23,500	24	35
Vietnam	Net Zero 2050	15,500	16	23
Malaysia	Net Zero 2050	11,600	12	17
Ukraine	Net Zero 2060	3,200	3	5
Cambodia	Net Zero 2050	3,100	3	5
Russia	Net Zero 2060	3,000	3	5
Mexico	Net Zero 2050	2,500	3	4
Bangladesh	Net Zero 2030	2,000	2	3
Total		**345,312**	**345**	**518**

Source: Global Steel Plant Tracker, Global Energy Monitor, March 2022.
Note: includes steel plants with capacity of at least 0.5 mtpa.

12. The countries with the highest production costs in BF-BOF production would face stranded asset risk first. This 132 mtpa BF-BOF capacity facing closure by 2030 would come from Japan, Germany, China, Italy, and the United States.

STEEL SECTOR EMISSIONS

In 2019 the global steel industry emitted over 3.6 Gt CO_2 emissions, including 2.6 Gt of direct CO_2 emissions per year and nearly 1.1 Gt of indirect CO_2 emissions from the power sector and combustion of steel off-gases. A benchmarking report for steel emissions shows that approximately 86% of these emissions came from BF-BOF steel production and 14% from EAF steel production.

GEM calculations show that steel sector CO_2 emissions rose from 3.6 Gt in 2019, to 3.7 Gt in 2020, and 3.8 Gt in 2021. In order to align with the IEA's Net-zero by 2050 scenario, direct CO_2 emissions from the global iron and steel industry need to be lowered to 1.8 Gt CO_2 by 2030 and 0.2 Gt CO_2 by 2050.

Unaccounted emissions from coal mine methane

Emissions calculations for steelmaking are typically divided into direct and indirect emissions. Direct emissions typically include the process emissions of the chemical reaction and operation of iron and steel units while indirect emissions include the emissions of energy generated to operate the steel plant. Other forms of embodied emissions sometimes included in the scope of steel emissions calculations include raw material transport and post-production processing. However, one important source of emissions that has not yet been factored into steel industry emissions assessments is coal mine methane.

Steel production can consume both types of coal, thermal and metallurgical coal. Thermal coal is consumed when the power used to generate electricity to operate the steel plant is coal-based. The consumption of thermal coal in the steel industry is challenging to assess without better data on power sources for each steel plant, but it is clear that decarbonizing the steel industry will depend on the ability to source clean energy for production. Metallurgical coal is consumed by the steel industry in the BF-BOF production process (see Appendix A). Steel produced through the BF-BOF production route uses approximately 770 kg of metallurgical coal per tonne of steel.

A recent report from Global Energy Monitor's Global Coal Mine Tracker found that global thermal coal operations (intended for power generation) emit 28 million tonnes of methane, a number identical to the IEA's findings in its latest Methane Tracker (2022), and global metallurgical coal operations currently emit 9.4 million tonnes of methane per year, with mixed thermal and metallurgical coal mines emitting an additional 5 million tonnes of methane. Using the IPCC's sixth assessment guidelines on methane's global warming potential, that means the world's operating metallurgical coal operations currently emit 280 to 780 Mt CO_2-equivalent emissions each year (when averaged over 100 and 20 years, respectively). Mixed thermal and metallurgical coal mines emit an additional 150 to 410 Mt CO_2-equivalent emissions per year.

The steel industry currently emits approximately 2.6 Gt of direct CO_2 emissions per year and 1.1 Gt of indirect CO_2 emissions from the power sector and combustion of steel off-gases. If the methane emissions from metallurgical coal mining are accounted for in global assessments of steelmaking emissions, the footprint of the steel industry may be as much as 27% (1 Gt CO_2-e20) higher than currently reported.[13]

