The State of the EUROPEAN STEEL TRANSITION

March 2025

This report was produced and endorsed by a broad community of experts and civil society groups who are advocating for a green steel transition in Europe. E3G and Beyond Fossil Fuels led on coordinating the project behind this publication, helping to compile and aggregate the views across civil society organisations.

Contents

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Executive Summary

The future we want to see for the EU steel industry

The European steel industry stands at a pivotal crossroads. As one of the most emissions-intensive sectors, responsible for 5% of the European Union's (EU) total emissions and over a quarter of industrial emissions, its transformation is essential to achieving the EU's ambitious climate goals. The steel sector must undergo rapid decarbonisation, shifting away from polluting coal-based production towards clean, near-zero emissions alternatives. This transition is not only an environmental imperative but also an opportunity to secure the industry's long-term competitiveness, ensure job security, and reinforce Europe's industrial leadership in a changing global market.

However, over 50% of EU steel production still relies on coal-based blast furnace-basic oxygen furnace (BF-BOF) routes. Most blast furnaces are aged and due for reinvestment or retirement before 2035, so a decision must be made: reinvest in outdated, polluting technology or accelerate near-zero emission steel alternatives.

Europe faces a narrow window for action. Key policy and investment decisions must be made to prevent the sector from being locked into decades of fossil-based production. The Clean Industrial Deal and the European Steel and Metals Action Plan present opportunities to drive the transition. The European Commission is also bringing forward a review of the Carbon Border Adjustment Mechanism (CBAM) in 2025, a crucial policy lever in the shift to a decarbonised European steel sector. From 2026, free emissions allowances for the steel sector under the EU Emissions Trading Scheme will be progressively phased out as the CBAM is phased in, ending completely in 2034. This timeline has already accelerated business plans for decarbonisation and is critical to ensuring well-planned transitions for the stock of coal-based blast furnaces, some of which still lack retirement dates.

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There is a clear pathway to green steel. Near-zero emissions steel production will be driven by green hydrogen-based direct reduced iron (H2-DRI) with electric arc furnaces (EAFs), maximising scrap-based EAF steelmaking and securing strategic partnerships for green iron imports. As of end-February 2025, 33 near-zero emissions steel projects have been announced – but only a fraction are progressing as scheduled. Improving policy support, energy infrastructure and green hydrogen deployment will all be critical to the transition.

Europe is currently a front-runner in near-zero emission steel innovation, but it faces growing competition from China and the Middle East and North Africa (MENA) region. China is already restricting new blast furnace approvals and ramping up H2-DRI production, while the MENA region is heavily investing in green steel. By investing in green steel technologies today, the EU will secure jobs and create resilience throughout the industrial value chain, as well as maintaining its early leadership in developing hydrogen-based DRI and EAF scrap-based steelmaking.

Circularity will be key. Increasing steel recycling and scrap-based production can significantly reduce emissions and reliance on virgin iron, while improving circular economy policies will enhance steel quality, reduce waste and ensure high-value scrap use. The upcoming Circular Economy Act and the proposed Regulation on Circularity Requirements for Vehicle Design and on Management of End of Life Vehicles will offer key policy levers for accelerating this.

With over 2.3 million jobs linked to the steel sector, ensuring a fair transition is critical. With the right policies in place, the transition to green steel can create new opportunities, including jobs in hydrogen infrastructure, renewable energy, and advanced manufacturing. Governments and industry leaders must work together to provide workforce retraining, regional economic support, and social safeguards to ensure a just transition for workers and communities.

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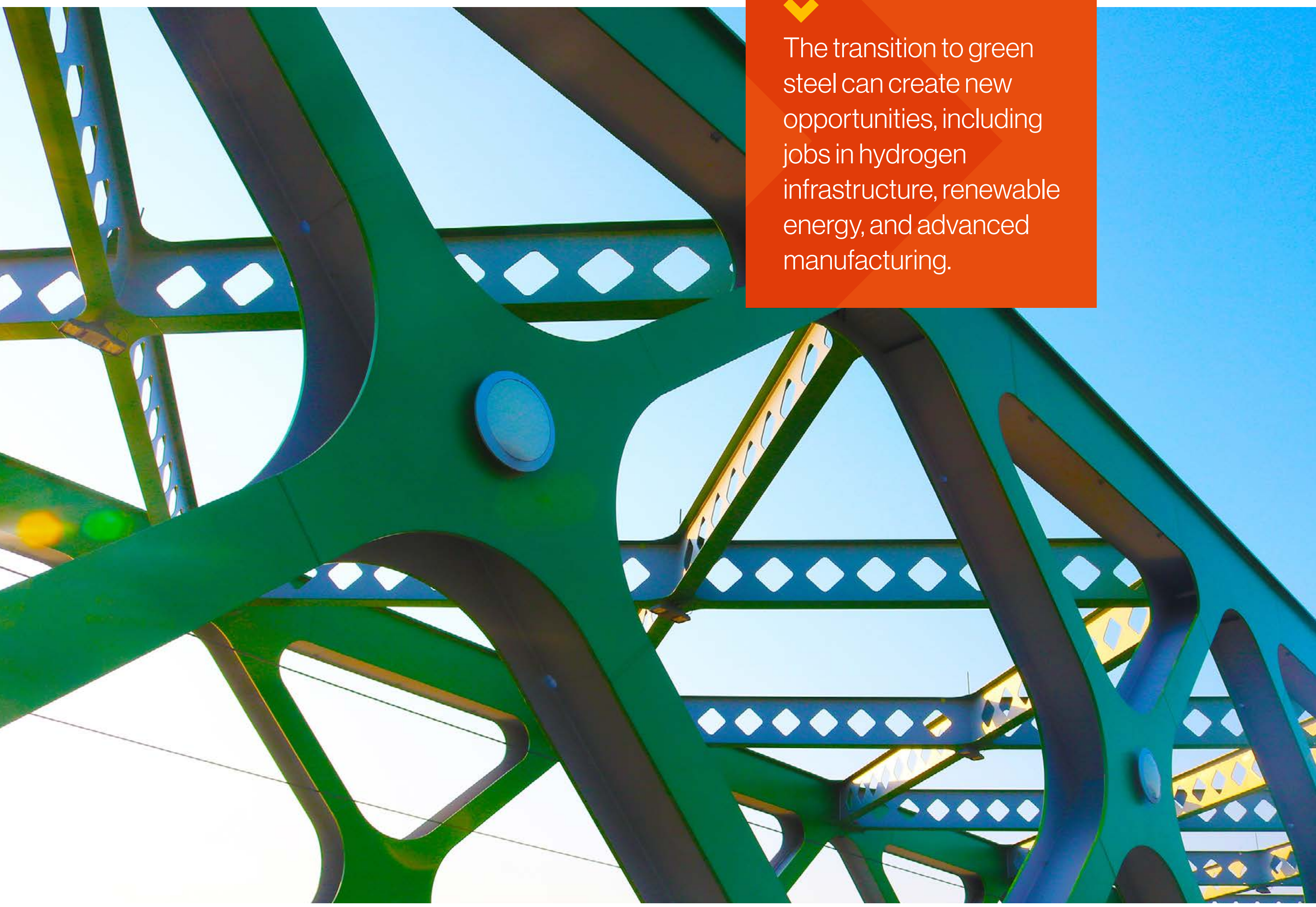

The private sector has a crucial role to play in scaling up the demand for green steel. Sectors such as construction, automotive, and manufacturing must commit to purchasing near-zero emissions steel, helping to create a viable market for sustainable production. Automakers, in particular, can drive significant change, as steel accounts for a substantial portion of vehicle manufacturing emissions. Despite some promising commitments from industry leaders, the vast majority of automakers and steel buyers have yet to make meaningful pledges to support the transition.

Similarly, while state aid and public financing have provided critical early-stage support, private financial institutions must step up their engagement. Banks, insurers, and investors need to integrate climate risk into their decision-making processes, prioritising investments in green steel over high-emissions alternatives.

Ahead of this critical policy window, and based on our analysis of the EU steel transition, we recommend the following priority policy interventions:

1. EU Member States need to commit to not permitting or financing any new BF-BOF and end public investments to reline existing ones. A framework needs to be developed that guarantees a transformation of the steel sector in Europe in line with a 1.5°C scenario.
2. Timely, ambitious, transparent and robust transformation plans are needed at both corporate and site level to ensure the future of steel production in Europe.
3. H2-DRI projects that have been supported with state aid need to be kept on track to deliver the first generation of new iron making facilities in Europe.
4. Policymakers should prioritize the decarbonisation of the steel sector by advancing renewable-powered electrification and harmonising grid decarbonisation across Member States
5. To protect steel workers in Europe, policymakers must implement robust social safety nets, such as a reinforced Just Transition Fund, and reskilling programmes to ensure workers are part of and benefit from the transition to a low-carbon economy.
6. State aid should be seen as an accompanying measure, complementary to private investments; part of a suite of policy measures alongside the enforcement of pollution prevention measures that can help drive steel decarbonisation. State aid needs to come with strict conditions to maximise public benefits.
7. Policymakers should adopt a standard for near-zero emissions steel production as well as create an enabling environment for lead markets for steel using recycling and scrap targets.
8. The European Commission and Member States should align public procurement with climate protection and zero pollution goals to develop green lead markets.

The EU's foundations were built on coal and steel, but its future must be shaped by green, near-zero emissions steel. By embracing bold policies, forward-looking investments, and innovative industrial strategies, Europe can lead the global transition towards sustainable steel production. Steps taken today will determine whether the EU secures its position as a green steel leader or falls behind in the race for industrial transformation. The future we want to see is one where European steel is not only competitive and resilient but also fully aligned with climate and environmental objectives, ensuring a thriving, pollution-free industry for generations to come.

Introduction

The European iron and steel sector is entering an era of deep structural change. The European Union (EU) has set an ambitious target: for Europe to become the first climate-neutral continent by 2050. Further, the European Commission has recommended a 90% reduction in net greenhouse gas emissions by 2040 relative to 1990.[1] Achieving these goals will require significant acceleration of emissions reductions across all sectors, including iron and steel, which currently account for 5% of EU emissions[2] and over a quarter of industrial emissions.[3] Coal-based ironmaking is also one of the most polluting industrial processes.[4] Moving towards near-zero emissions steel would not only contribute to the EU's climate goals but also support progress towards zero pollution and toxic-free goals.

New ambition to enable the steel transition

The EU must act quickly: the window for policy and investment decisions to prepare for the transition is rapidly closing. The year 2025 will be critical for advancing this agenda. The European Commission's Clean Industrial Deal presents an opportunity to enhance the EU's competitiveness and accelerate the transition of energy-intensive industries to climate neutrality. On a more granular level, the Commission will use the European Steel and Metals Action Plan to target the steel industry directly. In addition, the Commission is expediting a review of the Carbon Border Adjustment Mechanism (CBAM) to minimise the risk of carbon leakage in the sector. There are further policy opportunities to bolster the supply and use of steel scrap and create lead markets for green steel, including: the proposed Regulation on Circularity Requirements for Vehicle Design and on Management of End of Life Vehicles; the revision of the Ship Recycling Regulation; and the revision of the Waste from Electrical and Electronic Equipment (WEEE) Directive, a key pillar of the proposed Circular Economy Act.

Ahead of this important policy juncture, this report takes stock of the current state of the EU steel transition, sharing data derived from the first ever European-level tracker of blast furnaces, the European Steel Plant Database, developed with SteelWatch.[5] The report also includes a comprehensive

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1 https://www.e3g.org/news/from-communication-to-legislation-the-roadmap-to-the-eu-s-2040-climate-target/
2 European Environmental Bureau (2024) Our vision for a prosperous and sustainable industry: a positive blueprint for the future. https://euelections.eeb.org/industrial-blueprint/ and Sandbag (2024). A closer look at 2023 emissions: steelmaking caused a quarter of industry pollution. Brief. https://sandbag.be/wp-content/uploads/Sanbag_Brief_October24_A-closer-look-at-2023-emissions-1.pdf
3 Sandbag (2024). Op.cit.
4 WWF (2023) The Dirty Thirty – 30 most heavily polluting industrial installations in Germany. https://www.wwf.eu/?11717291/Dirty-Thirty-2023
5 This research was coordinated by SteelWatch and created for the undersigned civil society organisations.

aggregation and analysis of state aid deals made by Member States to support the steel transition.[6] The report bases its findings and recommendations on the recently published work of more than 30 civil society, research and intergovernmental organisations working to decarbonise the European steel and iron sector. This analysis will be used to highlight key enabling conditions for accelerated EU steel decarbonisation and outline recommendations for priority policy interventions.

European iron and steel making is reliant on large-scale use of coal

The European steel industry includes primary producers with blast furnaces and basic oxygen furnaces (BF-BOFs), secondary producers with electric arc furnaces (EAFs), and new producers focusing on hydrogen-based green steelmaking. Steel produced in a BF-BOF using coal, however, remains the dominant production route in Europe, accounting for roughly 55% of steelmaking capacity, with steel produced via EAF accounting for 45%.[7] This balance needs to change, fast.

Ironmaking in blast furnaces is a major source of CO_2 emissions (**Figure 1**), but this process can be replaced with direct reduction of iron ore (DRI) using fossil gas, hydrogen (H2) or a blend. To produce near-zero emissions iron, this process needs to use green hydrogen for the DRI. Steelmaking can also achieve near-zero emissions by using a mix of scrap and virgin iron made via H2-DRI, melted in renewable electricity-powered EAFs or a combination of electric smelters and basic oxygen furnaces.

As well as carbon, ironmaking in blast furnaces emits significant amounts of particulate matter, sulphur dioxide (SO_2), and nitrogen oxides (NOx).[8] These pollutants contribute to air quality issues and health problems;[9] emissions in the EU steel sector have been linked to premature deaths as well as substantial economic costs.[10] Despite this, the true cost of pollution – including its toll on public health – is not reflected in coal-based ironmaking.

