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Briefing paper

Steel in transition: aligning climate, trade and industrial policy

Steel decarbonisation challenges, green iron trade, and the international dimension of the EU's steel and metals action plan

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Key messages

The steel sector, responsible for nearly 8% of global GHG emissions, has viable pathways to decarbonisation but remains off-track for net-zero by 2050.

Steel decarbonisation is hindered by high costs, limited availability of clean energy and high-quality iron ore, lack of global standards, and uncertain demand for low-emission steel - all of which require strong industrial policy frameworks and international cooperation to overcome.

The EU Steel and Metals Action Plan advances decarbonisation and industrial competitiveness through regulatory, financial and trade measures that may create both opportunities and challenges for third-country steel producers and exporters.

The transition to green iron and low-emission steelmaking could reshape global supply chains, with production shifting toward renewable-rich regions. Importing green iron, for example from Northern Africa, offers the EU a cost-effective path to decarbonise and strengthen competitiveness of its steel industry.

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About this publication

This briefing paper has been prepared in the context of the First International Climate, Trade and Industrial Policy Dialogue, held in Brussels on 29 April 2025. This series of events aims to deliberate potential policy solutions that address opportunities and challenges posed by EU climate, trade, and industrial policies and identify opportunities that can be harnessed through collaborative approaches. All views provided are those of the authors and should in no way be attributed to ODI Europe or ECF.

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Abbreviations and acronyms

BF-BOF	blast furnace-basic oxygen furnace
CAPEX	capital expenditure
CBAM	carbon border adjustment mechanism
CCUS	carbon capture utilisation and storage
DRI	direct reduced iron
EAF	electric arc furnace
EBRD	European Bank for Reconstruction and Development
ECDPM	European Centre for Development Policy Management
ERT	European Round Table for Industry
EU	European Union
GEM	Global Energy Monitor
H2	hydrogen
H2-DRI-EAF	hydrogen direct reduced iron electric arc furnace
GHG	greenhouse gas
IEA	International Energy Agency
IOE	iron oxide electrolysis
LeadIT	Leadership Group for Industry Transition
OECD	Organisation for Economic Co-operation and Development
RMI	Rocky Mountain Institute
SMAP	European Steel and Metals Action Plan
WTO	World Trade Organization

1 A global overview of steel decarbonisation

The iron and steel sector is responsible for nearly 8% of global GHG emissions (OECD, 2024b). Given that it is one of the highest emitting industry sectors, reducing the carbon footprint in the steel sector is crucial for achieving global climate targets. Although investments in green steel and private sector decarbonisation commitments are gaining traction, the rising global demand for steel continues to drive up emissions in the sector. According to Breakthrough Agenda, the total CO_2 emissions from the steel sector increased between 2015 and 2023, and the steel sector is currently not on track to meet its net zero emission target by 2050 (IEA, 2024a). At the same time, a net-zero steel sector and a coal phase out in steelmaking by 2050 (or even in the early 2040s) are considered technically feasible (Agora Industry and Wuppertal Institute, 2023). Furthermore, the OECD reports that currently more than 90% of global steelmaking capacity is located in countries that have announced net-zero targets, and an increasing number of steel companies are developing decarbonisation strategies (OECD, 2024b).

Many researchers, including Agora Industry, note that the hard-to-abate label for the steel sector is no longer justified (Agora Industry and Wuppertal Institute, 2023). The sector has the potential to reduce emissions quickly, as key transition technologies are already available. Maximising secondary production using scrap in electric arc furnaces (scrap-based EAF) is the first best option for decarbonising steel production (Bataille et al., 2024) as it requires five to seven times less energy than primary steelmaking (Agora Industry and Wuppertal Institute, 2023).). This highlights the importance of strengthening circular economy practices. Simultaneously, decarbonising energy-intensive ironmaking processes will remain a key strategy. The emission intensive blast furnace-basic oxygen furnace (BF-BOF) route still makes up about 70% of global steel production; however, the hydrogen direct reduced iron electric arc furnace[1] (H2-DRI-EAF) is emerging as a preferred technology in announcements for low-

[1]The hydrogen direct reduced iron electric arc furnace (H2 DRI EAF) is a steelmaking process that uses hydrogen to reduce iron ore, and then melts it using electricity in an electric arc furnace. This technological route is capable of reducing CO2 emissions by 95% compared to conventional steelmaking if the hydrogen used is generated from renewable sources.

emissions production, and is considered the most mature decarbonisation pathway beyond 2030 (IEA, 2024a).

