7

Steel industry net-zero tracker

Long-term emissions reduction solutions include direct reduced iron in electric arc furnaces and increased scrap steel use; short-term solutions include the use of carbon capture.

- The steel industry has seen a rise in emissions, driven by an increase in production share from China and India, where production is highly emission-intensive.
- Progress is being made in electrifying secondary steel production, but more investment in renewable energy and cleaner technologies is essential for lowering emissions.

3%

Increase in absolute CO_2 emissions (2022-2023)

3%

Increase in emission intensity (2022-2023)

0.1%

Increase in demand (2022-2023)

STEEL

Key performance data 2023[291,292,293]

7%

Contribution to global CO_2e emissions

2.8 Gt CO_2e

Scope 1 and 2 emissions

1.8%

Emissions increase (2019-2023)

1.5 tCO_2e/t

Emissions intensity (per tonne of steel, 2023)

83%

Fossil fuels in the fuel mix (2022)

1.3 times

Demand in NZE scenario by 2050, compared to 2023

Performance summary

- The industry has seen an increase in emission intensity by 0.6%[294] in the 2019-2023 period. This is mainly driven by an increase in production in regions that heavily rely on blast furnaces, which are high in emissions intensity.
- Steel production saw a marginal increase by 0.1% in 2023 vs. 2022.[295]
- In 2022, the energy mix for steel production consisted of 73% coal, 14% electricity, 8% natural gas, 1% oil and 3% others, including bioenergy.[296]
- The planned capacity of BF-BOF went from 64.5% to 64%,[297] and EAF from 32% to 43%, from 2022 to 2023, indicating a move towards cleaner technology.[298]

Future emissions trajectory

- The industry targets a 45% reduction in intensity for primary steel and a 65% reduction for secondary steel by 2030, and net-zero emissions by 2050.[299]
- In total, 77% of large publicly traded steel companies consider climate change in their decision-making processes.[300]

Readiness key takeaways

Technology	2	– Scrap-based EAF with green power and BF-BOF with BECCS are the most advanced technologies. – BF-BOF with CCS and CCU are in the prototype stage, while direct reduced iron EAF (DRI-EAF) with CCS is at the demonstration stage and is expected to be commercially available by 2028.[301]
Infrastructure	1	– Of the 2050 fuel mix, clean power is expected to comprise 26%, hydrogen 29% and bioenergy 6%.[302] This will require 833 GW of clean power, 48 MTPA of clean hydrogen and 460 MTPA of biofuels capacity.[303] CCUS will also play a key role in reducing emissions. – Significant efforts in building clean power, hydrogen and bioenergy capacity are required to meet the 2050 net-zero requirements, as the current energy mix is dominated by fossil fuels.
Demand	3	– As of 2022, less than 10% of steel was produced using low-emission processes, with nearly all progress occurring in low-emission secondary production (e.g. recycling).[304] – Demand from the automotive industry has been on the rise, with the announcement of green supply agreements. There is especially high demand for use in EVs.
Capital	1	– The steel sector currently has an annual CapEx of $111 billion.[305] – The steel sector will require over $129 billion[306] in annual investments by 2050. Almost 70% of this investment must come from the ecosystem in the form of low-emission energy capacity investments. – Significant additional investment requirement, low industry margins and ease of increasing capital are leading to the low capital readiness score.
Policy	2	– The EU's Carbon Border Adjustment Mechanism (CBAM) will end free ETS allowances for steel by 2034 and impose tariffs on emissions-intensive imports.[307] – By 2025, China will prioritize the creation of a circular economy, seeking an increase in the use of scrap steel to 255 Mt by 2025 and peak steel production and sectoral emissions before 2030.[308]

Sector priorities

Company-led solutions

Mid-term (by 2030)

- Switch from BF-BOF to EAFs.
- Use renewable electricity in EAFs to cut carbon intensity for secondary steel.

Long-term (by 2050)

- Explore green hydrogen as a replacement for fossil fuels to be used in EAF.

Ecosystem-enabled solutions

Mid-term (by 2030)

- Standardize green steel and hydrogen, setting consistent standards for producing steel and hydrogen from low-carbon sources.
- Increase scrap collection to enable more scrap-based production.