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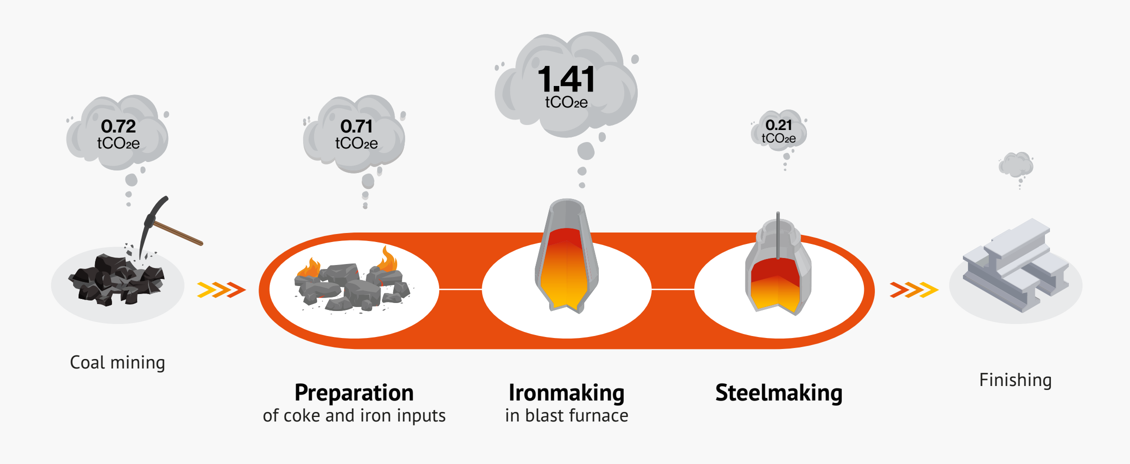
6 Research and reporting on the state aid decisions made by Member States was conducted by CAN Europe, EEB and ARIA.
7 European Steel in Figures 2024, EUROFER annual report (figures for 2023). https://www.eurofer.eu/publications/brochures-booklets-and-factsheets/european-steel-in-figures-2024
8 Further pollutants include benzene, arsenic, cadmium, lead and mercury. https://www.osservatoriodiritti.it/wp-content/uploads/2018/09/ilva-taranto-perizia-epidemiologica-2012.pdf
9 Centre for Research on Energy and Clean Air (2022). Unveiling the truth behind blast furnace pollution in South Korea. https://energyandcleanair.org/publication/unveiling-the-truth-behind-blast-furnace-pollution/
10 WHO (2023) Health impact assessment of steel plant activities in Taranto, Italy. https://www.who.int/europe/publications/i/item/9789289058360

FIGURE 1. CO_2 EMISSIONS DURING STAGES OF STEEL PRODUCTION



Note: The total emissions across the 3 stages of iron and steelmaking is 2.33tCO_2/tonne of crude steel (tcs). When estimated emissions from coal mining are added it is 3.05 tCO_2/tcs

Source: Adapted from SteelWatch Explainer[11]

The EU only has a narrow policy window in which to move its steel sector onto a climate-neutral and zero pollution pathway. The BF-BOF infrastructure is old and over half of blast furnaces are due to be retired before 2035. Steelmakers face critical investment decisions in the next 5 years. They need to decide whether to reinvest in carbon-intensive, highly polluting production; to switch to near-zero emission processes, or to shut down existing facilities entirely.

Coal-based routes are risky and incompatible with addressing climate change and the consequences of pollution. Coal-based ironmaking is also proving increasingly unprofitable.[12] Major companies like Stahl-Holding-Saar (SHS) and Acciaierie d'Italia have suspended operations to stabilise prices, with four blast furnaces idling and potentially closing. Moreover, from 2026, free emissions allowances for the steel sector under the EU emissions trading scheme (ETS) will be progressively phased out as the CBAM is phased in, ending completely in 2034.[13] These additional CO_2 costs will be decisive in ending the business case for continued coal-based iron making.[14]

The European steel sector has also been facing commercial pressures, particularly due to a rise in Chinese exports of steel and falling domestic demand within China. Announcement of tariffs on steel in the US have heightened the commercial challenges and strengthened calls for crisis support from governments.[15] The Russian invasion of Ukraine and the energy price crisis have reinforced the vulnerabilities of overreliance on imported fossil-based energy, including met coal for ironmaking. The steel industry in the EU faces multiple and deep challenges. In this context of clamour and crisis, it will be key to keep an eye on the long-term vision for a clean and competitive industry.

11 SteelWatch (2025). Why steelmaking drives climate change – and why it doesn't have to be this way. https://steelwatch.org/steelwatch-explainers/climate/

12 https://www.steelorbis.com/steel-news/latest-news/steelorbis-year-end-review-european-steel-industry-loses-its-competitiveness-1320870.htm

13 Free allowances in the EU Emissions Trading System (ETS) are permits given to certain industries including iron and steelmaking to emit a specific amount of greenhouse gases without cost, aimed at preventing carbon leakage. Phasing them out by 2034 will increase costs for these industries, encouraging further emission reductions and innovation in green technologies.

14 https://www.spglobal.com/commodity-insights/en/news-research/blog/metals/082423-eu-steel-emissions-to-see-higher-penalties-as-free-allowances-get-taken-away

15 https://www.eurofer.eu/press-releases/statement-on-u-s-steel-tariffs-by-eurofer-president-dr-henrik-adam

A brighter vision for the EU steel sector is possible

The origins of the EU are rooted in coal and steel. But securing a long-term future for the steel sector in Europe now means moving fast and decisively beyond fossil-based steel. By investing in a new generation of near-zero emissions steelmaking,[16] relying on green hydrogen and renewable electricity, the EU can secure jobs and resilience throughout the industrial value chain.

With its unique assets and strong starting point, Europe is currently viewed as a front runner in developing hydrogen-based DRI and EAF scrap-based steelmaking. Over half of near-zero emissions steel projects currently included in the global Green Steel Tracker are in the EU.[17] Many of the EU's largest steel producers have set carbon-neutrality pledges, including thyssenkrupp SE (Germany HQ) and SSAB (Sweden HQ) by 2045, and ArcelorMittal (Luxemburg HQ) by 2050. SSAB is planning to offer fossil-free steel as early as 2026. Stegra in Sweden aims to produce 5 million tonnes a year of near-zero emissions steel by 2030 at its plant in Boden, which is currently under construction.[18] Finland's Blastr is planning to build a plant in Inkoo that aims to produce 2.5 million tonnes of green hot- and cold-rolled steel by 2026.[19] The European Steel Association (EUROFER) has projected emissions reductions of 81.5 Mt carbon dioxide equivalent (CO_2e) per year by 2030 (EU iron and steel emissions are estimated to amount to 145 Mt CO_2e in 2023),[20] if the current pipeline of near-zero emissions steel projects is completed.

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Europe's world-leading decarbonisation of its power sector has placed it well ahead of other regions. In 2022, the EU generated the largest share of wind and solar electricity among the world's leading economies.[21] The availability of renewable energy is growing, but more will be needed for the electrification of industrial sectors. Steel producers will need to play their part in helping this transition by signing long-term power purchase agreements (PPAs) and committing to using 100% renewables for their production sites.

Decades of leadership on climate policy also mean that the EU has a head start on the policy framework required to accelerate steel sector transition. With the European Green Deal legislative package, the EU adopted a range of policy measures aimed at accelerating industry decarbonisation: support for early-stage commercialisation of innovative production processes under the EU ETS and the Innovation Fund, a more robust anti-carbon leakage system in the form of the CBAM, and targets to ensure green hydrogen uptake and prioritisation for industry sectors.[22]

16 While no internationally agreed definition of near-zero emissions steelmaking exists, the International Energy Authority (IEA) reserves the use of "near-zero emissions" for technologies that are already compatible with an energy system at net zero emissions. For the steel sector, that includes the EAF route and the H2-DRI route, when the hydrogen is produced through electrolysis. See: IEA (2024) Definitions for near-zero and lowemissions steel and cement, and underlying emissions measurement methodologies: summary of emerging understandings. https://iea.blob.core.windows.net/assets/0910c4ff-4008-48f5-a3ec-c52996ed694d/Definitionsfornear-zeroandlow-emissionssteelandcementandunderlyingemissionsmeasurementmethodologies.pdf

17 https://www.industrytransition.org/green-steel-tracker/

18 https://stegra.com/the-boden-plant

19 https://www.blastr.no/Newsroom/Post/?permalink=four-billion-euro-investment-planned-into-a-green-steel-plant-in-inkoo-finlan

20 https://www.eurofer.eu/issues/climate-and-energy/maps-of-key-low-carbon-steel-projects

21 https://strategicperspectives.eu/a-new-zero-carbon-industrial-era/

22 https://ptx-hub.org/industry-targets-in-european-legislation-for-hydrogen-and-ptx-products/

Steel companies have also received aid from Member State governments to support the transition, based on Climate, Energy and Environmental Aid Guidelines (CEEAG).

However, the EU will need to make bolder and faster decisions if it wants to translate pilot projects into industrial-scale production. Recent announcements from ArcelorMittal[23] and thyssenkrupp SE[24] have raised doubts about the progress of some of the most promising green steel projects in Europe, despite large amounts of public funding going towards their completion. The companies have voiced concerns over the slow pace of green hydrogen development, high electricity prices and a lack of offtake agreements from steel buyers. Although energy prices have largely receded to where they were before Russia invaded Ukraine, the rollout of hydrogen infrastructure has mostly stalled, raising concerns for steelmakers planning DRI facilities.[25]

Meanwhile, other countries are racing to establish clean steelmaking, investing billions in the sector. After limiting approvals for new blast furnaces, China only approved EAF steel projects in the first half of 2024, and is investing heavily in H2-DRI and electrolysers.[26] China is also planning to commission large amounts of green iron (sponge iron from DRI) from Australia.[27] In the Middle East and North Africa (MENA) region, Mauritania has high-grade iron ore and green hydrogen is being developed by countries like Oman and the United Arab Emirates in attempts to supply Europe[28] and India has introduced a new roadmap to enhance energy efficiency and increase renewable energy use in steel manufacturing.[29]


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These shifts ramp up pressure on the EU to transition its steel sector as quickly as possible. Urgent policy action and investment decisions will be needed in the next few years for the EU to retain its competitive edge. Steel transition is also a critical issue for Europe's economic and social cohesion. The steel sector indirectly employs more than two million people and supplies key industries, including automakers, construction and machinery.[30] The transition stands to benefit European society as a whole in terms of cost, strategic autonomy and improved air quality for the millions living near steel plants across the continent.

23 https://www.euronews.com/my-europe/2024/12/02/arcelormittal-green-steel-backtrack-raises-fears-for-industrial-transition
24 https://renewablesnow.com/news/thyssenkrupp-affirms-plan-for-green-steel-amid-massive-job-cuts-1267157/
25 https://www.hydrogenfuelnews.com/german-steel-industry-hydrogen/8569618/
26 https://www.scmp.com/business/article/3269981/china-marks-turning-point-after-limiting-approvals-coal-based-iron-and-steel-projects and Transition Asia (2024) Will China win the green steel race. H2-DRI-EAF market and policy development to 2030. https://transitionasia.org/wp-content/uploads/2024/10/EN_Will_China_Win_the_Green_Steel_Race_241010.pdf
27 Institute for Energy Economics and Financial Analysis (2023) Australia faces growing green iron competition from overseas. https://ieefa.org/resources/australia-faces-growing-green-iron-competition-overseas
28 Institute for Energy Economics and Financial Analysis (2022) MENA, a potential new hub for green steel and green iron metallics. https://ieefa.org/resources/mena-potential-new-hub-green-steel-and-green-iron-metallics
29 Ministry of Steel, Government of India (2023) Greening the steel sector in India: Roadmap and action plan https://steel.gov.in/en/greening-steel-sector-india-roadmap-and-action-plan
30 EUROFER (2024) European steel in figures 2024. https://www.eurofer.eu/publications/brochures-booklets-and-factsheets/european-steel-in-figures-2024

TABLE 1. STATE OF THE EU STEEL TRANSITION BY MEMBER STATE

Country	BF-BOF Share	EAF Share	Total number of BFs (operating + mothballed)	Total number of operating BFs	Operating, 2025 relining decision announced	Operating, at risk of relining	Operating, no retirement date, no imminent relining risk	OPERATING, RETIREMENT ANNOUNCED: Retirement before 2035	Retirement after 2035	Unknown retirement date	Mothballed	Decarbonisation projects
Austria	100%	0%	5	5	0	0	2	3	0	0	0	2
Belgium	63%	38%	2	2	0	0	1	1	0	0	0	1
Czech Republic	97%	3%	4	4	0	2	1	1	0	0	0	1
Finland	59%	41%	2	2	0	0	0	1	1	0	0	2
France	64%	36%	5	5	1	1	0	2	0	1	0	3
Germany	75%	25%	15	14	1	0	0	7	5	1	1	12
Hungary	74%	26%	1	1	0	0	0	1	0	0	0	1
Italy	24%	76%	4	1	0	0	1	0	0	0	3	1
Netherlands	100%	0%	2	2	0	0	0	2	0	0	0	2
Poland	52%	48%	2	2	0	1	1	0	0	0	0	0
Romania	52%	48%	1	1	0	0	0	1	0	0	0	2
Slovakia	88%	12%	3	3	0	2	1	0	0	0	0	0
Spain	28%	72%	2	2	0	0	0	2	0	0	0	2
Sweden	79%	21%	3	3	0	0	0	3	0	0	0	4
Total			**51**	**47**	**2**	**6**	**7**	**24**	**6**	**2**	**4**	**33**

Source: European Steel Plant Database developed with SteelWatch for this publication.


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Chapter 1.

State of the EU Steel Transition

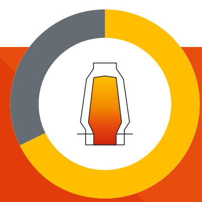
This chapter gives a snapshot of the state of play of the EU's steel transition: 1) mapping the existing stock of BF-BOFs across Member States, 2) evaluating plans for reinvesting or transitioning these plants to lower carbon processes, 3) mapping the companies who own critical assets, and (4) giving an overview of EU Member State efforts to financially support the transition to date.

Key Messages

- **Europe's blast furnace fleet is ageing.** Over half of EU blast furnaces are set to retire before 2035. Transition plans are urgently needed for the 15 blast furnaces operating without a retirement date.
- **There is a high risk of coal-based blast furnaces being relined.** Without intervention, costly relinings could extend coal-based steel production for decades.
- **Key projects in Europe's green steel pipeline are stalling:** 80% of the projected DRI capacity has not progressed beyond the announcement stage. Robust industrial policy is required to keep projects on track.
- **Different Member States offer different levels of support** to steel companies, reflecting different levels of resources. There is a lack of transparency on state aid decisions and a need for more conditions to be attached to this aid across the board.