A recent OECD study that analyses the decarbonisation strategies of companies[2] has shown that 74% plan to use carbon capture utilisation and storage (CCUS), 52% plan to implement H2-DRI-EAF, 11% are considering iron oxide electrolysis[3] (IOE), and 18% want to use scrap-based EAF (OECD, 2024b). Although CCUS is the most-cited technology route by companies in their respective strategies, according to Agora Industry's analysis, CCUS on the coal-based BF-BOF route is unlikely to play an important role in global steel transformation (Agora Industry and Wuppertal Institute, 2023). Carbon capture and storage on the BF-BOF route is unlikely to reduce direct CO2 emissions beyond 73% and cannot address upstream emissions (coal mine methane leakage). In addition, this route is unlikely to be economically viable and will face offtake risk in green lead markets (Agora Industry and Wuppertal Institute, 2023).

In terms of the steel decarbonisation ambitions of countries, the EU is currently viewed as the leader in developing hydrogen-based direct reduced iron (DRI) and scrap-based steelmaking (Choksey et al., 2025). Half of the steel projects with near-zero emissions in the global Green Steel Tracker (LeadIT, 2024) are in the EU and many of the largest steel producers in the EU have established carbon neutrality pledges (e.g., ArcelorMittal, SSAB, ThyssenKrupp). Meanwhile, other countries are also accelerating their steel decarbonisation aspirations. China is strategically positioning itself to lead in green steel production by 2030, leveraging its strengths in renewable energy and green hydrogen, adoption of hydrogen-based DRI technology, and development of high-grade iron ore supply chains (Transition Asia, 2024). India has prepared a roadmap and action plan for steel decarbonisation that emphasises enhancing energy efficiency, increasing the use of renewable energy and implementing carbon capture technologies as key strategies (Ministry of Steel, Government of India, 2024). Other countries, such as Brazil and Türkiye, are also eager to advance their steel decarbonisation efforts (Clark and Swalec, 2024; Sarı, 2024).

Despite the growing momentum in the steel transition, significant challenges remain. Although many companies and countries have set ambitious targets, the path to achieving a net-zero steel sector remains hampered by technological, economic, and policy-related barriers. Addressing these challenges will be critical to ensure the successful transformation of the steel industry and meeting global climate goals.

[2] The sample of 26 companies selected represents 40% of global crude steel production and around one third of global steelmaking capacity.
[3] Known also as the direct electrification route, this is an innovative method for producing iron by directly converting iron ore into pure iron using electricity, rather than traditional methods that reply on coal or coke. However, compared to other routes, such as DRI-EAF, their TRLs (technology readiness levels) are comparatively low.

2 Key challenges facing steel decarbonisation efforts

There is general agreement that advancing breakthrough technologies is crucial to transitioning the iron and steel sector (Rumsa et al., 2025). While significant progress has been made in clean energy innovation in recent years, approximately 35% of emissions reductions in the net zero scenarios rely on technologies still in the demonstration or prototype phase, meaning they are not yet commercially available (Climate Club, 2023). Beyond the availability of technology, the steel decarbonisation agenda faces several other critical barriers:

- **High cost of near zero emission production routes compared to conventional processes**: Steel decarbonisation is capital intensive, and as low carbon steelmaking technologies develop, larger investment along innovation chains will be required (OECD, 2024b). For example, the OECD (2024b) analysis shows that the estimated investment costs for a H2-DRI-EAF is €574/t capacity, which is about 30% higher than the CAPEX for a greenfield BF-BOF. For first movers to invest in high-risk decarbonisation technologies, public finance can be used to de-risk initial projects (Climate Club, 2023). This will be particularly important in emerging markets and developing economies (EMDEs) where the cost of capital is higher and the risks are greater.