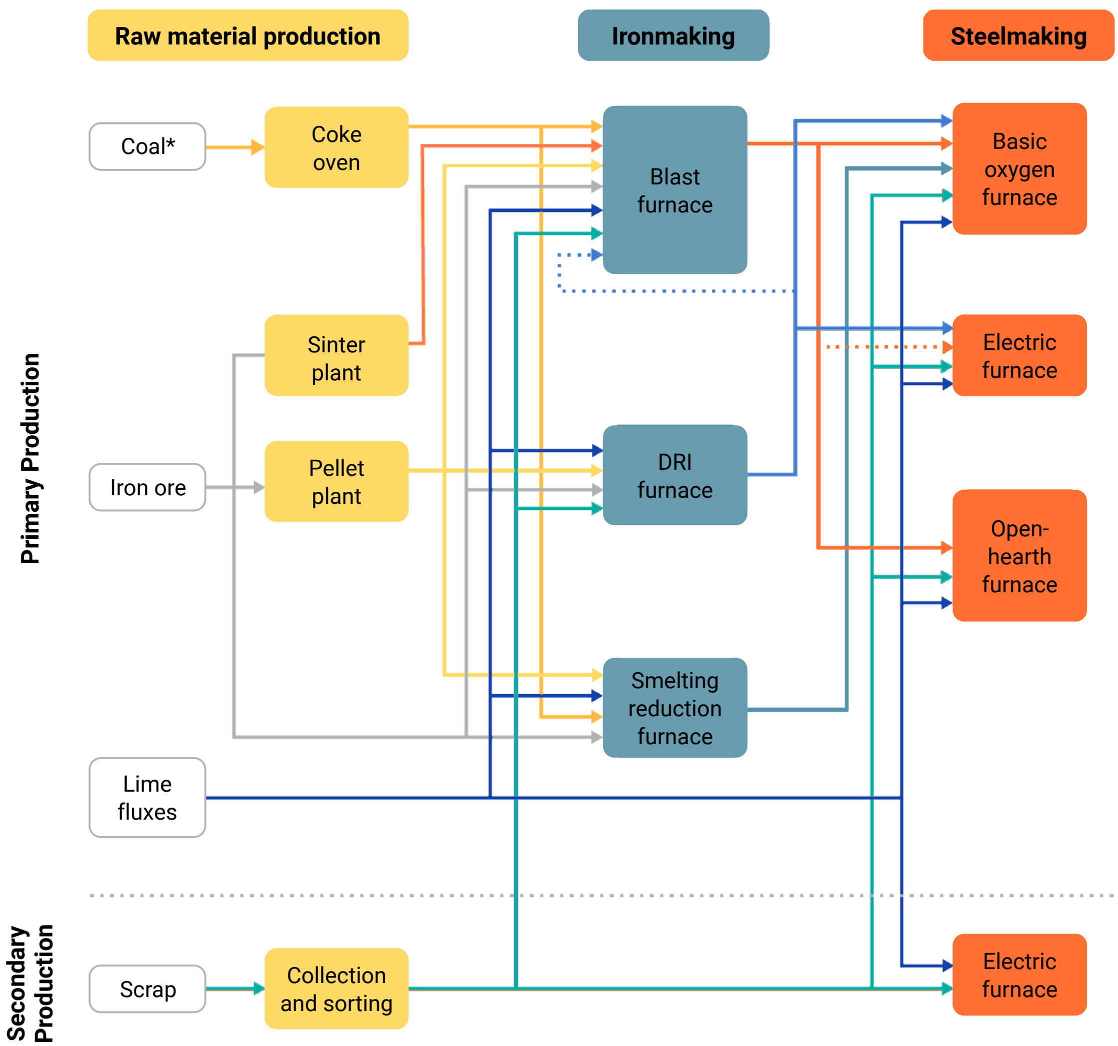
This raises concern about unaccounted emissions in steel decarbonization plans that rely heavily on retrofitting coal-based steelmaking with carbon capture, utilization, and storage, rather than fully transitioning away from this technology.

13. Based on 2021 estimates of steel production through the BF-BOF route the global steel industry and coal mine production, we assume that the steel industry consumes approximately 84% of all of the total combined production from metallurgical and mixed metallurgical/thermal coal mines.

APPENDICES

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.