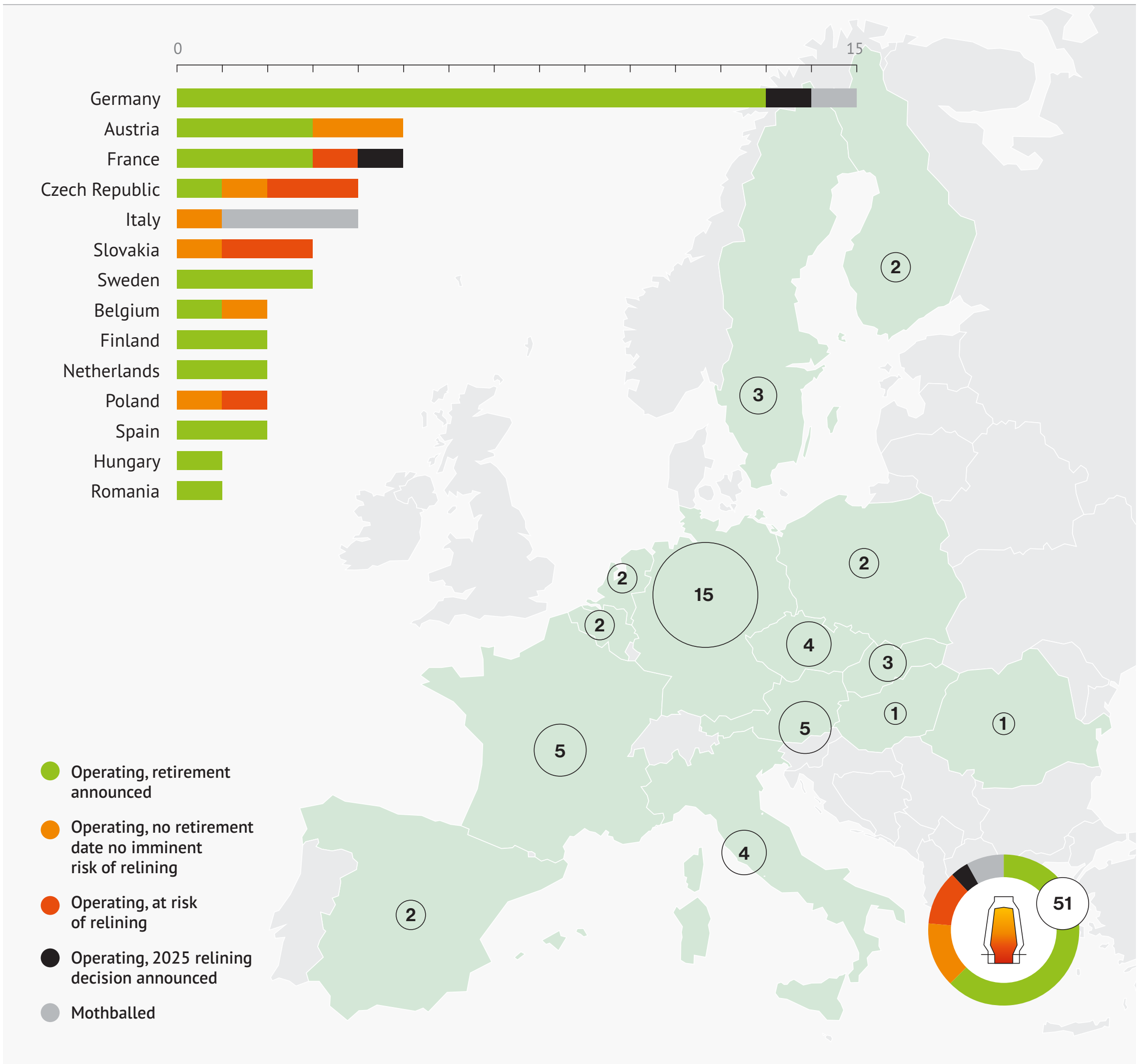
The European blast furnace fleet

With an average age of 50 years, and many over 70 years old, the EU's blast furnace fleet is getting dated. Every blast furnace needs substantial renovation – known as "relining" – approximately every 20 years. As each period comes to an end, the steelmaker faces the question of whether to invest millions in another two decades of operation, or to retire the plant. The current status of the retirement plans of the European blast furnace fleet is shown in Figure 2.



Of the **47** BFs that are currently operating, **32** have announced retirement dates.

FIGURE 2. EU BLAST FURNACE FLEET BY MEMBER STATE AND RETIREMENT STATUS



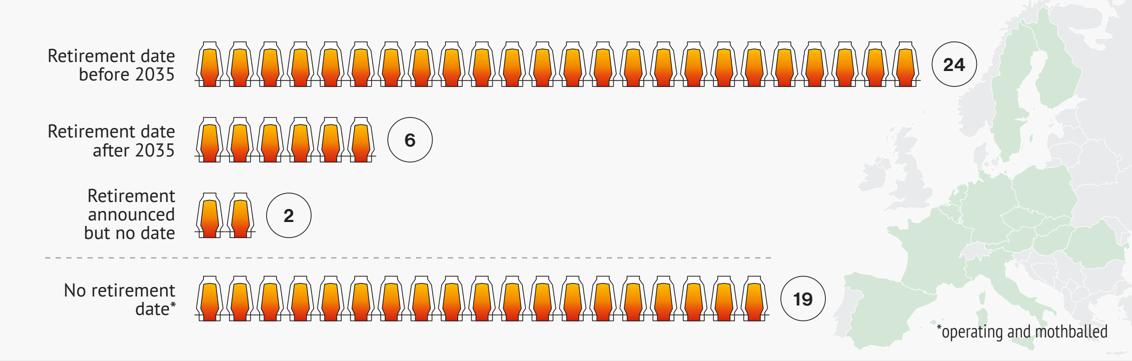
Note: The blast furnaces represented by the green coloured bars are those currently operating although the company has plans to retire them.

Source: European Steel Plant Database developed with SteelWatch for this publication.

Of the 47 BFs that are currently operating, 32 have announced retirement dates, the time at which the coal-based BF will end production. Of these, 24 are scheduled to retire by 2035, while the remaining 6 are set to run beyond 2035 (Figure 3). It is essential for keeping a 1.5°C pathway within reach that 2035 retirements go ahead as planned, while those set to run beyond are dragging European coal-based steelmaking well beyond what the climate requires and what is profitable under the EU ETS.[31]

31 The IEA's updated Net Zero by 2050 (NZE) Pathway indicates that all new heavy industry capacity must be near-zero emissions capable by 2030, if we are to keep warming below 1.5 °C. IEA (2023) Net zero roadmap: A global pathway to keep the 1.5 °C goal in reach. https://www.iea.org/reports/net-zero-roadmap-a-global-pathway-to-keep-the-15-0c-goal-in-reach

FIGURE 3. EU BLAST FURNACES WITH FIXED RETIREMENT DATES



Source: European Steel Plant Database developed with SteelWatch for this publication.

There are 15 operating blast furnaces for which there are no retirement dates. Two are already scheduled for investment in 2025, which could mean a lifetime extension of over 20 years if fully relined, while another six have been identified as at risk of relining based on age. The remaining seven are operating without a retirement date and without an imminent risk of relining. The pathway to ending coal-based iron and steel making is thus far from established, and there is an urgent need to provide clear retirement plans for the entire EU fleet.

In parallel there is the need for clear and transparent transition planning, where retirements are coupled with a green iron and steel pipeline. In the EU currently, 33 near-zero-emissions-capable decarbonisation projects have been announced, all of them EAF and DRI projects aimed at decarbonising steel production. Looking at Europe as a whole, roughly 33 million tonnes per year of near-zero emissions ironmaking capacity through DRI has been planned for construction before 2045 (see Figure 5). This DRI expansion is essential and needs to be accompanied by the sourcing of green iron to fill any gaps left by iron from scrap recycling.

Market factors have been important drivers of these retirement decisions. European companies face a challenging market: declining demand because of slowing production from major sectors like the automotive industry, and a lack of large-scale infrastructure development in recent decades. Compounding this, global overcapacity reached record highs in 2023, driving down prices in the steel market.[32] As a result, seven plants have been idled with job cuts across the sector. In late 2014, thyssenkrupp SE in Germany announced that it would cut 11,000 jobs by 2030 and close a plant in Germany.[33] In the UK, Tata Steel reached a £1.25 billion deal with the UK Government to close their unprofitable BF-BOFs and build a 3Mt EAF in Port Talbot, Wales. However, the deal – which came as the site was on the brink of total collapse – will axe up to 3,000 jobs,[34] leaving the UK Government scrabbling for a more proactive industrial transition plan.

Climate policy signals have reinforced the move away from coal. Since the phaseout of free ETS allowances for steelmaking was announced, steelmakers have known that coal-based steel no longer has a business case in Europe. From 2026, free emissions allowances for the steel sector will be progressively phased out as the CBAM is phased in, ending completely in 2034. This means that coal-based steel production will carry a steadily increasing price for the carbon it emits. Notably, there are no plans by companies in the EU to build new BF-BOFs.

32 https://www.oecd.org/en/about/news/speech-statements/2024/11/96th-session-of-the-steel-committee-statement-by-the-chair.html
33 https://www.recyclingtoday.com/news/thyssenkrupp-steel-plant-closing-layoffs-germany-potential-spinoff-2024/
34 https://news.sky.com/story/tata-steel-uks-biggest-steelworks-shuts-down-final-furnace-after-more-than-100-years-13224922

BOX 1

Central and Eastern Europe risks lagging behind the transition

Some regions are more exposed to competitiveness challenges than others. Central Eastern European (CEE) countries are at risk of falling behind the transition to green steel, with limited plans so far to build low-emissions DRI production units.

Of the 33 announced steel decarbonisation projects in Europe, only four are in CEE, and none of these are close to reaching a final investment decision.[35] The region generally has lower access to capital for decarbonisation projects, and the companies which own existing steel assets have seen repeated crises. There is a risk that the region either reinvests in coal-based production, increasing emissions, or closes the furnaces without sufficient capital to invest in green iron production.

Coking plant, Zdzieszowice, Poland

These countries tend to have less fiscal headroom to provide subsidies, and the steel sector relies on private investment to keep it going. Moreover, many of the key assets in the region are owned by companies with headquarters elsewhere, resulting in a lack of local decision-making power; many multinationals take decisions about the future of the region's plants based on European and international competitiveness rather than domestic industrial policy.[36] Multinationals therefore tend to prioritise decarbonisation investments in western Europe, both for commercial reasons and better policy conditions.

Poland's steel sector, for example, consists of a mix of domestic and foreign-owned companies and is dominated by a handful of producers. ArcelorMittal alone accounts for about half of steelmaking capacity, with blast furnace sites in Krakow and Dabrowa Gornicza and the largest coking plant in Europe in Zdzieszowice.[37] The future development of the sector is thus heavily dependent on ArcelorMittal's plans – but the company has no planned investments for new EAF facilities or any H2-DRI facilities. Instead, it shut down its blast furnace in 2020 in Krakow and temporarily paused operations at Dabrowa Gornicza.

Liberty Steel, which owns steel assets across the CEE region, has faced solvency issues at many of its plants in recent years. The Polish Czestochowa plant has gone insolvent in 2021 and is currently going through a bankruptcy process. The Ostrava plant in the **Czech Republic** is facing insolvency and has had to lay off thousands of workers since July 2024. Similarly in **Hungary**, the Dunaujvaros plant is fighting a liquidation suit.

35 European Steel Plant Database developed with SteelWatch for this publication
36 E3G (2023) Industrial transformation for all Europeans. https://www.e3g.org/publications/industrial-transformation-for-all-europeans/
37 https://gmk.center/en/news/arcelormittal-poland-reduced-steel-production-by-10-3-y-y-in-2023/

BOX 1

In **Romania,** the Galați plant, owned by Liberty Steel, has also faced difficult times. In 2024, it reduced its production capacity to its lowest level since February 2022. Last year, the plant was idled for a short period but partially restarted in July 2024 at the request of the government. The plant's management and Romanian authorities held discussions to identify possible solutions, including state mechanisms and financing programs to support the steel industry's competitiveness. At the end of 2024, the government announced a €150 million loan to help reduce the plant's emissions. While state-backed support schemes like this play a key role, enabling the transformation of the steel industry and the production of green steel also requires significant investments from the private sector.

Liberty Galați has a relatively ambitious transition plan, called the GREENSTEEL transformation plan. Launched in 2022, it broadly outlines a pathway for decarbonisation by 2030, switching from BF-BOF to DRI-EAF using natural gas in a transitional phase before switching to 100% renewable hydrogen by 2030. The switch in primary production is accompanied by a planned increase in liquid steel output, from 2.35 Mt/year to 4.1 Mt/year by 2030. Achieving deep decarbonisation will require substantial investments in renewable energy, green hydrogen production, and scrap steel supply.[38] However, it remains unclear how this plan is to be financed (apart from the aforementioned state aid) and how Romania could produce enough renewable hydrogen to reduce iron ore in a new DRI facility at national level.

Apart from Galați, all blast furnaces in Romania have been closed, with no plans for reopening.

Galati steel plant, Romania

Maintaining the current industrial base in CEE is key for the national economies, perhaps more so than in other parts of Europe, as the industrial sector currently accounts for a higher share of employment and gross value added than in most EU countries.[39] It is vital that intra-EU industrial relocation is not driven by which Member States can afford to give out the most in state aid subsidies. [40]

Structural changes in the region are to be expected, just as elsewhere in Europe. But the new industrial map of Europe should be based on a mix of factors, including national strategic considerations related to issues such as local employment and defence, assessments of competitive advantage based on energy prices, availability of feedstocks, access to finance and operational costs.

Source: Energy Policy Group and E3G

38 Miu, L. and Cîrligeanu, R. (2024) Decarbonising primary steel production in Romania, Energy Policy Group. https://www.enpg.ro/wp-content/uploads/2024/06/EPG_Report_Decarbonising-Romanias-primary-steel-production-1.pdf
39 E3G (2023) Industrial transformation for all Europeans. https://www.e3g.org/publications/industrial-transformation-for-all-europeans/
40 Miu, L. and Cîrligeanu, R., 2024. Op.cit.

Retiring, relining or transitioning to green?

Incumbent steelmakers across Europe face pivotal investment decisions over the next 5 years: they need to decide whether to shut down plants, reinvest in their existing asset base, or invest in near-zero emissions and zero-pollution production processes. This section gives an overview of the factors influencing these decisions, which assets are at risk of relining, which are being transitioned, and the status of green steel pilot projects.

RELINING RISK

The most substantial reinvestments in existing coal-based steel assets take the form of blast furnace relinings. These are major capital investments representing up to half of the cost of constructing a new blast furnace and that require shutting down operations for several months.[41] Depending on the nature of the relining project, a decision to reline could potentially lock in up to 20 years of carbon-intensive production at a given site.[42] Relining also raises serious environmental concerns, with the release of particulate matter contributing to severe air quality issues and health problems.[43]

Recent analysis carried out by SteelWatch has identified blast furnaces that are at imminent risk of being relined,[44] investments that would keep them online well past what is compatible with climate targets. These are blast furnaces for which there is no retirement date, and where the latest relining date is either unknown or took place over 13 years ago. Of these blast furnaces, two already have relinings scheduled for this year (2025), namely ArcelorMittal's plant in Dunkerque (France) and SHS's plant in Dillingen (Germany) (see Figure 4).

Based on the SteelWatch's Blast Furnace Emissions calculation tool[45] and the Global Energy Monitor Global Steel Plant Tracker data,[46] if all the blast furnaces identified as "at risk" in our methodology continue running or are relined, they are projected to emit a staggering 435.04 $MtCO_2$ over the next 20 years. Sending the right policy signals, increasing investor pressure and raising awareness of this risk will be key to making sure these plant owners have the confidence to invest in near-zero emissions technologies instead of relining. It is, therefore, crucial that EU and Member State policymakers responsible for industrial and economic planning consider a faster transition of the steel sector in their respective countries and adjust policies accordingly.

If all the blast furnaces identified as "at risk" continue running or are relined, they are projected to emit a staggering **435.04 $MtCO_2$** over the next 20 years.