- **The availability and affordability of renewable energy and green hydrogen**: The scaling of green hydrogen-based ironmaking will require the deployment of renewable-based electricity generation, hydrogen storage infrastructure, and ensuring sufficient water supply. However, in certain regions, including Europe, hydrogen production currently faces significant challenges, including high costs and availability (Choksey et al., 2025). Moreover, hydrogen transport and storage are economically inefficient as a result of energy losses and high infrastructure costs. However, these costs can be reduced by strategically locating hydrogen hubs close to iron ore mines and processing plants in countries with abundant iron ore and high renewable energy potential such as Australia and Brazil (De Villafranca Casas et al., 2022).

- **Lack of international certification and common global understanding on definitions for near-zero emissions steel:** The absence of a shared methodology for measuring emissions from industrial materials and products can hinder effective cross-border trade and comparison (WTO, 2022). Additionally, a unified definition of near- and low-emission standards in steelmaking may help prevent market fragmentation and minimise buyer confusion (Climate Club, 2023). Currently, there is no internationally agreed definition of near-zero emissions steelmaking; however, according to the IEA (2024b), a global common understanding is emerging around near-zero emissions threshold values for steel.

- **Uncertain demand and need to create early markets for low-emissions steel:** Currently, low-carbon steelmaking has higher costs than conventional steelmaking, and this cost differential will remain for the foreseeable future. This ’green steel premium’ reduces demand, slowing the adoption of low carbon technologies. To overcome this barrier and provide greater certainty on the size of market for producers, policymakers can support the development of lead markets through public procurement, labelling and standards, and other regulatory incentives, as proposed by the EU in the Steel and Metals Action Plan (European Commission, 2025a).

- **The limited availability of DR-grade iron ore:** The switch to the H2-DRI-EAF route will require high-quality iron ore (the so-called DR grade pellets) which has low levels of impurity and high levels of iron content, above 66% (Agora Industry and Wuppertal Institute, 2023). Currently, only 3-4% of iron ore shipments are of this quality (OECD, 2024b). To overcome this barrier and meet the growing demand for high-grade ores, processes used to upgrade iron ore must be improved and new high-quality iron ore mines must be commissioned (Rumsa et al., 2025).

- **The availability of recycled scrap with low contaminants:** Today, around 30% of steel is produced through recycling scrap, however, this share is forecast to rise to up to 45-50% by 2050 (OECD, 2024a). Policies to keep scrap flows clean, such as clear requirements for scrap sorting and shredding at the end of useful life of steel-containing products, will be needed to ensure that secondary steel can be used in most applications (Agora Industry and Wuppertal Institute, 2023).

The achievement of steel decarbonisation by 2050 is likely to depend on a broad set of enabling policies. This includes ensuring access to clean and affordable energy for the steel and other metals industries through the faster deployment of renewable energy, investment in grid infrastructure and solutions such as energy storage, dispatchable generators, and demand-side management (Choksey et al., 2025). Clear and ambitious regulatory frameworks and market setting policies, such as decarbonisation targets, carbon pricing mechanisms with effective anti-carbon leakage policies, as well as standards and product labelling, can contribute to creating market certainty and guiding investment decisions. Additionally, public supply-side support through grants, concessional finance, or carbon contracts for difference will also play an important role in de-risking early-stage investments (Climate Club, 2023).

Box 1 Challenges identified during the dialogue

A common global understanding of the definitions of near-zero emissions steel was one of the challenges that was discussed during the ODI-ECF dialogue. One participant noted that the debate about definitions and standards for green steel has intensified, reflecting the complexity of the issue. The carbon intensity and material properties of steel vary significantly depending on whether it is produced from iron ore or scrap, making it difficult to establish universally accepted definitions. While chain of custody approaches are gaining traction, there remains a lack of consistent standards. To ensure global alignment and support trade, standards for low-carbon steel should be interoperable. In this context, the steel industry and its associations are collaborating with the WTO in efforts to harmonise definitions and certification frameworks.

Another challenge identified during the dialogue was global steel overcapacity, which leads to market distortions and is one of the rationales for the European Steel and Metals Action Plan put forward by the European Commission. It was also noted that global overcapacity impacts steel decarbonisation efforts, first, directly, by continuous growth in emissions-intensive steel production capacities, and second, indirectly, by squeezing profit margins of companies that try to invest in low carbon emissions technologies.