*Coal is a key material input to coke ovens for conversion into coke; while not represented here, it is also an energy input into other process units, alongside other energy inputs like natural gas and electricity.

Notes: Iron ore includes concentrate, lump and fines. Electric furnace includes both EAFs and induction furnaces. DRI input into blast furnace and blast furnace input into EAFs are less common (dashed lines).

BF-BOF steelmaking

In Blast Furnace-Basic Oxygen Furnace (BF-BOF) steelmaking, iron ore and metallurgical coal are converted to pig iron (aka hot metal, crude iron) in the blast furnace. Crude steel is produced in the basic oxygen furnace, which uses pig iron and steel scrap as its primary feedstocks, though small amounts of direct reduced iron (DRI) may be used as a supplemental input. The BF-BOF steelmaking process often includes pelletization and sintering of iron ore and coking of metallurgical coal as preliminary processes for iron and steelmaking. Producing one tonne of steel through the BF-BOF steelmaking route emits around 2.2 tonnes of CO_2 and requires roughly 20.8 GJ of energy, assuming global average electricity carbon intensity. Options for decarbonizing the BF-BOF steelmaking route are difficult and limited because of the use of metallurgical coal as a reductant in the ironmaking process: As coal is heated to melt the iron ore, carbon monoxide is produced, which reduces oxygen in the iron ore but releases CO_2 as a byproduct, called process emissions. Given that process emissions are a fundamental step of BF-BOF steelmaking, the abatement potential is limited, with the use of zero carbon electricity in the BF-BOF steelmaking process reducing emissions by just 7.4%. Hydrogen can be used to partially substitute metallurgical coal as a reductant in the BF-BOF steelmaking process, with a maximum carbon emissions reduction of 21.4% per tonne of steel. Together, zero carbon electricity and hydrogen injection can abate a maximum of 28.8% of CO_2 emissions in BF-BOF steelmaking, based on current estimates.

EAF steelmaking

Electric Arc Furnace (EAF) steelmaking uses steel scrap, DRI (aka sponge iron), or a combination of these materials as the primary feedstock. DRI production turns iron ore into iron using a reducing gas such as carbon monoxide (produced from natural gas or coal) or hydrogen (produced from natural gas, coal, or using an electrolyzer that relies on electricity to split water into hydrogen and oxygen). Scrap-based EAF production results in approximately 0.3 t CO_2 / t crude steel (not including embodied emissions), while natural gas-based DRI-EAF production results in approximately 1.4 t CO_2 / t crude steel. Coal can also be used in DRI-EAF production, with average emissions ranging from 1.3–1.8 t CO_2 / t crude steel for the COREX/FINEX process and 3.2 t CO_2 / t crude steel for the rotary kiln process. Hydrogen-based DRI-EAF production results in an average of 0.71 t CO_2 / t crude steel, though actual emissions vary widely depending on the production route of the hydrogen and electricity source. Producing one tonne of steel through the EAF steelmaking process requires 9.0 GJ of energy on average globally. The average energy intensity for EAF steelmaking drops to 6.2 GJ/t crude steel if China and India are excluded from estimates. EAF energy intensity for these countries is high due to the high use of DRI and pig iron as feed materials.

It is important to note that the emissions intensities of EAF steelmaking processes vary based on electricity sources and feed materials, particularly the choice of reductant in the DRI process. For the purpose of comparing the emissions intensities of major steelmaking processes, Table 2 assumes the IEA's global average emissions intensity for electricity imported from the grid. In both BF-BOF and EAF steelmaking, the iron production portion is responsible for the majority share of emissions in the steelmaking process.