41 Vogl, V., Olsson, O. and Nykvist, B (2021) Phasing out the blast furnace to meet global climate targets. https://www.sciencedirect.com/science/article/pii/S2542435121004359

42 Vogl, V., Olsson, O. and Nykvist, B (2021) Op.cit.

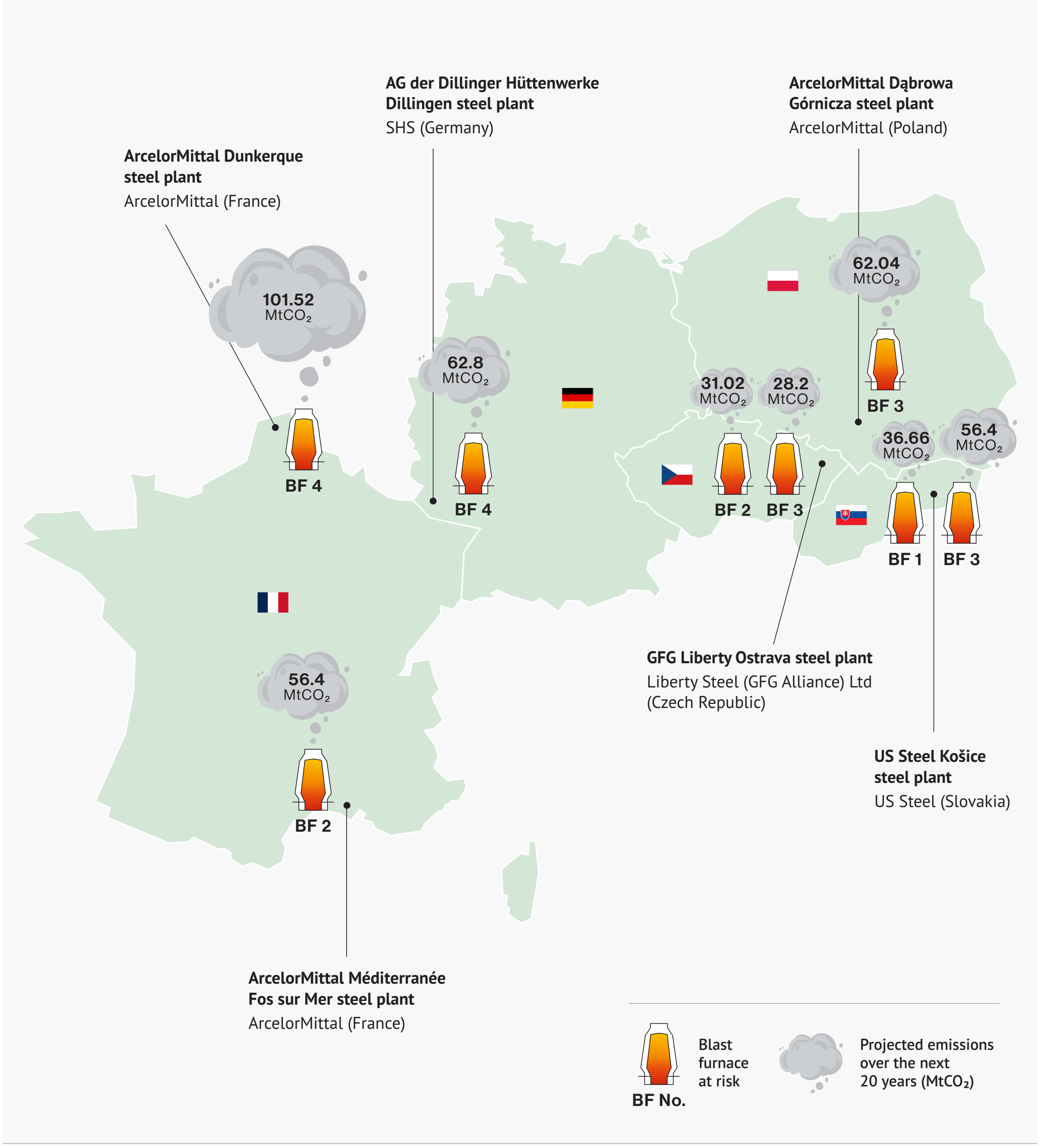
43 Centre for Research on Energy and Clean Air (2022). Unveiling the truth behind blast furnace pollution in South Korea. https://energyandcleanair.org/publication/unveiling-the-truth-behind-blast-furnace-pollution/

44 See section 1.2 of the Annex 1 for details of the methodology for categorising relining risk.

45 See section 1.4 of the Annex 1 for details on the calculation methodology.

46 https://globalenergymonitor.org/projects/global-steel-plant-tracker/

FIGURE 4. PLANTS THAT HAVE ONGOING RELININGS OR ARE "AT RISK" OF HAVING ONE OF THEIR BLAST FURNACES IMMINENTLY RELINED



Source: Steel plant database developed with SteelWatch for this publication. See Annex 1 for further details of the methodology.

TRANSITIONING TO GREEN

To achieve near-zero emissions ironmaking and steelmaking, European companies will need to both transition their coal-based ironmaking and increase their ability to recycle and process scrap steel through the secondary steelmaking route. There are three interrelated pathways to choose from.

- **Steel making in EAFs** can emit less than 0.4 tonnes of CO_2 per tonne of steel in direct and indirect emissions[47] – about 85% less than the BF-BOF route. An EAF melts materials like steel scrap as well as virgin iron using high-voltage electric arcs between electrodes. The process involves charging the furnace with direct reduction iron or scrap metal, creating an electric arc to generate intense heat, and melting the materials. This method allows for efficient recycling and production of steel. Emission levels depend primarily on the source of electricity.[48]

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  - Existing EAF facilities will need to source renewable electricity, invest in improving scrap recovery, and (assuming some virgin iron is also needed) source near-zero emissions iron from Europe or beyond.
  - Investments in EAFs have increased in recent years. Seven have been announced as part of companies' transition plans to decarbonise. Four of these new EAFs are currently under construction in Sweden (Oxelösund constructed by SSAB), Spain (Gijón constructed by ArcelorMittal)[49] and Austria (Linz and Donawitz constructed by Voestalpine). Four others were announced in 2024.[50]

- **Electrolytic hydrogen-based direct reduced iron with EAFs (DRI-EAF-H2)** is where electricity is sourced from renewable sources resulting in emissions reductions of up to 95%.[51] This route's mitigation potential will depend on the carbon-intensity of the electricity used to produce hydrogen and power the EAF.[52]

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  - For existing BF-BOF facilities, this pathway will mean closing down blast furnaces and converting ironmaking capacity to H2-DRI. In cases where onsite H2-DRI is not available, plant owners will need to source scrap and/or H2-DR iron. The steelmaking part can either be continued in the BOF, complemented by renewable-powered electric smelters, or be shifted to renewable-powered EAFs.

47 This is an average across the EU and depends on how clean the electricity in a given country is. The more reliant the grid is on renewables, the less CO_2 per tonne will be produced.

48 The potential to scale up steel recycling in EAFs will vary by site and country, conditional on the availability and quality of scrap and access to low cost, renewable electricity. Shifting from BF-BOF to EAF may also have implications for which steel grades can be produced and may result in job losses relative to more labour-intensive BF-BOF production.

49 https://spain.arcelormittal.com/comunicados/construccion-aceria-electrica-gijon/

50 Leadership Group for Industry Transition (LeadIT) (2024) Green Steel Tracker. https://www.industrytransition.org/green-steel-tracker/

51 Agora Industry and Wuppertal Institute (2023) 15 insights on the global steel transformation https://www.agora-industry.org/publications/15-insights-on-the-global-steel-transformation

52 https://bellona.org/news/eu/2021-05-hydrogen-in-steel-production-what-is-happening-in-europe-part-two

- The first large-scale mills are under construction and 20 projects have been announced. Scale up and deployment will hinge on the availability and cost of electricity, which is the key cost component in the production of renewable hydrogen. Within Europe, there are huge regional differences in the availability of renewable power and in the price of power. DRI plants will likely run on fossil gas until enough renewable hydrogen is available to supply them. Clear regulation and incentives will be needed to ensure plants shift to renewable hydrogen as soon as it is available, to avoid locking-in another fossil-fuel based steelmaking process.

> **Sourcing renewables-based hot briquetted iron (HBI) (Green Iron) in the locations that have favourable conditions to feed EAF-based steel making in another location.**
- This would entail securing offtake agreements and strategic trade partnerships with suppliers of green HBI. Countries like Sweden are already building their first-generation DRI facilities based on locally produced green hydrogen.

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In theory, there are two further options: molten iron ore electrolysis and steelmaking with carbon capture, utilisation and storage (CCUS). However, iron ore electrolysis is still at an early stage of deployment. As for CCUS, it is not yet clear that it will be able to deliver anywhere near zero-emission steel. Among steel companies currently pursuing low-carbon steel projects, none are considering commercial-scale projects using post-combustion CCUS with blast furnaces.[53]

Of the decarbonisation pathways outlined above, electrolytic hydrogen-based direct reduced iron with EAFs (DRI-EAF-H2) has attracted the most investment in the last decade. Between 2022 and 2024, nine DRI projects were proposed by established steel producers to decarbonise their primary steel operations across Europe – in Austria, Belgium, Finland, France, Germany, Spain and Sweden (see Annex 2). Steel start-ups like Stegra have also emerged as leaders in this sector, building the first generation of hydrogen-based DRIs.

53 Global Steel Transformation Tracker https://www.agora-industry.org/data-tools/global-steel-transformation-tracker

FIGURE 5. EUROPEAN NEAR-ZERO EMISSIONS CAPABLE DECARBONISATION PROJECTS

Iron making capacity (DRI) (Mt/year)

Steelmaking capacity (EAF) (Mt/year)

YEAR Announced start year

Current project status:

- Announced
- In construction
- Final investment decision secured

(1) **Greentec Steel - Linz**
voestalpine, Linz (Austria)
Steelmaking (EAF): 1.6 Mt/yr — **2027** — In construction

(2) **Greentec Steel - Donawitz**
voestalpine, Donawitz (Austria)
Steelmaking (EAF): 1.7 Mt/yr — **2027** — In construction

(3) **ArcelorMittal Belgium DRI**
ArcelorMittal, Ghent (Belgium)
Iron making (DRI): 2.5 Mt/yr — Steelmaking (EAF): 2.5 Mt/yr — **2030** — Announced

(4) **TZMS Třinecké železárny Třinec steel plant,**
Moravia Steel, Třinec (Czech Republic)
Steelmaking (EAF): 2.6 Mt/yr — **2031** — In construction

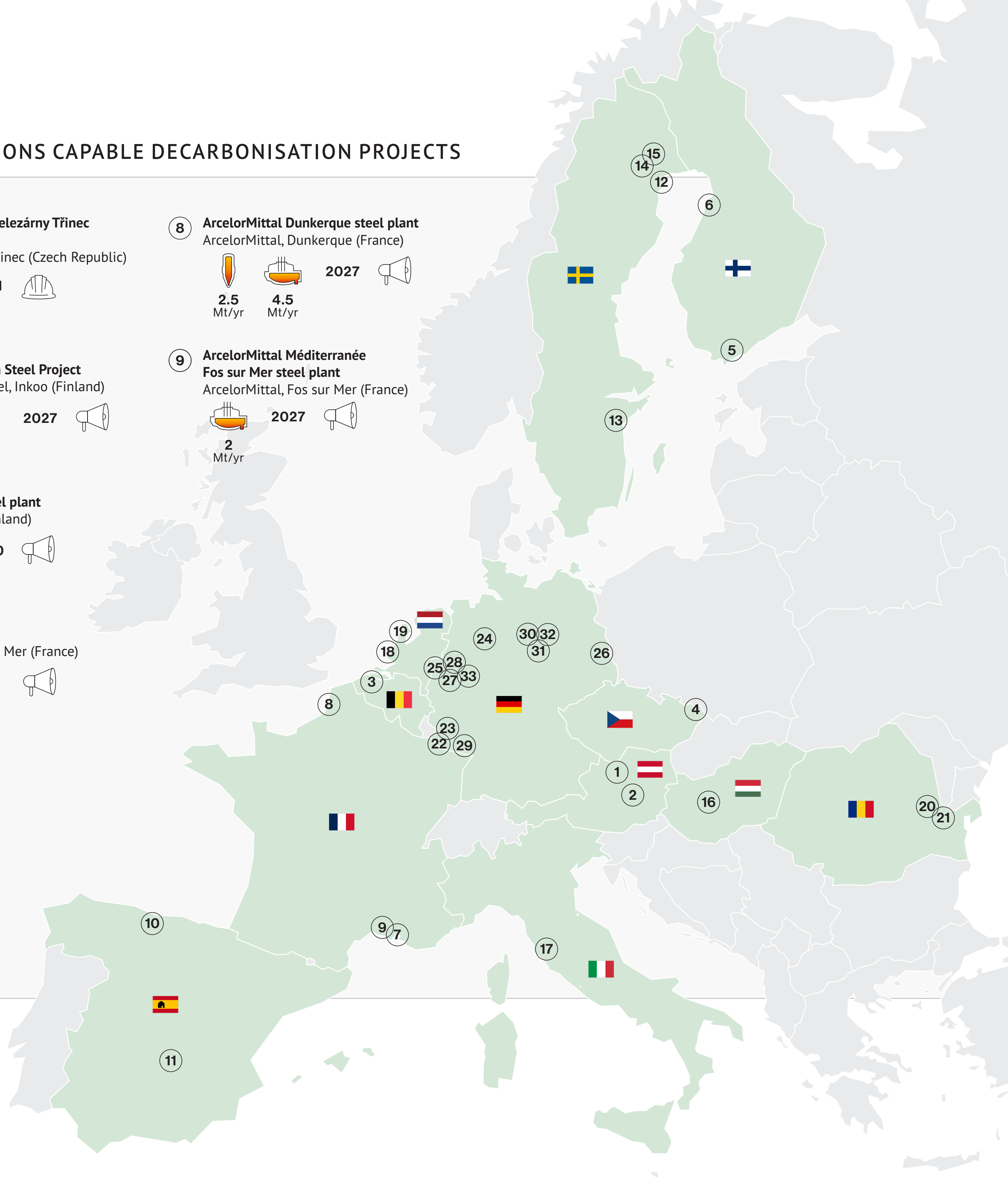
(5) **The Blastr Green Steel Project**
Blastr Green Steel, Inkoo (Finland)
Iron making (DRI): 2.5 Mt/yr — Steelmaking (EAF): 2.5 Mt/yr — **2027** — Announced

(6) **SSAB Raahe steel plant**
SSAB, Raahe (Finland)
Steelmaking (EAF): 2.6 Mt/yr — **2030** — Announced

(7) **GravitHy**
GravitHy, Fos sur Mer (France)
Iron making (DRI): 2 Mt/yr — **2028** — Announced