Source: Participants' inputs from the First International Climate, Trade and Industrial Policy dialogue

3 The EU Steel and Metals Action Plan and its implications for third countries

Published on 19 March 2025, the European Steel and Metals Action Plan (SMAP) outlines a number of concrete actions to strengthen the sector's competitiveness and safeguard the industry's future in the EU amid high energy costs and intensifying international competition (European Commission, 2025b). Specifically, the EU plan focuses on six pillars: 1) ensuring access to clean and affordable energy, 2) preventing carbon leakage, 3) strengthening European industrial capacities, 4) promoting circularity, 5) defending quality industrial jobs, and 6) de-risking projects through lead markets and public support (European Commission, 2025a). Many of the elements of this plan would, if implemented, probably exert significant impacts on international trade and steel supply chains.

3.1 CBAM scope expansion: exports and downstream products

The CBAM's definitive period begins in 2026, which is when the gradual phase-in of import pricing and the graduate phase out of free ETS allowances will begin. Although CBAM targets imports, it does not address the risk of carbon leakage that may occur due to the decreasing competitiveness of EU exports that that have been subject to the ETS price. To mitigate this risk, the Commission plans to present a respective policy solution towards the end of 2025 (European Commission, 2025a).

Furthermore, the Commission considers that there is a risk that carbon leakage could shift downstream in the value chain, either through circumvention (modifying CBAM-covered goods to avoid obligations) or increased imports of downstream products from countries with no or less ambitious carbon pricing. To counteract this risk, the SMAP proposes to extend CBAM to certain downstream steel and aluminium products. A recent OECD study found that CBAM with its current limited coverage negatively affects downstream non-covered sectors that face increased input costs, therefore diminishing their competitiveness (Dechezleprêtre et al., 2025). If the Commission decides to extend the scope of CBAM and provide a solution for export-related carbon leakage, this will likely put additional pressure on third country producers to decarbonise in order to compete with EU producers.

3.2 Strengthening of trade defence instruments to counteract global overcapacity

In order to replace the currently applicable safeguard measure which expires in June 2026, the Commission plans to introduce new long-term protective measures by late 2025 (European Commission, 2025a).

In addition, the EU is considering to introduce a "melted and poured" rule to prevent the circumvention of import duties by tracking the actual origin of metal production (European Commission, 2025a). The introduction of the "melted and poured" rule may complicate supply chains and potentially increase administrative costs for third-country producers. Countries such as Türkiye and Viet Nam could be affected given their sizeable imports of hot rolled coils from China, which is then processed and exported to other markets, including the EU (Steel Orbis, 2025).

Finally, the Commission proposes a more restrictive application of trade defence instruments (TDIs) in order to limit the competitive effects of overcapacity in third countries in the European market. For instance, anti-dumping and anti-subsidy duties may be imposed upon the threat of injury to domestic industry, rather than only once injury has taken effect.

3.3 Boosting circularity and the use of steel scrap in the EU

To support steel decarbonisation and reduce the EU’s dependence on imported primary raw materials, the Commission is planning to stimulate the demand for recycled metals and increase the volume of scrap used for recycling in the EU (European Commission, 2025a). To that end, the EU is considering introducing recycled content targets in key sectors, such as the automotive sector, as well as potential trade measures, including export fees or export duties to ensure sufficient availability of scrap. The Commission is monitoring export restrictions and subsidies by third countries that affect metal scrap availability and may propose a trade measure by the third quarter of 2025, including the potential introduction of a reciprocity rule. It also aims to use trade measures to prevent potential ’scrap leakage’ to countries with lower environmental and social standards (European Commission, 2025a). Keeping more scrap in the EU could have an adverse effect on major scrap importers, such as Türkiye, which produces most of its steel from secondary materials (Gros and Coi, 2025).