Long-term (by 2050)

- Develop infrastructure for producing and distributing green hydrogen.

Performance

The sector currently accounts for 7% of global CO_2e emissions. Emissions are mainly driven by the heavy use of fossil fuels in the energy-intensive production process, which account for around 75% of the current fuel mix.

TABLE 10 **Steel industry performance**

Performance metric	Change (2019-2023)
Industry output	+1.2%[309]
Emission intensity	+0.6%[310]
Total CO_2e emissions	+1.8%[311]

In the 2019-2023 period, demand increased by 1.2% while emission intensity increased by 0.6%. The increase in emission intensity is primarily due to the increase in steel production in high-emission regions. For example, steel production saw an increase in China, which continues to rely heavily on the more emission-intensive BF-BOF processes. India also saw an increase in steel production, where coal is the primary source of energy, leading to higher emissions per unit of steel produced.

There are three established methods of steel production currently in use, with varying levels of energy intensity (and hence emissions intensity). The most common production route is BF-BOF, which is used for 72% of global steel production, followed by scrap steel-EAF (scrap-EAF), which constitutes 21% of global steel production, and DRI-EAF, which constitutes 7% of global steel production.

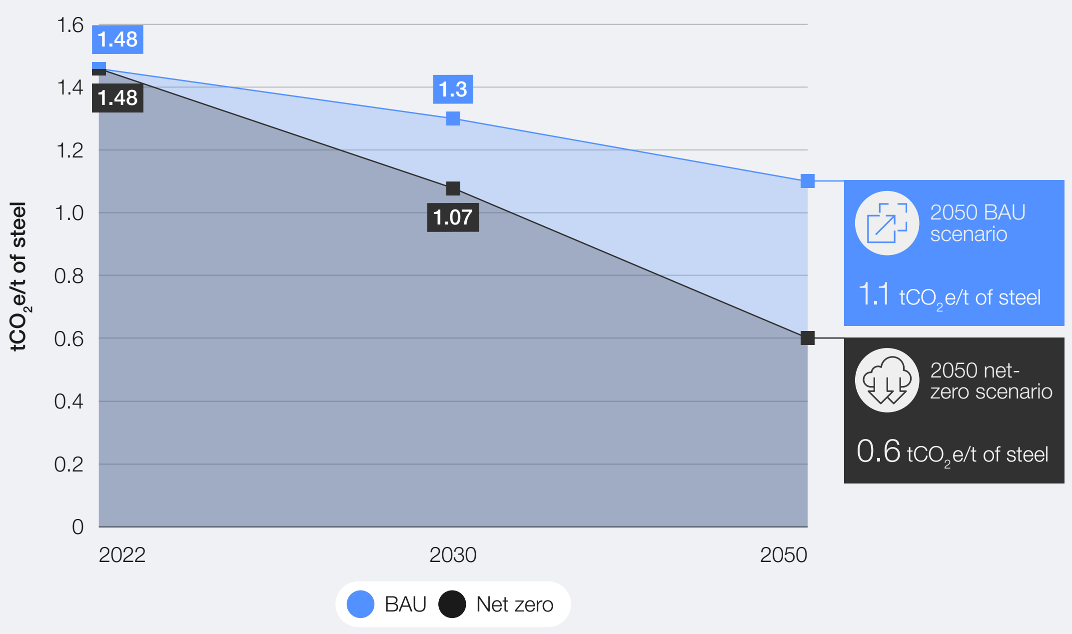
The energy intensity of BF-BOF and DRI-EAF processes is around 22-2023 gigajoules per tonne (GJ/t) of steel, while for scrap-EAF it is less than half (around 10 GJ/t), which is a key reason for its lower emissions intensity.[312] The BF-BOF process emits 2.3 tonnes of CO_2 per tonne of steel, whereas the scrap-EAF process emits only 0.7 tonnes and the DRI-EAF process emits 1.4 tonnes.[313] The steelmaking process varies across regions, with China and India mainly using the BF-BOF process with coal as primary fuel, the EU using BF-BOF with advanced BF technologies to lower emissions intensity, and the US having the highest share of scrap-EAF steel production and thus the lowest emissions intensity globally.