(8) **ArcelorMittal Dunkerque steel plant**
ArcelorMittal, Dunkerque (France)
Iron making (DRI): 2.5 Mt/yr — Steelmaking (EAF): 4.5 Mt/yr — **2027** — Announced

(9) **ArcelorMittal Méditerranée Fos sur Mer steel plant**
ArcelorMittal, Fos sur Mer (France)
Steelmaking (EAF): 2 Mt/yr — **2027** — Announced



(10) **Gijón DRI and EAF**
ArcelorMittal, Gijón (Spain)
2.3 Mt/yr · 1.1 Mt/yr · 2026

(11) **Hydnum Steel Castilla-La Mancha plant**
Hydnum Steel, Puertollano (Spain)
>0 Mt/yr · 2.6 Mt/yr · 2030

(12) **Luleå mini-mill**
SSAB, Luleå (Sweden)
2.5 Mt/yr · 2028

(13) **Oxelösund mini-mill**
SSAB, Oxelösund (Sweden)
1.5 Mt/yr · 2026

(14) **Stegra Boden Phase 1**
Stegra, Boden (Sweden)
2.1 Mt/yr · 2.5 Mt/yr · 2026

(15) **Stegra Boden Phase 2**
Stegra, Boden (Sweden)
2.1 Mt/yr · 2.5 Mt/yr · 2030

(16) **Liberty Steel Dunaferr Dunaújváros steel plant**
Liberty Steel (GFG Alliance), Dunaújváros (Hungary)
3 Mt/yr · 2030

(17) **Metinvest Piombino steel plant**
Metinvest, Piombino (Italy)
>0 Mt/yr · 3 Mt/yr · 2027

(18) **Green Steel Plan 2030**
Tata Steel, Ijmuiden (Netherlands)
3.15 Mt/yr · 3 Mt/yr · 2030

(19) **Green Steel Plan 2030 Phase 2**
Tata Steel, Velsen-Noord (Netherlands)
3 Mt/yr · 7.5 Mt/yr · 2035

(20) **GREENSTEEL Project**
Liberty Steel (GFG Alliance), Galati (Romania)
3 Mt/yr · 2030

(21) **GREENSTEEL Project**
Liberty Steel (GFG Alliance), Galati (Romania)
>0 Mt/yr · 1.1 Mt/yr · 2030

(22) **Power4Steel Project**
SHS, Dillingen/Saar (Germany)
2 Mt/yr · 1.9 Mt/yr · 2028 · €

(23) **Power4Steel Project Phase 2**
SHS, Dillingen/Saar (Germany)
1.4 Mt/yr · 2035

(24) **Bremen DRI (Steel4Future)**
ArcelorMittal, Bremen (Germany)
2 Mt/yr · 1.75 Mt/yr · 2026

(25) **ArcelorMittal Duisburg steel plant**
ArcelorMittal, Duisburg (Germany)
1.3 Mt/yr · 2030

(26) **Eisenhüttenstadt DRI (Steel4Future)**
ArcelorMittal, Eisenhüttenstadt (Germany)
0.15 Mt/yr · 1.75 Mt/yr · 2026

(27) **H2KM Project**
Hüttenwerke Krupp Mannesmann (HKM), Duisburg, Germany
>0 Mt/yr · 3 Mt/yr · 2025

(28) **H2KM Project**
Hüttenwerke Krupp Mannesmann (HKM), Duisburg, Germany
>0 Mt/yr · 3 Mt/yr · 2045

(29) **Saarstahl Völklingen Steelmaking Plant**
SHS, Völklingen, Germany
1.75 Mt/yr · 2027 · €

(30) **SALCOS µDRAL project**
Salzgitter, Salzgitter (Germany)
2.1 Mt/yr · 1.9 Mt/yr · 2026

(31) **SALCOS µDRAL project**
Salzgitter, Salzgitter (Germany)
>0 Mt/yr · >0 Mt/yr · 2030

(32) **SALCOS µDRAL project**
Salzgitter, Salzgitter (Germany)
>0 Mt/yr · 2033

(33) **tkH2Steel**
thyssenkrupp, Duisburg (Germany)
2.5 Mt/yr · smelter +BOF · >0 Mt/yr · 2026

Source: LeadIT (2024). Green Steel Tracker. Leadership Group for Industry Transition. https://www.industrytransition.org/green-steel-tracker/

However, recent announcements have highlighted that several key projects have stalled – with companies including thyssenkrupp and ArcelorMittal re-evaluating their decarbonisation plans. As of August 2024, 80% of the projected DRI capacity had not progressed beyond the announcement stage, 17% was under construction and only 3% was already in operation. For EAF flat capacity, 65% was in the announcement phase, 32% was under construction and 2% was operational.[54]

The planned pipeline of green steel pilots is just the tip of the iceberg when it comes to EU steel decarbonisation. As noted, currently planned DRI-EAF capacity only accounts for a third of the EU's current average annual iron-making capacity.[55] Moreover, on a site level, green steel pilot projects are often only intended to replace a portion of existing assets. The project at thyssenkrupp's Duisburg plant, for example, is only transitioning one blast furnace to a hydrogen-based DRI plant, leaving three without clearly defined transition plans. This scenario is common across the sector. Without detailed transition plans at company and plant level, companies risk falling short of meaningful decarbonisation.

Given the challenging growth and competitiveness outlook for Europe, and doubts about existing green steel projects, EU policymakers must step up efforts to support the new generation of green steel production.

The green steel pilot project at thyssenkrupp's Duisburg plant, is only transitioning one blast furnace to a hydrogen-based DRI plant.

thyssenkrupp, Duisburg Germany

54 Authors' own calculation based on https://globalenergymonitor.org/projects/global-steel-plant-tracker/
55 Based on author's analysis of European Steel Plant Database developed with SteelWatch and European Steel in Figures 2024: https://european-steel.eu/publications/brochures-booklets-and-factsheets/european-steel-in-figures-2024

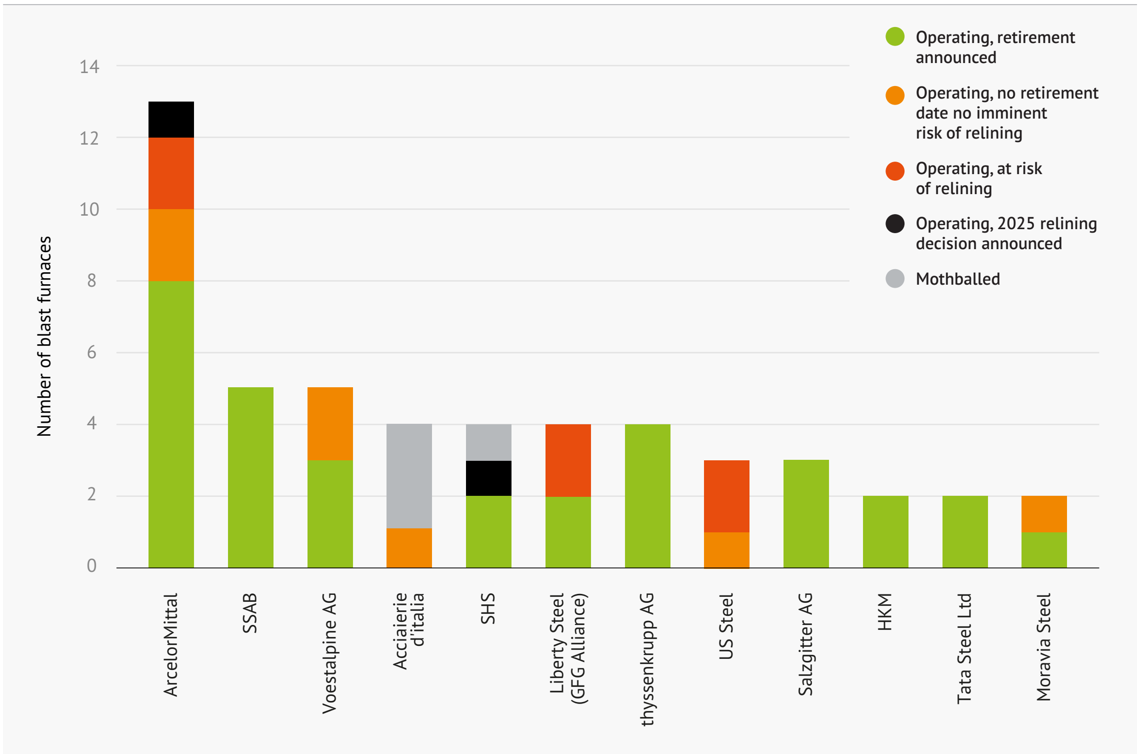
Who "owns" the EU steel transition?

A handful of companies dominate the EU primary steel-making sector (**see Figure 6**). Of these companies, three are major multinational firms: ArcelorMittal, Liberty Steel and Tata Steel. Their global supply chains mean they can put pressure on governments to offer favourable conditions and increased subsidies with fewer conditions, in the face of threats to move operations abroad. These are publicly listed companies focused on returning profits to shareholders over environmental or employment conditions (**see Box 2** on corporate governance structures and how these may influence the steel transition).

By contrast, national companies tend to have a greater interest in converting their steel production domestically, as they cannot easily move their operations to another country. Companies based just in one jurisdiction include: thyssenkrupp Steel, Salzgitter AG, and SHS, all based in Germany; and Voestalpine in Austria.

As noted in **box 1**, most steel assets in Central and Eastern Europe are not owned by companies headquartered in the region but by multinationals like Liberty Steel (London), ArcelorMittal (Luxemburg), and others headquartered in Western Europe. This results in a lack of local decision-making power: multinationals are taking decisions about the future of the region's plants based on European and international competitiveness rather than domestic industrial policy.[56]

FIGURE 6. BLAST FURNACES BY STEEL COMPANY OWNERSHIP



Source: Steel plant Database developed with SteelWatch for this publication.

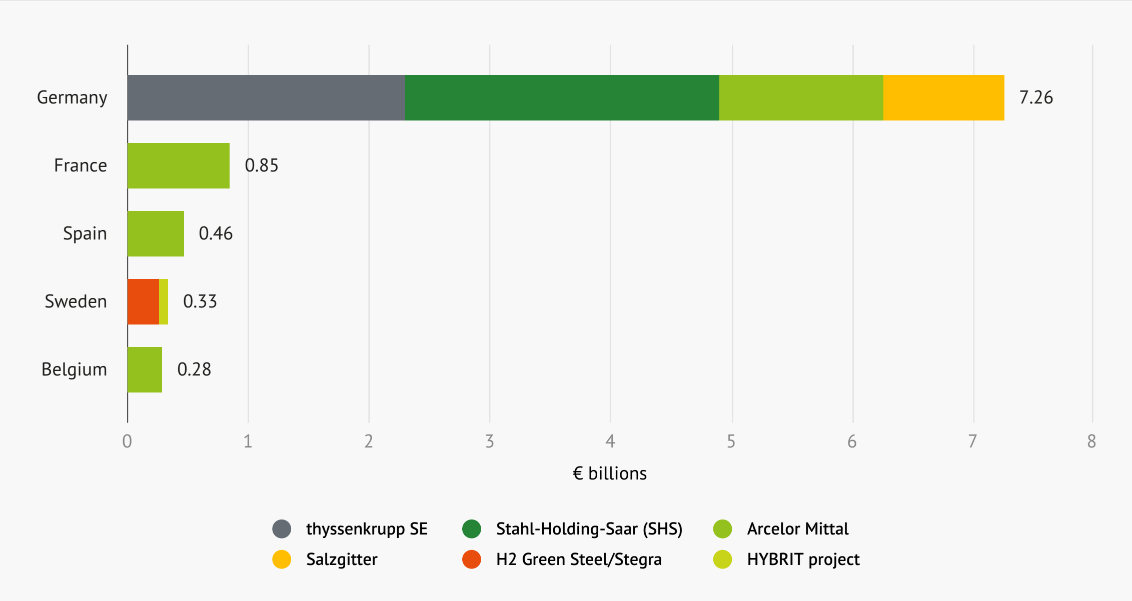
56 https://www.e3g.org/publications/industrial-transformation-for-all-europeans/

EU state aid support for steel transition

Many technological options for decarbonising steel will be more expensive than conventional production processes for some years to come.[57] As a result, they will need the support of robust industrial policy and government subsidies to get them off the ground. This section gives an overview of EU Member State efforts to financially support the steel transition via state aid, highlighting differences in the volume and nature of state support available as well as in the governance and conditions attached.

The level and nature of support by EU Member States vary, reflecting different levels of fiscal resources. In the last two years, several Member States, including Belgium, Germany, Finland, France, Spain and Sweden, have decided to use public money to facilitate the transition of their ironmaking capacity towards climate-neutral technology. Nearly €9.3 billion in state aid has been approved by the European Commission, mainly in the form of direct grants, for projects planning to use renewable or low-carbon hydrogen produced through electrolysis in DRI, as well as EAF and other ancillary facilities (e.g., electrolysers, melting units) (**Figure 7**).

FIGURE 7. AMOUNT OF STATE AID ALLOCATED TO SUPPORT THE STEEL TRANSITION BY COUNTRY (€ BILLIONS)



Note: See Annex 2 for full details of state aid allocation.

Germany is the clear leader, having allocated over €7 billion to decarbonise its steel industry. As the EU's largest steel producer, with access to larger financial resources than most other Member States, this is unsurprising. However, Germany faces significant challenges regarding the competitiveness of its green steel, primarily due to high projected hydrogen prices.[58] Germany is also unique in allocating money towards the operating costs of running the new DRI plants

57 Agora Industry, Wuppertal Institute and Lund University (2024) Low-carbon technologies for the global steel transformation. A guide to the most effective ways to cut emissions in steelmaking.https://www.agora-industry.org/publications/low-carbon-technologies-for-the-global-steel-transformation

58 https://www.pik-potsdam.de/en/news/latest-news/securing-competitiveness-of-energy-intensive-industries-through-relocation-the-pulling-power-of-renewables

on green hydrogen. Other Member States, like Belgium, France, Spain and Sweden, are hoping that supporting capital expenditure will be sufficient to support companies (most prominently ArcelorMittal) to build the first generation of DRI plants in their countries.

To underscore the game-changing potential of these projects to reduce carbon emissions, if the projects in France, Germany and Spain were completed they would lead to the closure of six blast furnaces and reduce emissions by an expected 321.9 million tonnes of CO_2.[59] The retired facilities would be replaced with five new direct reduction plants and eight new EAFs. State aid for these five projects alone amounts to €7.2 billion.[60]

If projects in France, Germany and Spain were completed they would lead to the closure of six blast furnaces and reduce emissions by an expected **321.9 $MtCO_2$.**

However, some of the companies benefiting from state aid have signalled that they are backtracking on their commitments. Around €3 billion was allocated to five projects by ArcelorMittal in France, Germany, Spain and Belgium. In November 2024, the company announced that they were delaying all their decarbonisation projects in Europe.[61] The statement sent shockwaves across the steel industry, raising immediate concerns over what this means for other EU pilot projects. thyssenkrupp's DRI project in Duisburg (which has received €2.3 bn in state aid) is also facing headwinds due to an internal corporate disagreement over the direction of the company (see Box 2). In both cases, significant public investment has not been sufficient to ensure the projects go ahead.