Appendix B

Comparison of IEA decarbonization roadmaps[14]

	Sustainable Development Scenario (SDS)	Faster Innovation Case	Net Zero by 2050 Scenario (NZE)
Report source	Iron and Steel Technology Roadmap	Iron and Steel Technology Roadmap	Net Zero by 2050
Energy system goal	2°C / net-zero 2070	1.5°C / net-zero 2050	1.5°C / net-zero 2050
Steel sector goal relative to 2019 CO_2 emissions	2.3 Gt CO_2 emitted in 2030 1.2 Gt CO_2 emitted in 2050 0.3 Gt CO_2 emitted in 2070 54% reduction in direct, process emissions by 2050	0.3 Gt CO_2 emitted in 2050 88.5% reduction in direct, process emissions by 2050[15]	1.8 Gt CO_2 emitted in 2030 0.2 Gt CO_2 emitted in 2050 92% reduction in direct, process emissions by 2050
Share of steel production using EAF	29% in 2019; 57% by 2050	Assumed same as SDS	24% in 2020; 37% by 2030; 53% by 2050
Scrap as share of input	32% in 2019; 45% by 2050	Assumed same as SDS	32% in 2020; 38% by 2030; 46% by 2050
Material efficiency	Responsible for 40% of cumulative emissions reductions relative to 2019 baseline by 2050	Reduces steel demand by 19% relative to 2019 by 2050	Reduces steel demand by 20% relative to 2020 by 2050
Technology performance improvements (BAT and best practices)	21% of cumulative emissions reductions by 2050		While the NZE cites the importance of installing BAT and optimizing operational efficiency of equipment, they do not provide estimated emissions savings from technology performance improvements.
Technologies still in development/prototype phase	Responsible for 30% of cumulative emissions reductions by 2050 Responsible for approximately 40% annual emissions savings in 2050	Introduced to market by 2026 Responsible for approximately 75% annual emissions savings in 2050	Responsible for 54% of cumulative emissions reductions by 2050[16]
Hydrogen-based DRI	Responsible for 8% of cumulative emissions reductions by 2050 15% of steelmaking capacity equipped by 2050 Introduced to market by 2030 One electrolytic hydrogen-based DRI plant built per month after market introduction	Introduced to market by 2026 Two 100% renewable hydrogen-based DRI plants built per month after market introduction	29% steelmaking capacity equipped by 2050
CCUS (including blue hydrogen-DRI)	Responsible for 16% of cumulative emissions reductions by 2050 Introduced to market by 2030 One 1 Mt CO_2 captured per year CCUS project installed every 2–3 weeks after market introduction Reaches 400 Mt CO_2 captured per year by 2050	Introduced to market by 2025 Two 1 Mt CO_2 captured per year CCUS projects built every month after market introduction	53% steelmaking capacity equipped by 2050 Reaches capture total of 670 Mt CO_2 by 2050
Iron ore electrolysis	Not deployed	5% of steelmaking capacity equipped by 2050 Introduced to market by 2030 One plant built every two months from 2030 to 2050	13% of steelmaking capacity equipped by 2050

14. The IEA reports that total direct emissions from the iron and steel sector were approximately 3.7 Gt CO_2 in 2019 (2.6 Gt CO_2 direct emissions and 1.1 Gt CO_2 indirect emissions). According to the IEA's NZE report, direct emissions in 2020 were 2.4 Gt CO_2. The NZE projected heavy industry (including steel, chemicals, and cement) emissions reductions of 20% by 2030 and 93% by 2050 relative to a 2020 emissions baseline. Emissions reductions for the NZE were recalculated relative to a 2019 baseline for comparison with the SDS and Faster Innovation Case.

15. IEA states that direct global emissions from the iron and steel sector "fall to reach a level in 2050 that is 75% lower than in the Sustainable Development Scenario."

16. Recalculated for 2019 baseline. Responsible for 60% of cumulative emissions reductions by 2050 relative to 2020 baseline.