3.4 Creating stronger incentives for domestic low-carbon steel adoption

Given that many decarbonisation investments remain economically unviable due to high capital and operational costs, the EU aims to establish lead markets through regulatory incentives, public procurement, as well as resilience and sustainability criteria to encourage faster adoption of low-carbon steel (European Commission, 2025a). As the EU fosters lead markets for low-carbon steel, third-country exporters may face higher barriers to access the EU market unless they align with low-emission requirements. Adoption of sustainability criteria in procurement could mean that third country producers need to adjust their production methods, adopt certification schemes, or report emissions transparently to meet future EU procurement standards. At the same time, these policies will drive the demand for green steel inputs (e.g., renewable hydrogen, DR-grade iron ore) which could be supplied from resource-rich third countries, presenting opportunities for strategic partnerships.

Finally, the SMAP also mentions ongoing EU strategic partnerships and the possibility of strengthening supply chain resilience with third countries, which could involve "investing in partner countries and redefining industrial collaborations to create a more sustainable and resilient steel production ecosystem" (European Commission, 2025a). While the Action Plan does not include further details on this strategy, increased green iron trade and global steel supply chain transformation could strengthen the European steel decarbonisation agenda by making it more cost effective.

Box 2 Stakeholders' views on the EU Steel and Metals Action Plan

During the dialogue, a Commission representative emphasised the strategic importance of maintaining a strong domestic steel industry within the EU, particularly in the current geopolitical context - given defence-related needs - and affirmed the EU's willingness to deploy various instruments to safeguard it. However, it was recognised that while the EU prioritises the protection of its domestic steel industry, it remains open to source a portion of its (green) iron needs from countries that have access to cheap green hydrogen to diversify the EU's supply chains and lower steel production costs.

It was also mentioned that while the policies in the European Steel and Metals Action Plan may appear protectionist to partner countries, the EU is monitoring the impact they will have on the rest of the world. The Commission also believes that the new trade instrument - Clean Trade and Investment Partnerships (CTIP) - could foster the creation of mutually beneficial partnerships that support green steel supply chain integration and investments.

Some third countries found that, in terms of impacts, the measures proposed in the SMAP, go far beyond the EU market and may be challenging for the steel sector in third countries, as third countries do not have enough fiscal space to provide similar support. Furthermore, some partner countries fear that the use of trade defence instruments could negatively impact their steel exports to the EU, given their exposure to the EU market. Other countries noted the possibility of creating partnerships with the EU to foster green steel and green iron trade and emphasised that they have interests similar to the EU – e.g., sovereignty and a desire to produce more and better to meet domestic demand.

Another participant suggested that, to mitigate the effects of protectionist policies, the EU could support partner countries in aligning with market-based rules, foster cooperation on developing green steel standards, and assist in the establishment of carbon pricing mechanisms, as well as facilitate green iron imports from partner countries.

Source: Participants' inputs from the First International Climate, Trade and Industrial Policy dialogue

4 Green iron trade and the transformation of the global steel supply chain

The transition to low-carbon steel production has the potential to reshape global steel supply chains, leading to a geographic reconfiguration of iron and steelmaking. Traditionally, iron and steel production has taken place in large, integrated plants located near abundant coal and iron ore resources. With the rise of green iron technologies, iron production is expected to shift towards regions rich in iron ore and abundant renewable energy, enabling more sustainable and cost-effective ironmaking (Wilmoth et al., 2024). At the same time, steel production will likely remain concentrated in industrial hubs with strong manufacturing capabilities and high demand. The evolving landscape presents opportunities for certain countries and regions to establish themselves as key players in emerging 'import-export green iron corridors', facilitating low-emission trade routes (Wilmoth et al., 2024). Bilici et al. (2024) estimated that if a global green iron market emerges early - driven by H2-DRI production in countries with low-cost renewable electricity - it could result in annual cost savings of USD 25-45 billion by 2050, equivalent to 2.2–3.9% of total yearly production costs.

The shift to H2-DRI-EAF steelmaking will require a significant supply of green hydrogen and affordable renewable electricity, which are currently lacking in Europe. As a result, the EU plans to supplement its domestic hydrogen production, targeted at 10 million tonnes, with imports of 10 million tonnes of hydrogen by 2030 (European Commission, n.d.b). Given their resource endowment, regions such as Northern Africa, Brazil and Australia are emerging as promising green hydrogen exporters, but also producers of hydrogen-derived products, such as hot briquetted iron (Wilmoth et al., 2024) which can be transported at reasonable costs (Bilici et al., 2024). Between domestic hydrogen production, importing green hydrogen, and importing green iron, this last option, as argued by Wilmoth et al. (2024), is emerging as the most cost-effective one to contribute to EU steel decarbonisation.