Moreover, to date most of the decisions approved by the European Commission have not yet been made public,[62] leaving taxpayers and workers unaware of the conditions attached to the disbursements. It is also worth noting that these state aid decisions have heavily favoured more energy intensive primary iron production routes, neglecting the potential of scrap-based routes based on EAFs and improving recycling methods.

Finally, the current state aid rules (CEEAG) do not fully address other issues such as pollution prevention benefits or meeting the EU's zero-pollution ambition. This is particularly problematic for the steelmaking sector, which produces harmful pollutants such as particulate matter, sulphur dioxide and nitrogen oxides.[63] These pollutants are mostly released during the coking process to refine metallurgical coal into coking coal, and during the burning of coal in a blast furnace to produce iron. Although the framework for state aid includes chapters on pollution and the circular economy, these are often applied in isolation, preventing a comprehensive assessment of projects and only partially addressing market failures related to pollution.

59 321.9 Mt for the projects in Gijón, Dunkerque, Duisburg, Saarland and Bremen+Eisenhüttenstadt. The number is the sum of cumulative emission reductions cited in the Commission's state aid press releases. The available information on project timeframes is 15 and 16 years for Dunkerque and Bremen/Eisenhüttenstadt, respectively, with no other timeframes known from these projects.
60 ARIA (2025). EU State Aid at a Crossroads: Green Steel Projects are Stalling Despite Public Subsidies Worth Billions
61 https://corporate.arcelormittal.com/media/press-releases/arcelormittal-provides-update-on-its-european-decarbonization-plans
62 To date, only 2 out of 10 state aids schemes have been made public (source: DG Competition)
63 Centre for Research on Energy and Clean Air (2022). Unveiling the truth behind blast furnace pollution in South Korea. https://energyandcleanair.org/publication/unveiling-the-truth-behind-blast-furnace-pollution/

BOX 2

Corporate Governance is crucial: German state-supported projects

Germany is investing more than any other country in decarbonising its primary steel industry. The government has committed €7.3 billion in direct state aid and pledged over €10 billion through climate protection carbon contracts for difference.

The aim is to build five DRI plants, invest in a hydrogen core network and cover operational costs during the initial years of the transformation. This ambitious scheme will support thyssenkrupp SE, Salzgitter AG, ArcelorMittal and Saar-Holding-Stahl (SHS) at different stages of their decarbonisation journeys.

The mixed results of Germany's projects highlight the need for strong corporate governance to ensure investments benefit both regions and taxpayers. SHS for instance, is currently spending €4.6 billion to build the 'largest decarbonisation project in Europe', alongside corporate partner Dillinger. The Power4Steel project has been allocated €2.6 billion in state aid by the German Government to build a DRI facility with two EAFs to run on green hydrogen as soon as it is available.[64] SHS is run by a foundation whose purpose is to promote local value creation and preserve jobs.[65] It has provided transition plans for both of its blast furnaces, and co-facilitates the GreenSteelSkills,[66] a government funded project to counteract the lack of local skilled workers.

Salzgitter AG's SALCOS green steel brand will be one of the first certified with the new Low Emission Steel Standard[67] and it was the workers' council that actively demanded and significantly advanced this green transition. The company, which is 26.5% owned by the State of Lower Saxony, delivered its first CO_2-reduced electrical steel to an automotive supplier in South Africa in 2024.

By contrast, thyssenkrupp SE faces significant hurdles due to investor pressures to sell the steel business after years of declining returns from its coal-based operations. The uncertainty caused a public fight between thyssenkrupp SE steel workers' unions and the management of its mother company, and reported boardroom clashes over the future of the company management seeded doubts about its commitment to replace one of its blast furnaces in Duisburg with a DRI plant.[68]

The strong governance structures at SHS and Salzgitter AG have contributed to their projects' resilience. They highlight the importance of strategic oversight in managing such large-scale transitions. Whilst financial investment is critical, governance structures are equally important to ensure the successful decarbonistion of the steel industry.

Source: Germanwatch [69]

64 https://en.saarstahl.com/news/press-releases/next-step-in-the-transformation-central-plants-ordered-for-power4steel-europe-s-largest-decarbonization-project/?id=17507
65 https://en.saarstahl.com/saarstahl/company/guidelines/
66 https://www.inno-vet.de/innovet/de/die-projekte/alle-projekte-von-a-bis-z/InnoVET_PLUS/GreenSteelSkills.html [in German]
67 The Low Emissions Steel Standard (LESS) is a framework designed to measure and report greenhouse gas emissions in the steel industry, aiming to reduce carbon emissions and promote sustainable practices. It came into effect in April 2024.
68 https://www.bloomberg.com/news/articles/2024-08-29/thyssenkrupp-steel-ceo-departs-amid-dispute-over-unit-s-future
69 https://background.tagesspiegel.de/energie-und-klima/briefing/so-klappt-es-trotzdem-mit-dem-umbau-der-deutschen-stahlindustrie [in German]

FIGURE 8. MILESTONES ALONG THE PATHWAY TO A CLIMATE-NEUTRAL EU STEEL SECTOR

2025

- No new relinings of existing BF-BOF infrastructure
- Blast furnace operators adopt comprehensive company and plant-level transition plans
- European policymakers establish green lead markets driving public demand for cleaner steel
- Private sector steel buyers sign ambitious offtake agreements with Europe's burgeoning green steel industry

2030

- Blast furnace production has been replaced by both increased DRI (at least 30% of EU iron production) and increased share of scrap in steelmaking
- Scrap is more efficiently recycled with increased collection rates and recycling rates of over 90%
- The first generation of DRIs are up and running with secure green hydrogen routes
- Corridors developed for green iron supplies to EAFs, across the EU and from beyond the EU

2040

- Recycling rates for scrap are over 95% due to regulations on copper contamination and more circular scrap deals between car manufacturers and secondary steel producers. Europe is still a leading exporter of scrap steel but is also able to supply its own domestic needs.
- No coal-based iron making in Europe. The first DRI facilities proved successful and are expanding.
- Imported iron is green iron and not pig iron
- EAFs only use a mix of scrap and green iron, and only renewable energy

Chapter 2.

How do we transition to green steel in Europe?

Having taken stock of the state of the EU steel transition and the current challenges facing the sector in chapter 1, this chapter highlights the key enabling conditions that will accelerate and smooth the EU steel transition over the next five years: 1) the build out of renewable energy and low-carbon infrastructure, 2) material efficiency, circularity and enhanced recycling, 3) just transition frameworks, 4) lead markets, and 5) the role of private finance in supporting early-stage commercialisation.

Key Messages

- **Green steel will significantly increase electricity needs**, requiring rapid investments in renewables, grids and storage to ensure affordable, stable power. Emission reduction can already be achieved by greening the current electricity supply used in steelmaking.
- **Green hydrogen is crucial for upgrading to green primary steelmaking**, but production is far below demand. The EU's hydrogen targets will not be met without urgent action, putting key projects at risk. Policymakers must scale up investment and ensure hydrogen is directed to industries like steel, where it delivers the deepest emissions cuts.
- **More efficient steel use and recycling** can cut emissions and reduce reliance on primary steel.
- **Early preparation is key for a just transition.** The coming changes will impact 300,000+ workers. Retraining and social protections must be prioritised.
- **The private sector has a major role to play.** Industry must drive demand for green steel via procurement commitments and offtake agreements.

Scaling renewable energy and low-carbon infrastructure

RENEWABLE ELECTRICITY NEEDS

The BF-BOF/primary steel making route currently accounts for around 55% of crude steel in the EU. This route emits roughly 2.0 tonnes of CO_2 per tonne of crude steel produced.[70] Although there are multiple factors influencing the carbon intensity of primary steel production, the electricity mix plays a role. Roughly 10% of the energy input used in BF-BOF steel production comes from electricity.[71]

±10% of the energy input used in BF-BOF steel production comes from electricity, while more than **50%** of the energy used in the EAF steel production process is electricity.

The EAF/secondary steel making route accounts for the remaining 45% of crude steel production in Europe.[72] It is much less carbon intensive, producing only about 0.4 tonnes of CO_2 per tonne of crude steel.[73] More than half of the energy used in the EAF steel production process is electricity,[74] although downstream processes like hot rolling can also be electrified, potentially increasing the share of electricity used. Reducing emissions in steelmaking can take multiple approaches, including decreasing emissions from existing EAF-based production by greening its power supply and increasing the share of steel produced from scrap rather than virgin iron. However, expanding the use of the scrap-EAF method requires sufficient scrap availability and adequate regulations, market incentives and labelling metrics to collect, sort, process and use as much high-quality scrap as possible.

The steel sector in Europe consumes 75TWh of electricity per year. Of that, 55TWh is purchased from the grid – roughly the electricity demand of Portugal and more than that of 15 other EU Member States.[75] The rest is generated by primary steelmaking (predominantly BF-BOF) from its industrial residual gases and used on-site.[76] However, as the sector transitions to near-zero emission steelmaking and phases out BF-BOF production, this self-generated power source will also disappear. Replacing it will require more grid-connected electricity, amplifying the need for large-scale renewable energy deployment to support the industry's decarbonisation.

70 Figures for EU-27. Hasanbeigi, A. (2022) Steel climate impact: an international benchmarking of energy and CO_2 intensities. Global Efficiency Intelligence. https://static1.squarespace.com/static/5877e86f9de4bb8bce72105c/t/624ebc5e1f5e2f3078c53a07/1649327229553/Steel+climate+impact-benchmarking+report+7April2022.pdf

71 This includes casting, rolling and finishing. Hasanbeigi, A., Springer, C., Sibal, A. (2024) Electrifying European industry - Part 1: Electrification of industrial processes. Global Efficiency Intelligence. https://static1.squarespace.com/static/5877e86f9de4bb8bce72105c/t/6719f901a1b4411b805a5211/1729755423661/EU+Industry+electrification-+Part+1-Process+electrification.pdf

72 Latest data from 2023 – Eurofer (2024). European steel in figures 2024. https://www.eurofer.eu/publications/brochures-booklets-and-factsheets/european-steel-in-figures-2024

73 Figures for EU-27. Hasanbeigi, A. (2022) Steel climate impact: an international benchmarking of energy and CO_2 intensities. Global Efficiency Intelligence. https://static1.squarespace.com/static/5877e86f9de4bb8bce72105c/t/624ebc5e1f5e2f3078c53a07/1649327229553/Steel+climate+impact-benchmarking+report+7April2022.pdf

74 Hasanbeigi, A., Springer, C., Sibal, A. (2024) Electrifying European industry - Part 1: Electrification of industrial processes. Global Efficiency Intelligence. https://static1.squarespace.com/static/5877e86f9de4bb8bce72105c/t/6719f901a1b4411b805a5211/1729755423661/EU+Industry+electrification-+Part+1-Process+electrification.pdf

75 Ember, EU Electricity Trends, 2023. https://ember-energy.org/latest-insights/european-electricity-review-2024/eu-electricity-trends/#electricity-demand

76 EUROFER (2024) Position Paper: The European steel industry recommendations on industrial demand side response. https://www.eurofer.eu/assets/publications/position-papers/the-european-steel-industry-recommendations-on-industrial-demand-side-response/202403-EUROFER-Position-Paper-Industrial-Demand-Side-Response_Final.pdf

To align with a 1.5ºC scenario, the European power sector needs to achieve net-zero emissions and be fossil-free and predominantly powered by wind and solar energy by 2035.

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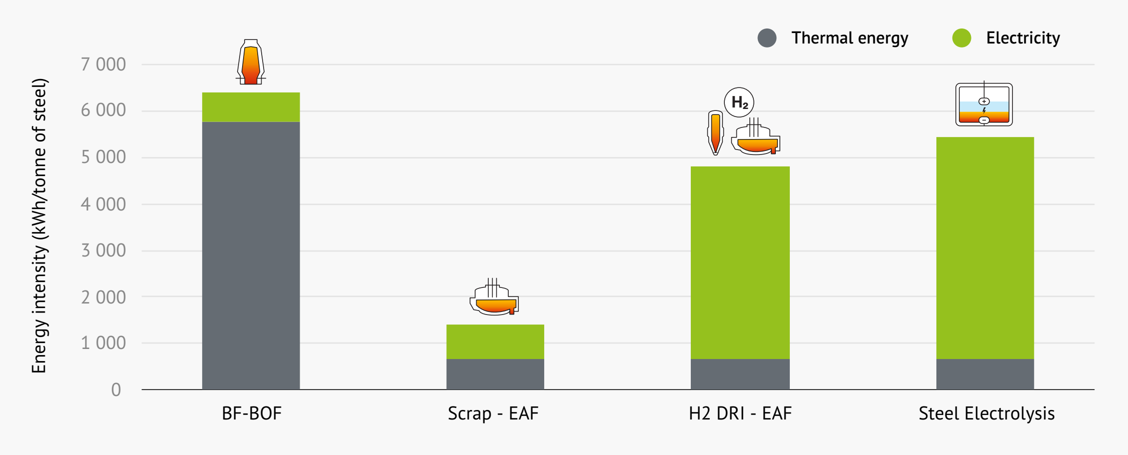
In 2023, an estimated 7.6 $MtCO_2$ could have been saved if the electricity supply of EAFs had come entirely from renewables (equating to around 5% of total emissions from the steel sector).[77] The carbon intensity of the grid depends on the electricity mix used in operations. Based on EAF crude steel production per country,[78] average electricity use per tonne of crude steel[79] and each country's grid carbon intensity,[80] over 75% of these emissions are estimated to have come from steelmaking in Italy (3 Mt), Germany (1.9 Mt) and Poland (1.0 Mt).

To align with a 1.5°C scenario, the European power sector needs to achieve net-zero emissions and be fossil-free and predominantly powered by wind and solar energy by 2035.[81] The steel sector will play a key role in supporting this transition. However, current efforts fall far short of what is needed. Recent data from Action Speaks Louder[82] highlights the global potential for improvement: **ArcelorMittal could increase its renewable energy use by 60 times, and SSAB has the capacity to quadruple its usage. While these figures reflect their global operations, the situation in Europe is similarly pressing.** Efforts must be accelerated to ensure that the electricity Europe's steel sector is consuming comes from renewable energy sources. This requires policymakers to scale up the deployment of renewable energy and steel producers to prioritise renewables-based electricity procurement.