Coal has been the dominant fuel used in the steel production process and has consistently contributed to around 75% of the fuel mix for the last five years. Thus, there is a need for technologies that can replace coal power with renewable and low-emission fuels. For example, blast furnaces could be coupled with bioenergy and carbon capture and storage, which is known as BF-BOF with BECCS.

Readiness

FIGURE 41

Emission intensity trajectory for the steel sector



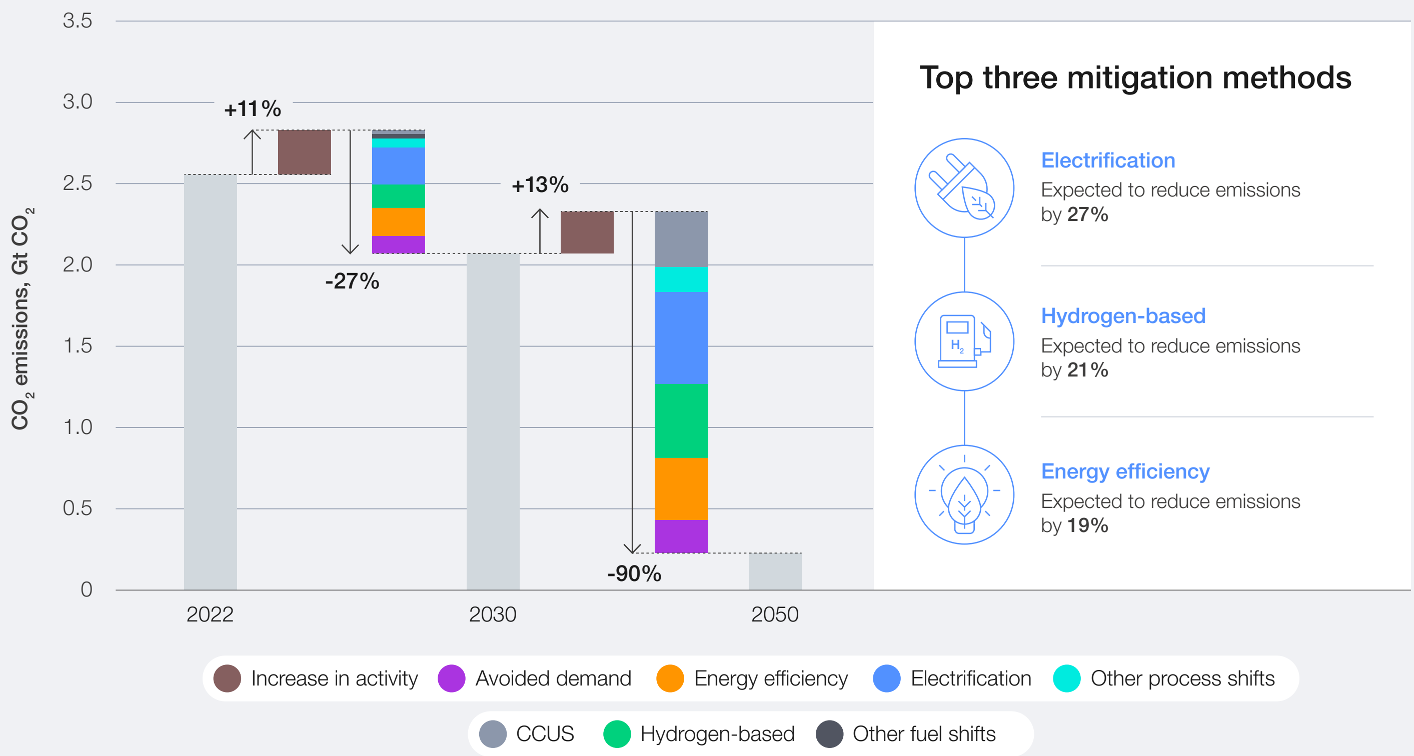
Source: IEA and STEPS Scenario (BAU).

The demand for steel is expected to grow by 32% by 2050. This increase will primarily be driven by rising urbanization and industrialization in emerging economies, and the growth of green energy infrastructure due to the energy transition, which will require significant amounts of steel.