Karkare and Medinilla (2024) make the case that Europe can achieve multiple benefits by partially decentralising iron and steel production and importing green iron (HBI) from countries in Northern Africa. Firstly, this would reduce overall energy costs, ensuring long-term sustainability of European steel production, including exports, while preserving jobs and advancing EU decarbonisation efforts. It would also reduce the need for expensive subsidies to expand DRI production in Europe and facilitate the creation of a CBAM-compliant green iron and steel trade network that integrates European industries with Southern Neighbourhood facilities. Finally, it would support the displacement of existing imports of finished steel from high-emission countries, thus contributing to a more sustainable and competitive steel industry globally and fostering resilience of the European supply chain. For Northern Africa and other countries well placed to export green iron, it could provide opportunities to scale higher value iron products, develop local clean energy industries, and create new jobs (Wilmoth et al., 2024).

However, the expert consensus is that such a transformation of steel supply chains is a deeply complex and politically sensitive issue as it brings critical trade-offs between reshoring and nearshoring, supply chain resilience, competitiveness, and strategic dependencies (Karkare and Medinilla, 2024). In the EU, the steel industry is considered strategically important, and the fear of further deindustrialisation and job losses (ERT, 2024) means that the EU appears to prioritise protective trade policies such as strengthening its steel safeguard measure, triggering TDI-investigations upon threat of injury to the domestic industry (European Commission, 2025c), and offering significant subsidies to domestic steel producers (GMK Center, 2024).

Box 3 Stakeholders' views on green iron trade

Many participants in the ODI-ECF dialogue agreed that the separation of energy-intensive ironmaking from steel production offers a promising opportunity for mutually beneficial partnerships. Brazil and Germany were highlighted as a potential flagship example and a model for others to follow. One participant estimated that importing green iron from Brazil could significantly lower steel production costs in Germany, where domestic green iron production is currently expensive due to high energy prices. While using imported green hydrogen offers some cost reduction, it remains less competitive than importing finished green iron. For Brazil, shifting from exporting iron ore to green iron could triple export value and generate substantial job creation, making the partnership economically advantageous for both sides.

It was also noted by one participant that for green iron trade partnerships to be successful and mutually beneficial, several key elements should be considered: joint ownership of production assets, enhanced coordination across the supply chain, aligned policy support underpinned by a formal Memorandum of Understanding (MoU), inclusion of investment mechanisms such as offtake agreements, and robust technology cooperation. However, the current political landscape presents challenges for such partnerships, and strategic decisions will be required on which segments of the supply chain to offshore and which to retain within the EU.

Source: Participants' inputs from the First International Climate, Trade and Industrial Policy dialogue

5 Outlook

The path forward for steel decarbonisation would, ideally, entail coordinated global action to overcome critical barriers: closing the cost gap between conventional and green steel, securing access to renewable energy and green hydrogen, scaling up breakthrough technologies, agreeing on common standards, and setting up lead markets. International cooperation can help generate a more cohesive approach to steel decarbonisation and act as a ’bridge’ between policymakers, private actors, financial institutions, and civil society (De Villafranca Casas et al., 2022). Initiatives such as the Breakthrough Agenda, Leadership Group for Industry Transition, Climate Club, WTO Voluntary Steel Standards Principles, and Responsible Steel can pave the way to harmonise standards, unlock finance, and promote technology sharing at the global scale.

The EU SMAP aims to link industrial competitiveness with the EU’s decarbonisation agenda - a model that has the potential to influence global steel trade and investment flows. For resource-rich emerging economies, this presents an opportunity to position themselves as key suppliers in the new green steel value chains, particularly through green iron exports. The direction of this evolving trade landscape - towards greater strategic integration or increased fragmentation - will likely reflect how different countries navigate the trade-offs between employment, economic security, economic efficiency, and principles of international equity in advancing a just and equitable transition for the steel sector.

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