When considering how to achieve low-carbon primary steel production, the hydrogen DRI-EAF and steel electrolysis routes stand out for implying the greatest increase in electricity demand. Specifically, hydrogen DRI-EAF would increase demand by 5 times compared to the BF-BOF method and 4.5 times compared to the scrap-EAF route, while steel electrolysis would increase demand by 6 times compared to BF-BOF and 5.5 times compared to scrap-EAF. In both cases, **if these processes were powered exclusively by renewable energy, total emissions from the steel sector could be zero.**

77 Methodology for this calculation can be found in section 1.3 of Annex 1. Emissions from the steel sector in 2023, equalled 145 Mt (Sandbag)
78 Worldsteel (2023) Crude Steel Production Figures per country 2023. https://worldsteel.org/data/world-steel-in-figures-2024/
79 These figures have been extracted from the overall figure for electricity used from the grid (55TWh). EUROFER (2024) Position Paper: The European steel industry recommendations on industrial demand side response. https://www.eurofer.eu/assets/publications/position-papers/the-european-steel-industry-recommendations-on-industrial-demand-side-response/202403-EUROFER-Position-Paper-Industrial-Demand-Side-Response_Final.pdf
80 Statista, Ember. Figures for 2023.
81 The IEA's 1.5°C compatible global energy scenario strongly recommends that advanced economies achieve this milestone by 2035: https://ember-energy.org/latest-insights/new-generation/
82 Action Speaks Louder (2024) Testing the mettle: ranking steel companies' current renewable energy use. https://speakslouder.org/report/testing-the-mettle/

FIGURE 9. ENERGY INTENSITIES OF DIFFERENT STEELMAKING PROCESSES



Source: Adapted from data in Hasanbeigi, A., Springer, C., Sibal, A. 2024. Electrifying European Industry - Part 1: Electrification of Industrial Processes. Global Efficiency Intelligence. Florida, United States.

While the exact technology mix and timeline for decarbonising Europe's steel sector in line with a 1.5°C scenario remain uncertain, the potential increase in electricity demand from steel transition will have a profound impact on the power sector.

According to Eurofer, the European steel sector consumes 75TWh of electricity per year. If the industry were to reduce emissions by about 80 million tonnes by 2030, its electricity demand would be more than double, reaching 165TWh by 2030 (roughly twice Belgium's final annual electricity consumption). Of this, 90TWh would just be for hydrogen production (2.12Mt hydrogen per year).[83] Estimates suggest that this would require installing 138GW of onshore wind, 257GW of solar and 123GW of offshore wind by 2030.[84] By 2050, the sector's electricity demand is projected to increase fivefold to 400TWh of electricity (close to the annual electricity consumption of France), of which 230TWh would be used for hydrogen production.[85]

If backed by a strong increase in renewable energy, electrifying the steel industry will reduce CO_2 emissions. However, if electricity and hydrogen production are mainly powered by fossil fuels, it could have the opposite effect, leading to a rise in emissions.

Considering that the steel sector needs to speed up decarbonisation efforts to align with a 1.5°C scenario, increasing the electrification of processes and ensuring a higher uptake of renewable electricity will need to happen even faster. Achieving this level of electrification whilst reducing emissions in line with 1.5°C, implies careful planning in the context of the energy transition, investing in grid infrastructure and solutions like energy storage, dispatchable generators, and demand-side management. Also, investments in new renewable power generation capacity will be required. Steelmakers need to play their part by bringing additional renewable power online. Finally, securing long-term renewable power through power purchase agreements (PPAs), as European steel manufacturers are increasingly doing, can also help to provide the renewable energy supply needed for electrification.

83 Eurofer, Implementation of RFNBOs targets in industry pursuant Art.22a RED 2023/2413, 2024. https://www.eurofer.eu/assets/publications/position-papers/implementation-of-rfnbos-targets-in-industry/2024-EUROFER-Recommendations-for-the-implementation-of-Art.22a-REDIII-RFNBOs-sub-targets-industry.pdf
84 EUROFER (2024) Position Paper: The European steel industry recommendations on industrial demand side response. https://www.eurofer.eu/assets/publications/position-papers/the-european-steel-industry-recommendations-on-industrial-demand-side-response/202403-EUROFER-Position-Paper-Industrial-Demand-Side-Response_Final.pdf
85 EUROFER (2024) Op.cit.

There are positive examples of corporate action, such as Iberdrola's partnership with Acciaierie Venete in Italy for solar power, Vattenfall's PPA with Salzgitter for offshore wind energy, and Sidenor in Spain which has recently invested €40m in eight solar parks (43MWh) to directly fuel their operations. Moreover, it is encouraging that some companies are basing their green steel mill concepts on 100% renewable power.[86] However, leading steelmakers still average less than 10% of renewable energy in their total energy mix, with SSAB being the most advanced at 19%.

Three key conclusions:

Importance of electrification in decarbonising steel production: Shifting to renewable-powered electrification is crucial in both iron-ore based and scrap-based steelmaking. Incorporating electricity from renewable sources can mitigate emissions associated with electricity use, which comprises around 10% of BF-BOF energy input and more than half of EAF energy input (including casting, rolling and finishing). Reducing emissions in steelmaking can include greening EAF power supply and increasing scrap-based production over virgin iron. Increasing the share of EAF-based production is essential for optimising energy efficiency and reducing reliance on hydrogen for decarbonisation. By greening their power supply, EAFs already have the potential to reduce emissions to nearly zero, making them a promising pathway for reducing emissions in the steel sector in the short term.

The impact of renewables on emissions reduction: The CO_2 emissions from grid electricity use vary by country due to differences in grid carbon intensity. For example, in countries with a coal-heavy grid like Poland, the emissions from EAF crude steel production are higher compared to those with a cleaner grid mix, such as Spain. For example, in 2023, Poland produced 5 Mt less of crude steel from EAFs than Spain, whilst emitting 1.5 times more CO_2 through grid electricity use. Increasing the share of renewable electricity in grids across Europe could significantly reduce CO_2 emissions from this steelmaking route, especially benefitting those countries with high EAF production and high grid carbon intensity, like Italy.

The shift to near-zero primary steel production methods (like hydrogen DRI-EAF and steel electrolysis) will also reduce emissions from steelmaking whilst increasing electricity demand. However, the electricity requirements for these processes are 5 to 6 times higher than for BF-BOF and 4.5 to 5.5 times higher than for EAFs. Therefore, it is necessary to **ensure that electricity and hydrogen production are powered by renewable energy. Otherwise, there is a risk of increasing CO_2 emissions.**

It is necessary to ensure that electricity and hydrogen production are powered by renewable energy. Otherwise, there is a risk of increasing CO_2 emissions.

Investment in renewable energy and infrastructure: To meet these growing demands and avoid grid congestion, bottlenecks and competition between industries and households for renewable energy, substantial investments in additional renewable energy capacity, grid infrastructure, energy storage, and demand-side management are needed.[87] Steel companies are large energy users with significant political influence, and heavily reliant on renewable energy

86 https://www.weforum.org/stories/2024/06/5-steel-producers-have-overcome-challenges-to-decarbonize-steel-production/

87 CAN-Europe (2024) 100% RES based electrification: the electrification action plan civil society wants to see. https://caneurope.org/content/uploads/2024/12/100-RES-based-electrification-The-Electrification-Action-Plan-Civil-Society-Wants-to-See.pdf

to meet their net-zero targets. Immediate steps by steel companies to supply and/or purchase renewable energy have the potential to unlock significant momentum in wind and solar markets, ensuring the steel industry plays its part in tripling the global renewables capacity as required by 2030.

GREEN HYDROGEN AVAILABILITY

Green hydrogen is pivotal for decarbonising the steel industry. However, its production faces significant challenges, including high costs and limited availability. The EU has set ambitious targets to both produce and import 10 million tonnes of renewable hydrogen by 2030.[88] This would require 140 GW of electrolyser capacity.[89] Yet, as of late 2024, Europe was producing only an estimated 0.023 million tonnes of renewable hydrogen annually, highlighting a substantial gap between aspiration and reality.[90]

The H2-DRI projects announced by the European steel sector will require a projected 2.12Mt of hydrogen.[91] Several European initiatives are expected to kickstart the production of renewable hydrogen at scale. These include the Projects of Common Interest (PCIs), Important Projects of Common European Interest (IPCEIs) and the Hydrogen Bank, some of which are also targeting the production of green steel. However, the Joint Research Centre has said that RePowerEU's expectation for 30% of EU primary steel production to be decarbonised with renewable hydrogen by 2030 is unlikely to be met, if the development of the sector is not significantly accelerated.

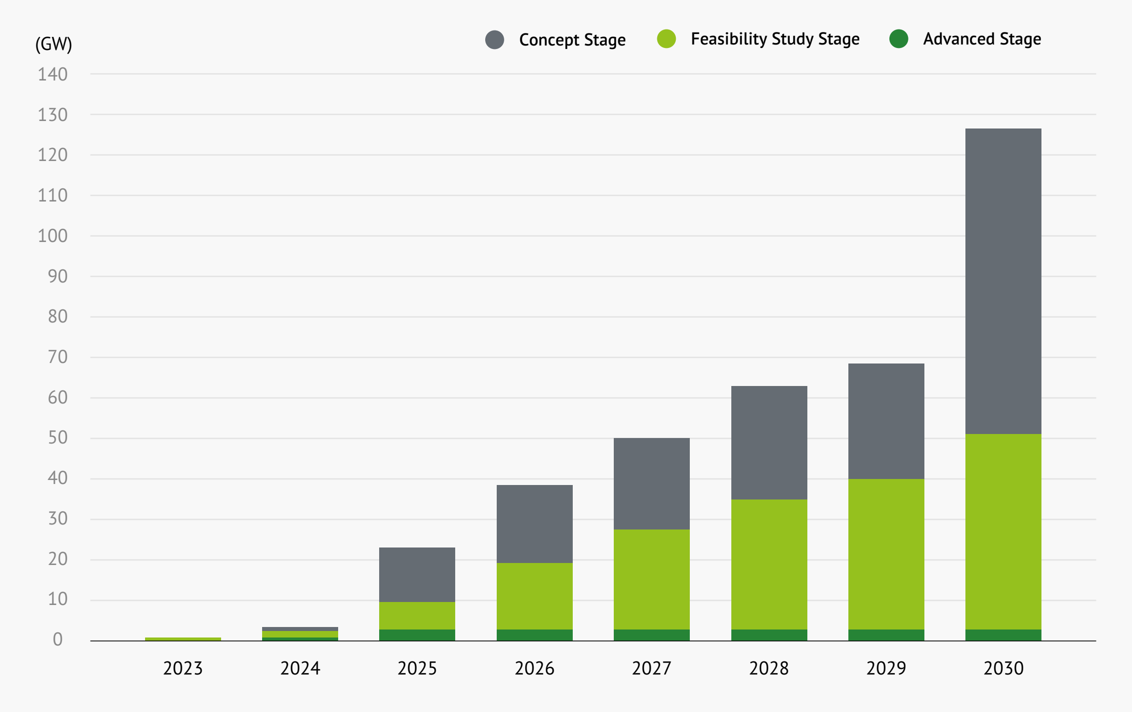
The EU has set ambitious targets to both produce and import **10 million** tonnes of renewable hydrogen by 2030.

©FOTOGRIN/Shutterstock

88 https://energy.ec.europa.eu/topics/eus-energy-system/hydrogen_en#:~:text=The%20EU%27s%20hydrogen%20strategy%20and%20REPowerEU%20plan%20have,and%20low-carbon%20hydrogen%20to%20help%20decarbonise%20the%20EU.
89 European Electrolyser Summit, 2022 Declaration (co-signed by the Commission).
90 Joint Research Centre (2025) Delivering the EU Green Deal: Progress towards targets https://op.europa.eu/en/publication-detail/-/publication/33a4bbe1-e2b0-11ef-be2a-01aa75ed71a1/language-en
91 EUROFER (2024) Op.cit.

Similarly, a special report on the EU's industrial policy support for renewable hydrogen by the European Court of Auditors from November 2024, found that the EU's production target is already unlikely to be met due to lacking electrolyser capacity.[92] Electrolytic hydrogen projects under construction only amount to 0.3 Mt of hydrogen. Even in an accelerated scenario that accounts for intensified efforts, clean hydrogen provision will be limited to 4.4 Mt by 2030.[93]

FIGURE 10. ELECTROLYSER CAPACITY OF PROJECTS ANNOUNCED (CUMULATIVE, IN GW) BY STAGE AND PROJECTED YEAR OF ENTRY INTO OPERATION (AS OF OCTOBER 2023)



Note: Advanced stage includes projects that are operational, or where the stage is "under construction", or for which a final investment decision has been taken.

Source: ECA, based on data from the International Energy Agency.

Given these constraints, it is important to allocate green hydrogen to sectors where it can have the biggest impact on emissions. Directing this valuable resource towards industries like steel, which are challenging to decarbonise through other means, will be vital for achieving substantial emissions reductions.

While green hydrogen holds promise for transforming the steel industry, current production capacities and infrastructural developments are insufficient to meet projected demands. Strategic planning and accelerated investment are essential to bridge this gap.

92 European Court of Auditors (2024) Special report 11/2024: The EU's industrial policy on renewable hydrogen. https://www.eca.europa.eu/en/publications?ref=SR-2024-11

93 Hydrogen Europe (2024. Clean hydrogen monitor 2024. hydrogeneurope.eu/wp-content/uploads/2024/11/Clean_Hydrogen_Monitor_11-2024_V2_DIGITAL_draft3-1.pdf

GREEN IRON TRADE

Green iron trade/HBI within the EU could play a pivotal role in steel decarbonisation, especially given the limited and costly supply of green hydrogen. EU Member States with abundant renewable energy resources, such as those in the Iberian Peninsula, Finland and Sweden, are well-suited to produce iron through the DRI process using green hydrogen. This green iron can then be traded across the EU, enabling countries with less access to renewable energy to benefit from low-carbon steel production. Trade can also be fostered beyond the EU with countries with abundant renewable resources and access to iron ore.[94] By harnessing these opportunities for green iron production in different locations, the EU can lower the costs of the transition domestically. This collaborative approach will help ensure that green hydrogen is utilised where it can have the most significant impact, supporting the EU's broader climate goals.

Bilateral strategic partnerships can play a crucial role in establishing green iron trade routes by fostering international cooperation and aligning regulatory frameworks. This includes setting common standards for carbon emissions, certification processes and environmental impact assessments.[95] The Green H2 Catapult initiative, supported by RMI, has emphasised the role of joint financial incentives and international climate finance in supporting green iron projects. And trade agreements can facilitate free trade and market stability.[96] Finally, capacity-building initiatives, such as training programmes and knowledge exchanges, can be used to develop the necessary skills and expertise for green iron production in third countries.[97]

Circularity and material efficiency

Decarbonising steel and iron making by only using breakthrough technologies will create challenges: the breakthrough technologies need to be available and cost effective, and they will require higher demand for electricity, infrastructure and resources. A complementary pathway to transform iron and steel making in Europe would be to adopt circular solutions and place greater emphasis on demand-side measures. This would entail focusing on three main levers: increasing the share of EAFs processing scrap steel, improving material efficiency and enhanced recycling.