Thus, the industry must act quickly to reduce emission intensity and offset the increase in demand. The top three decarbonization levers for steel are electrification, use of hydrogen in production and energy efficiency.

FIGURE 42

Decarbonization levers and top mitigation methods (NZE Scenario)



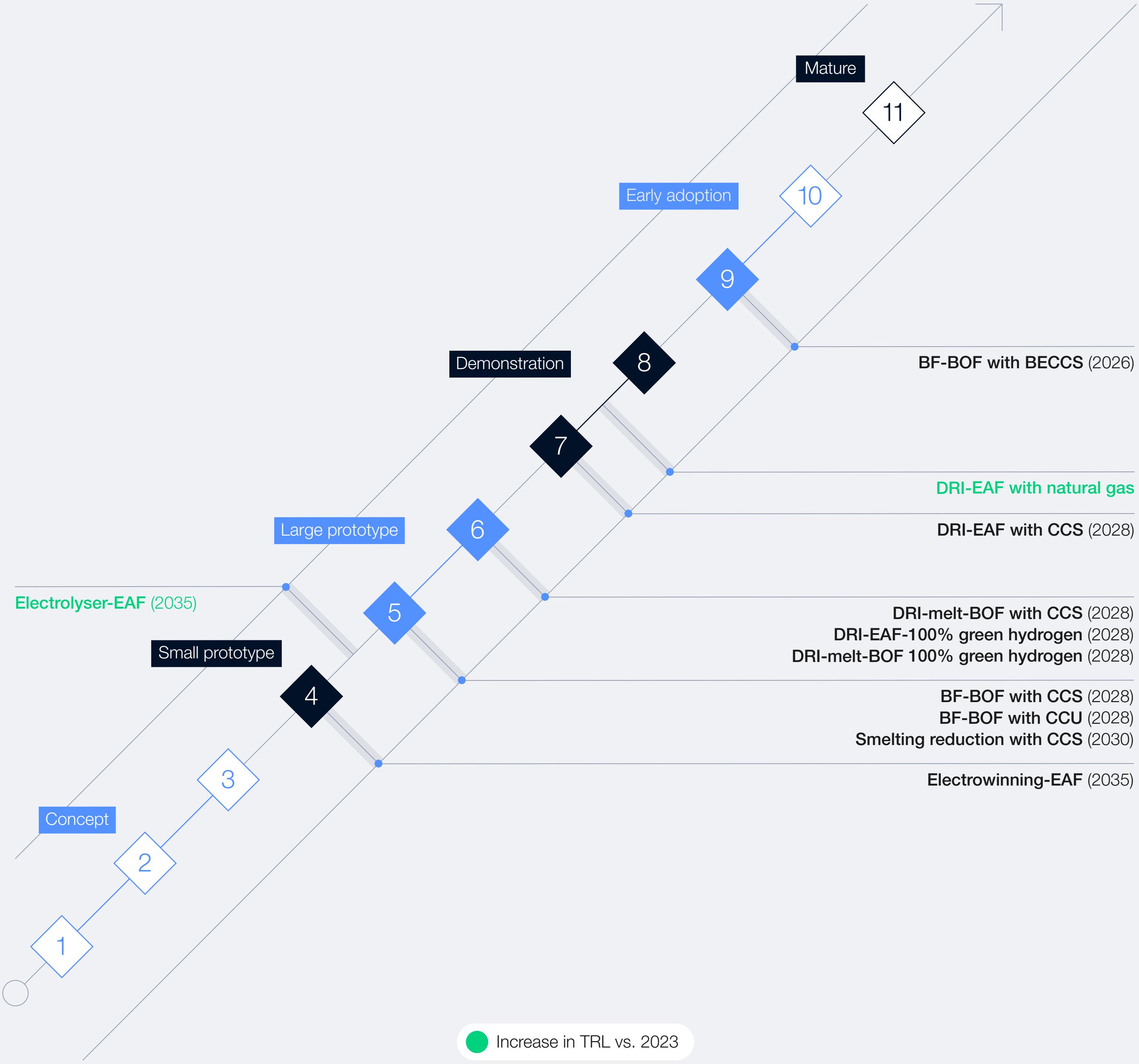
Source: IEA.