Appendix C

Operating steelmaking capacity by country and production process

Country	Total Capacity (ttpa)	BOF Capacity (ttpa)	EAF Capacity (ttpa)	OHF Capacity (ttpa)	Unspecified Capacity (ttpa)
China	1,083,100	803,792	100,978	0	178,330
India	113,812	48,355	34,019	0	31,438
Japan	113,139	82,381	30,758	0	0
United States	109,262	36,200	73,062	0	0
South Korea	84,510	53,000	31,510	0	0
Russia	83,406	33,800	26,806	0	22,800
Turkey	52,570	13,300	39,270	0	0
Germany	48,060	36,260	11,800	0	0
Brazil	42,580	32,220	10,360	0	0
Ukraine	42,322	32,002	2,320	8,000	0
Iran	38,500	5,300	33,200	0	0
Italy	34,225	11,500	22,725	0	0
Mexico	25,690	7,000	18,690	0	0
Vietnam	24,900	15,540	9,360	0	0
Taiwan	18,980	16,100	2,880	0	0
Spain	18,340	5,400	12,940	0	0
France	17,350	11,850	5,500	0	0
Canada	15,549	9,000	6,549	0	0
Egypt	14,850	2,100	12,750	0	0
Saudi Arabia	14,580	1,180	13,400	0	0
Malaysia	14,070	3,500	9,870	0	700
Indonesia	13,700	7,500	3,400	0	2,800
United Kingdom	11,020	8,100	2,920	0	0
North Korea	10,720	0	0	0	10,720
Poland	8,830	5,000	3,830	0	0
Belgium	8,050	5,000	3,050	0	0
Algeria	7,700	0	7,700	0	0
Austria	7,570	7,570	0	0	0
Thailand	7,550	0	7,550	0	0
Netherlands	7,500	7,500	0	0	0
South Africa	7,150	6,400	750	0	0
Argentina	6,850	3,200	3,650	0	0
Czech Republic	6,200	6,000	200	0	0
Kazakhstan	6,000	6,000	0	0	0
Australia	5,810	4,400	1,410	0	0
Sweden	5,810	3,800	2,010	0	0
Romania	5,150	3,000	2,150	0	0
Bangladesh	4,788	0	4,788	0	0

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Operating steelmaking capacity by country and production process — *continued*

Country	Total Capacity (ttpa)	BOF Capacity (ttpa)	EAF Capacity (ttpa)	OHF Capacity (ttpa)	Unspecified Capacity (ttpa)
Finland	4,663	2,600	2,063	0	0
Slovakia	4,500	4,500	0	0	0
Oman	4,250	0	4,250	0	0
Nigeria	3,600	1,300	2,300	0	0
Luxembourg	3,500	0	3,500	0	0
United Arab Emirates	3,500	0	3,500	0	0
Greece	3,300	0	3,300	0	0
Belarus	3,000	0	3,000	0	0
Hungary	2,840	1,600	1,240	0	0
Serbia	2,700	2,200	500	0	0
Qatar	2,558	0	2,558	0	0
Syria	2,200	0	2,200	0	0
Peru	2,000	0	1,250	0	750
Chile	1,970	1,450	520	0	0
Bosnia and Herzegovina	1,940	1,140	800	0	0
Morocco	1,800	0	1,800	0	0
Libya	1,750	0	1,750	0	0
Portugal	1,700	0	1,700	0	0
Georgia	1,570	0	120	1,450	0
Bulgaria	1,400	0	1,400	0	0
Iraq	1,250	0	1,250	0	0
Kuwait	1,200	0	1,200	0	0
Bahrain	1,100	0	1,100	0	0
Pakistan	1,100	0	1,100	0	0
Azerbaijan	1,000	0	1,000	0	0
Moldova	1,000	0	1,000	0	0
Uzbekistan	1,000	0	1,000	0	0
Singapore	800	0	800	0	0
Slovenia	726	0	726	0	0
Albania	700	0	700	0	0
Norway	700	0	700	0	0
Switzerland	668	0	668	0	0
New Zealand	650	650	0	0	0
Angola	500	0	500	0	0
Guatemala	500	0	500	0	0
Philippines	500	0	500	0	0
World	**2,208,329**	**1,348,690**	**602,651**	**9,450**	**247,538**

Source: Global Steel Plant Tracker, Global Energy Monitor, March 2022.
Note: includes steel plants with capacity of at least 0.5 mtpa.