STEEL

2 Technology

Technologies to implement the decarbonization levers are at different readiness levels. Three key pathways are currently available: increased use of scrap, use of clean hydrogen for primary steel production and CCUS technology for primary steel production.

FIGURE 43 **Decarbonization TRLs and year of commercial availability**



Source: Accenture analysis based on data from IEA ETP Clean Energy Technology Guide and MPP.

Technology pathway 1: Increased use of scrap

The increased use of scrap is an important decarbonization lever for steel production, since scrap-based (secondary) production through the scrap-EAF process currently emits less than one-third of emissions compared to primary production through the BF-BOF process. This is because it eliminates the need for the processing of iron-ore, which is an emissions-intensive step. Furthermore, if renewable energy is used in the scrap-EAF process, the emissions from this process can be lowered to near-zero levels. The IEA projects that the share of scrap in metallic inputs for steel production will reach 48% by 2050.

Technology pathway 2: Clean hydrogen-based primary production

One of the most promising developments in steelmaking technology is the use of hydrogen-based direct reduced iron (DRI with H_2) production, which emits water vapor instead of CO_2, instead of traditional blast furnaces. Several pilot projects, particularly in Europe (e.g. Sweden's HYBRIT project), are exploring this technology with the aim of achieving large-scale commercial viability in the coming years.

Technology pathway 3: CCUS technology for primary production

The adoption of CCUS in the BF-BOF process is expected to reduce CO_2e emissions by up to 90%.[314] Most CCUS technologies for steel production are expected to become commercially available after 2028. Another key technology that has seen progress recently is the injection of biomass in place of coal in the blast furnace, which, when coupled with CCS, can lead to further emissions reduction. The use of CCUS is expected to reduce steel emissions by 13% by 2050.

1

STEEL

Infrastructure

According to MPP, the steel sector currently relies primarily on fossil fuels, with 106 GW of coal power and 45 MTPA of natural gas capacity available, while the clean power and hydrogen capacity available is negligible.[315]

To meet the 2050 net-zero targets, the 2050 fuel mix for steel will need to look significantly different. Clean power will need to supply 26% of the energy required for production, necessitating 833 GW of installed clean power capacity. Hydrogen will need to provide 29% of the energy required, supported by advancements in hydrogen-powered production processes, requiring 48 MTPA of hydrogen capacity. To further reduce emissions, 853 MTPA of CCUS capacity will be required. Biofuels are expected to contribute to 6% of the 2050 fuel mix and will require a capacity of 458 MTPA. However, it is expected that 15% of the energy mix in 2050 will still come from unabated fossil fuels, due to the emission-intensive nature of steel production.

FIGURE 44 **Infrastructure for decarbonization capacity**

	Current capacity used	Capacity required (2050)
Clean power generation	Less than 1 GW	833 GW
Clean hydrogen production	Less than 1 MTPA	48 MTPA
CO_2 transport and storage	Less than 1 MTPA	853 MTPA

Source: Accenture analysis based on data from MPP.

STEEL

3 Demand

Currently, less than 1% of steel meets the industry's net-zero thresholds. The estimated B2B green premium of steel remains high, at 40%, but is expected to fall by 2050 with the drop in energy prices for renewable energy and hydrogen.

The demand for low-emission steel is expected to increase, especially from the automotive industry, since the B2C green premium for cars is less than 1%. Many companies (including BMW, Volkswagen and Volvo) have announced plans to use low-emission steel in the production of EVs. There has also been an increase in green steel supply agreements announced, with the transport sector constituting nearly half of them. The most prominent of these agreements are Volvo Trucks' purchase of SSAB's first batch of fossil-free steel and the Mercedes Benz agreement with Stegra (formerly known as H_2 Green Steel) for 50,000 tonnes of steel made with hydrogen.[316]

Access to scrap steel is not evenly distributed globally, and hence poses a challenge in increasing share of secondary steel production. There is a need to improve supply chain efficiency to ensure consistent flow of recyclable materials. To further reduce emissions, steel producers should adopt a circular economy model and recycle and reuse their steel scrap to increase secondary steel production.

FIGURE 45 **Top countries/regions in steel production and demand**

	Percentage of overall production	
1	China	54%
2	Europe	7%
3	India	7%
4	North America	6%
5	Japan	5%

	Percentage of overall demand (2022)	
1	China	52%
2	Europe	8%
3	North America	8%
4	India	6%
5	Japan	3%

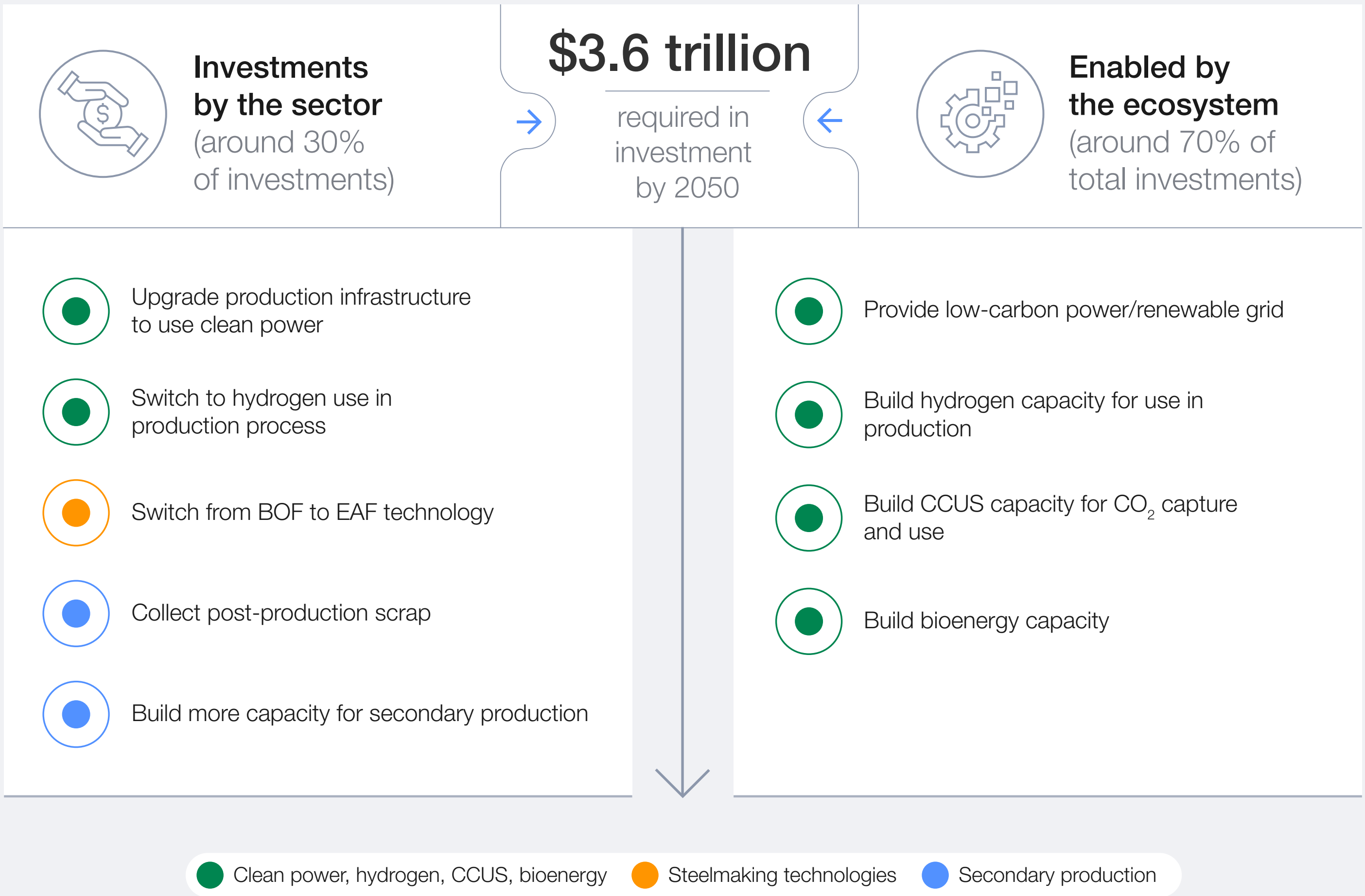
Source: World Steel.