Appendix D

Operating ironmaking capacity by country and production process

Country	Total Capacity (ttpa)	BF Capacity (ttpa)	DRI Capacity (ttpa)	Unspecified Capacity (ttpa)
China	874,736	872,216	0	2,520
Japan	97,815	97,815	0	0
India	84,822	56,793	28,029	0
Russia	62,672	43,372	7,700	11,600
Ukraine	42,765	42,765	0	0
South Korea	41,900	41,900	0	0
Germany	33,090	32,690	400	0
United States	32,245	25,845	6,400	0
Iran	25,650	0	25,650	0
Brazil	24,680	24,680	0	0
Mexico	18,198	12,338	5,860	0
Vietnam	16,742	16,720	22	0
Taiwan	15,900	15,900	0	0
Turkey	13,850	13,850	0	0
France	11,960	11,960	0	0
Egypt	10,350	1,400	8,950	0
Italy	9,590	9,590	0	0
Indonesia	8,850	7,500	1,350	0
Canada	8,810	7,810	1,000	0
United Kingdom	8,360	8,360	0	0
Malaysia	8,090	4,700	3,390	0
Venezuela	6,815	0	6,815	0
Netherlands	6,310	6,310	0	0
Saudi Arabia	6,300	0	6,300	0
Algeria	6,200	1,200	5,000	0
Austria	5,710	5,710	0	0
Czech Republic	5,300	5,300	0	0
South Africa	4,620	3,420	1,200	0
Poland	4,500	4,500	0	0
Spain	4,480	4,480	0	0
Belgium	4,430	4,430	0	0
Kazakhstan	4,348	4,348	0	0
Argentina	4,220	3,220	1,000	0
Australia	4,200	4,200	0	0
Sweden	3,925	3,925	0	0
Slovakia	3,600	3,600	0	0
Nigeria	3,320	1,300	2,020	0
Romania	3,000	3,000	0	0

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Operating ironmaking capacity by country and production process — *continued*

Country	Total Capacity (ttpa)	BF Capacity (ttpa)	DRI Capacity (ttpa)	Unspecified Capacity (ttpa)
Finland	2,600	2,600	0	0
Qatar	2,423	0	2,423	0
Serbia	2,200	2,200	0	0
United Arab Emirates	1,900	0	1,900	0
Oman	1,800	0	1,800	0
Libya	1,750	0	1,750	0
Trinidad and Tobago	1,700	0	1,700	0
Bahrain	1,600	0	1,600	0
Hungary	1,300	1,300	0	0
Bosnia and Herzegovina	1,100	1,100	0	0
Albania	1,000	1,000	0	0
Chile	730	730	0	0
Georgia	725	725	0	0
New Zealand	650	0	650	0
Peru	400	0	400	0
World	**1,554,231**	**1,416,802**	**123,309**	**14,120**

Source: Global Steel Plant Tracker, Global Energy Monitor, March 2022.
Note: includes iron plants with capacity of at least 0.5 mtpa.

Appendix E

Steel capacity under development

Country	BOF capacity under development (ttpa)
China	157918
India	122994
Indonesia	23500
Vietnam	15500
Malaysia	11600
Myanmar	4000
Ukraine	3200
Cambodia	3100
Russia	3000
Mexico	2500
Iran	2280
Bangladesh	2000
Mozambique	250

Country	EAF Capacity under development (ttpa)
China	49215
Iran	31300
India	21043
United States	12421
Philippines	10000
Russia	5050
Italy	3900
Namibia	3000
Saudi Arabia	2940
Belgium	2500
France	2500
Australia	2400
Canada	2400
Japan	2300
Brazil	2100
Turkey	2000
Ukraine	1800
Bangladesh	1800
Vietnam	1300
Indonesia	1200
Algeria	1150
Spain	1100
Sweden	1000
United Arab Emirates	1000
United Kingdom	1000
Netherlands	900
Morocco	800
Pakistan	600
Malaysia	500
Iraq	500
Mozambique	250
Georgia	250

Source: Global Steel Plant Tracker, Global Energy Monitor, March 2022.
Note: includes steel plants with capacity of at least 0.5 mtpa.