STEEL

1 Capital

The steel industry will need substantial capital investment to advance low-emission production technologies. To support these technologies, a significant investment towards low-emission energy capacity will also be required. Overall, the estimated additional investment required is $3.6 trillion, out of which almost 70% must be invested by the ecosystem, while only around 30% must be invested by the sector companies. Ecosystem investments will include those needed to build capacity for hydrogen, clean power, CCUS and bioenergy, while investments by companies will be mainly focused on transitioning to net-zero compliant production technologies.

FIGURE 46 **Investments required by the sector and enabled by the ecosystem**



Source: Accenture analysis based on data from MPP.

With the steel industry's ROIC at 10%[317] and its WACC at 9.4%,[318] the industry's profits are only slightly higher than its costs of financing. This narrow margin means that without additional support from external factors (such as technological advancements, policy incentives and industry collaboration), the industry may struggle to afford and implement the significant changes needed for effective decarbonization. The availability of scrap will influence investments in EAF infrastructure across different countries, with the EU and China having the highest potential to expand their EAF-based production.

Approximately 77% of large publicly traded steel companies view climate change as a key consideration for their strategic assessment and integrate it into their operational decision-making. Meanwhile, 15% of companies are building basic emissions management systems and process capabilities. Finally, 8% of companies acknowledge climate change as a business issue.

STEEL

2 Policy

The production of steel is highly concentrated globally, with China and India contributing to over 60% of the total output, and future demand from these countries is expected to be significant. However, key policies aimed at emissions reduction are currently being developed primarily in the US and Europe. Hence, it is critical to develop and enforce supportive policies in regions where most of the demand and production comes from.

To support the journey towards net-zero emissions, the key focus areas of policy in the steel sector should be:

– Investment in the development of new steelmaking technologies that are less emission and energy intensive compared to existing processes (e.g. EAF technologies with the use of low-emission fuels)

– Direct funding/incentives for increasing capacity for renewable energy, hydrogen, CCUS and biofuels required to power the new steelmaking processes

– Demand-side interventions for green public procurement (as an example) to stimulate the demand for green steel

Furthermore, international collaboration must align emissions-accounting methodologies for steel to effectively track and monitor progress towards net-zero targets, especially in major producing countries like China and India.

TABLE 11 **Steel industry policy summary**

Policy type	Policy instruments	Key examples	Impact
Market-based	**Carbon price**	– EU-ETS[319] – California ETS[320] – South Korea ETS[321] – China ETS[322]	Incentivizes steel producers to reduce emissions, but impact is limited by free emission allowances and lower carbon prices.
	Border adjustment tariff	EU CBAM[323]	Emission-intensive steel exporters to the EU face increased costs of compliance. Currently, 30% of steel consumed is imported from non-EU countries. The policy needs to be complemented by transparent and fair carbon accounting standards.
	Carbon price	India's Carbon Credits Trading Scheme (pending launch in 2026)	India's domestic voluntary carbon market will include the iron and steel sector, and is expected to launch in 2026.
Mandate-based	**Product standards**	China's Action Plan for Industrial Carbon Peaking[324]	By 2025, steel suppliers are expected to achieve an annual recycling capacity of 180 million tonnes.
Incentive-based	**Direct funding**	UK Green Steel Fund[325]	£2.1-3.5 billion clean steel fund, with the aim of establishing up to 3.78 Mt of additional secondary steel capacity, 4.44 Mt of low-emissions primary steel capacity and 5 Mt of domestic hydrogen-DRI capacity.
	Tax credits and subsidies	IRA tax-credits to clean power, green hydrogen and CCUS[326]	These can potentially reduce the cost of near-zero-emission steel by up to 35%. With limited funding available in developing economies, international funding collaboration mechanisms are an option to raise the required capital.
	Direct funding	EU Clean Steel Partnership[327]	Funding to support research and innovation for carbon neutral steel production.

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