INCREASE THE SHARE OF EAFS TO PROCESS SCRAP STEEL

To achieve this, Europe will need to use more scrap in steelmaking and use steel more efficiently in products (material efficiency). Agora Industry's 2023 assessment of global steel decarbonisation found that a significant shift towards more scrap-based steel production was necessary to achieve a net zero steel sector by the 2040s.[98] EAFs offer the advantage of melting various metallic feedstocks, including steel scrap, pig iron from BFs, and sponge iron from DRI furnaces. Additionally, increased use of scrap in EAFs could secure steelmakers' investment in H2-DRI-EAF thanks to greater flexibility in the supply chain, as part of the DRI can be replaced by scrap.

94 These include Canada, South Africa, and Mauritania, while currently iron miners in Australia are already making commitments to produce green iron. Agora Industry and Wuppertal Institute (2023) 15 insights on the global steel transformation https://www.agora-industry.org/publications/15-insights-on-the-global-steel-transformation

95 Agora Industry and Wuppertal Institute (2023) Op.cit.

96 RMI (2024) Green Iron Corridors: Transforming the Steel Supply Chains for a Sustainable Future - Green Hydrogen Catapult. https://greenh2catapult.com/green-iron-corridors-transforming-the-steel-supply-chains-for-a-sustainable-future/

97 RMI (2024) Op.cit.

98 Agora Industry and Wuppertal Institute (2023) Op.cit.

MATERIAL EFFICIENCY

Strategies to reduce energy and resource use, and promote reusing and recycling products and materials, would both serve the EU climate target and enhance the resilience and competitiveness of the industry. They would also be in keeping with the EU waste hierarchy, which is intended to reduce waste and encourage reuse of products.[99] Enhanced circularity measures such as improved recycling, material efficiency and circular business models have the potential to reduce emissions by 22–26% by 2050, with significant potential to reduce primary steel demand in sectors like mobility by up to 70%.[100]

The default scenario of the EU's 2040 impact assessment is that steel production/consumption will remain constant until 2040. But its LIFE scenario foresees a 15% reduction, with positive impacts on resource, investment and energy needs (**see Box 3**).

BOX 3

European Commission 2040 impact assessment LIFE scenario

As part of its 2040 climate target communication, the European Commission included a LIFE scenario, which assumes a more efficient use of natural resources – a shift in consumption patterns that allows for a more shared and circular economy. It would include extending a product's lifetime, material efficiency and substitution, or circularity by design. This would limit reliance on technologies such as carbon capture and storage across the board and lower the need for primary production in industry (and the ensuing energy, resource and infrastructure needs).

It would also yield several co-benefits such as less air pollution and a reduced dependency on raw materials. The LIFE scenario aligns with long-term forecasts for dwindling steel demand, which is projected to fall by 15% by 2050.[101] It also reflects the need for Europe to be aware of its strategic dependencies and resilience in a challenging geopolitical context: the iron-ore production route makes Europe more vulnerable based on its increasing reliance on imports for coking coal and iron ore/concentrates (75% imported, as of 2022).

99 Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (Text with EEA relevance) https://eur-lex.europa.eu/eli/dir/2008/98/oj/eng

100 CAN Europe (2022) CAN Europe's transformation pathway recommendations for the steel industry https://caneurope.org/content/uploads/2022/06/CAN-Europe_2022_Recommendations_Steel_Transforming-the-sector.pdf

101 Commission Staff Working Document Impact Assessment Report Part 2 Accompanying the Communication on Securing our future Europe's 2040 climate target and path to climate neutrality by 2050 building a sustainable, just and prosperous society, SWD(2024) 63 final, 6 February 2024 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52024SC0063&qid=1741558140224

ENHANCED RECYCLING

Although a high percentage of steel is recycled (over 90% of stainless steel and over 80% of waste steel), there are still major issues with the quality of these recycling methods. Often different grades of steel are recycled together, diluting the quality of the grade; similarly, steel can be melted down with other parts of, for instance, a car that will contaminate the end product with alloys and elements like copper that cannot be removed. This means that recycled steel is often not suitable for car manufacturers, for instance, who need higher grades of steel for the body of a car. Improving how materials are used and recycled would involve two key strategies: lightweighting and post-use recycling.

Steel is a main contributor to the emissions caused by cars manufacturing. Sourcing near-zero emissions steel could reduce vehicle manufacturing emissions by up to 27%, ultimately making Europe a leader in resource efficiency and reducing dependency on imports.[102]

Increasing the share of recycled steel would require the use of high-quality scraps, meaning better end-of-life management to facilitate closed-loop recycling. Presently, the majority of steel scrap, most of it from end-of-life vehicles, is contaminated with copper and subsequently downcycled outside the EU. Enhancing steel scrap recycling within Europe by increased copper removal from end-of-life vehicles would boost the resilience of the European supply

> Enhancing steel scrap recycling within Europe by increased copper removal from end-of-life vehicles would boost the resilience of the European supply chain.

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102 Bui, A. Isenstadt, A., Zhou, Y., Bieker, G. and Negri, M. (2024) Technologies to reduce greenhouse gas emissions from automotive steel in the United States and the European Union. https://theicct.org/publication/technologies-to-reduce-ghg-emissions-automotive-steel-us-eu-jul24/

chain in two ways: it would stimulate the end-of-life sector and elevate the value of steel scrap, and simultaneously it would generate copper, a critical raw material for environmental transition that is currently in short supply.

Recent research by IMT-IDDRI indicates that significant reduction of copper content in end-of-life vehicles can be achieved with minimal investments, allowing for significant scrap input in EAFs while remaining economically viable.[103] The proposal for a Regulation on Circularity Requirements for Vehicle Design and on Management of End-of-Life Vehicles (under discussion as of end-February 2025) could establish the conditions for improved dismantling and/or sorting of steel scrap and create demand for high quality recycling steel from end-of-life vehicles through future recycled content requirements.

Increasing the share of recycled steel would also greatly support the sector's resilience, competitiveness and paths towards climate neutrality, especially given that the secondary route is 79% less CO_2-intensive than primary production, and that €19 billion is lost in materials each year due to losses in collection, process yield, alloys and quality.[104] The EU with its high and saturated steel stock (around 12 tonnes per capita of steel in use) is particularly well placed to access scrap and maximise its usage to meet demand.[105] In terms of global responsibility, there is also much to achieve in using less steel to deliver the same level of wellbeing to citizens through products: a fair share of steel use per capita compared to a 1.5°C compatible scenario would point to 6 tonnes per capita (currently 10–14 tonnes in industrialised countries, 2 tonnes in emerging economies).[106]

THE UPCOMING POLICY WINDOW FOR IMPROVING CIRCULARITY

Improving the circularity of steel requires an effective legal framework addressing the entire lifecycle of products that use steel, from product design to end-of-life management. Measures that increase the availability of steel scrap in Europe, such as increasing the number of end-of-life vehicles or ships being processed in the EU, need to be combined with both supply- and demand-side measures, particularly for lead markets such as the automotive industry.

Tailoring recycled-content targets for relevant product groups (e.g. vehicles and ships) to replace flat-steel (mainly produced through the carbon intensive BF-BOF route) can create the necessary demand to scale-up steel recycling. Tailored targets can thus create and strengthen functioning markets for high-quality recycling steel and overcome the obstacle of the 'green premium'.[107]

Several windows of opportunity to tap into the potential circularity of steel already exist in the EU policy space, while others will arise in the next 5 years. A good example is the current implementation of the Ecodesign for Sustainable Products Regulation (ESPR) for iron and steel products, the revision of the End-of-Life vehicles Directive, and the announced Circular Economy Act for the end of 2026, which will include the revision of the WEEE Directive and the Ship-Recycling Regulation.

103 https://institut-mobilites-en-transition.org/en/programmes/steel-the-circular-economy-the-challenges-of-carbon-free-automotive-steel-production/
104 Material Economics (2020). Preserving value in EU industrial materials: a value perspective on the use of steel, plastics, and aluminium. https://materialeconomics.com/node/15
105 Material Economics (2018) The Circular Economy a Powerful Force for Climate Mitigation. https://www.energy-transitions.org/publications/the-circular-economy/#download-form
106 Watari et al. (2020) Global metal use targets in line with climate goals, Environmental Science & Technology, 54 (19). DOI:10.1021/acs.est.0c02471
107 Sandbag (2024) From niche to mainstream: shaping demand for green steel https://sandbag.be/wp-content/uploads/Report-on-Demand-side-2.pdf

A just steel transition

If the steel industry is going to stay within planetary boundaries and reduce emissions to near zero by 2050, many of the blast furnaces we have online today will have to retire sooner than their technical lifetime would allow. The analysis that underpins this briefing has identified 24 blast furnaces (nearly half of the existing fleet) that have retirement dates before 2035. As Europe cannot achieve its climate goals without decarbonising the steel industry, the other half of the fleet will also have to retire well before 2050. This presents a risk for workers in the steel sector, but also an opportunity for a just transition that prioritises pollution prevention and health protection.

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The EU steel industry employs over 300,000 people directly[108] and another 2.3 million indirectly.[109] That is around 1% of all people employed in the EU.[110] With 500 production sites across 22 of the 27 Member States, the EU steel industry generates on average €191 billion in revenue (or about 1.2% of the bloc's GDP[111]) every year.[112] Although it is currently unclear how jobs will be impacted in the process of replacing BF-BOFs with H2-DRI-EAF plants, we can be sure that it will cause major disruption for steel workers if just transition principles are not front and centre.

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108 https://www.eurofer.eu/statistics
109 https://www.eurofer.eu/statistics
110 Employment in Europe – Statistics and facts. https://www.statista.com/topics/4095/employment-in-europe/?__sso_cookie_checker=failed
111 Quarterly national accounts - GDP and employment - Statistics Explained. https://ec.europa.eu/eurostat/statistics-explained/index.php?oldid=662874
112 https://www.eurofer.eu/statistics

The steel transition will create opportunities, for example in the production of new electrolysers and building pipelines to transport green hydrogen to DRI plants. Although temporary, the construction of these large infrastructure projects could become keystone job creators if regional skills initiatives like the GreenSteelSkills program in Germany's Saarland are replicated across the continent.[113] The best-case scenario in the French sectoral transition plan showed an increase in jobs in the steel sector by 2050.[114] However, even in such best-case scenarios the nature of jobs will evolve and retraining will be needed.

As has been seen with the early closures in Port Talbot (Tata Steel) and, soon, Scunthorpe (British Steel), without proper plant-level transition plans in place steel plants face closures with devastating consequences on workers and local communities. Steel workers are aware of this and are advocating for new steel-making facilities to secure future jobs. In Germany, the Industrial Union, IG Metall (IGM), has been advocating for a green steel future in Germany since 2020.[115] In 2024, IGM went head-to-head with the board of thyssenkrupp AG to ensure that investments in green steel are maintained and that jobs in Germany are secured for the future.[116]

> Without proper plant-level transition plans in place steel plants face closures with devastating consequences on workers and local communities.

Early planning is key to a just transition, and it is important that policy decisions reflect this. Public support, including state aid, must come with more stringent social and environmental conditions.[117] New near-zero emissions steel projects should be developed with input from local communities, local economic development agencies, local employment agencies and workers. Involving unions and civil society organizations in the planning and execution will ensure job creation, support for skills development and retraining, better public health outcomes for local communities, and improved environmental outcomes.[118]

Indeed, to ensure fairness and effectiveness, all state aid should come with strong social conditions.[119] These conditions would prevent subsidy-shopping by companies, which risks undermining the single market and increasing the economic divergence between Member States. By harmonising social and environmental conditions across the EU, public support can promote green businesses, create quality jobs, and deliver sustainable infrastructure, benefiting both people and the environment. This approach would also ensure that public funds are used efficiently and equitably, fostering a more inclusive and resilient economy.

113 GreenSteelSkills – Kompetenzen für grünen Stahl - BMBF InnoVET (n.d.) https://www.inno-vet.de/innovet/de/die-projekte/alle-projekte-von-a-bis-z/InnoVET_PLUS/GreenSteelSkills.html [In German]
114 Sectoral transition plan for the steel industry in France. https://librairie.ademe.fr/ged/9045/Sectoral_Transition_Plan_for_steel_industry_in_France.pdf
115 https://www.igmetall.de/service/publikationen-und-studien/metallzeitung/metallzeitung-ausgabe-juliaugust-2020/stahl-hat-eine-gruene-zukunft
116 https://www.manager-magazin.de/unternehmen/industrie/stellenabbau-bei-thyssenkrupp-steel-ig-metall-verweigert-verhandlungen-a-5f38f71e-184e-48c3-9fd9-b5b73887f107 [In German]
117 https://caneurope.org/letter-to-the-eu-heads-of-states-clean-industrial-deal/, and https://caneurope.org/content/uploads/2024/11/Joint-statement-social-envi-conditions-CID-Nov2024.pdf
118 https://caneurope.org/just-transformation-vision-principles/
119 https://caneurope.org/content/uploads/2024/11/Joint-statement-social-envi-conditions-CID-Nov2024.pdf

Role of the private sector in building lead markets for green steel

The private sector plays a crucial role in generating lead markets for green steel, particularly through offtake agreements. These essential building blocks provide the investment security and coordinated supply and demand-side action needed for the steel industry's green transition. The policy environment will need to enable the uptake of offtake agreements, with policymakers understanding that there are some gaps that the private sector and first movers simply cannot fill. Public procurement measures are needed – and governments will have to take on risk. They will need to support lead market creation and send out positive market signals. And they will need to complement and synergise with voluntary demand corporate commitment platforms, like SteelZero[120] and the First Movers Coalition,[121] which many European businesses/companies are members of. With a more supportive policy environment, corporates can then reduce their own emissions by procuring green steel in their operations.

Steel-consuming sectors, including construction, automotive and energy infrastructure, are critically important for scaling demand for near-zero emissions steel. The automotive industry, as the second-largest consumer of steel, is uniquely positioned to drive this transformation. Automakers can significantly influence the market by committing to purchase green steel, thereby ensuring a steady demand. According to a recent publication by the International Council on Clean Transportation (ICCT), only 2% of the global steel used by major automakers is currently covered by green steel offtake agreements.[122]

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By increasing their procurement of green steel, automakers can help reduce the steel sector's greenhouse gas emissions.[123] Such commitments not only support the development of fossil-free steel production technologies but also build the confidence necessary for the steel industry to invest in these green technologies. This collaborative effort between the private sector and steel producers will be vital for achieving the broader goals of sustainability and climate neutrality. Transport & Environment's 2024 study on the cost to consumers of green steel in cars showed that switching to 40% green steel would add just €57 to the price of an electric vehicle by 2030, and using 100% green steel by 2040 will cost only €8 more per vehicle compared to conventional steel.[124]

120 https://www.theclimategroup.org/steelzero
121 https://www.weforum.org/stories/2023/12/first-movers-coalition-john-kerry-net-zero-decarbonization-green-tech/
122 https://theicct.org/publication/green-steel-automakers-us-europe-sep-24/
123 https://theicct.org/publication/green-steel-automakers-us-europe-sep-24/
124 https://www.transportenvironment.org/articles/green-steel-can-cut-climate-impact-of-car-production-for-just-eur57-a-vehicle

BOX 4

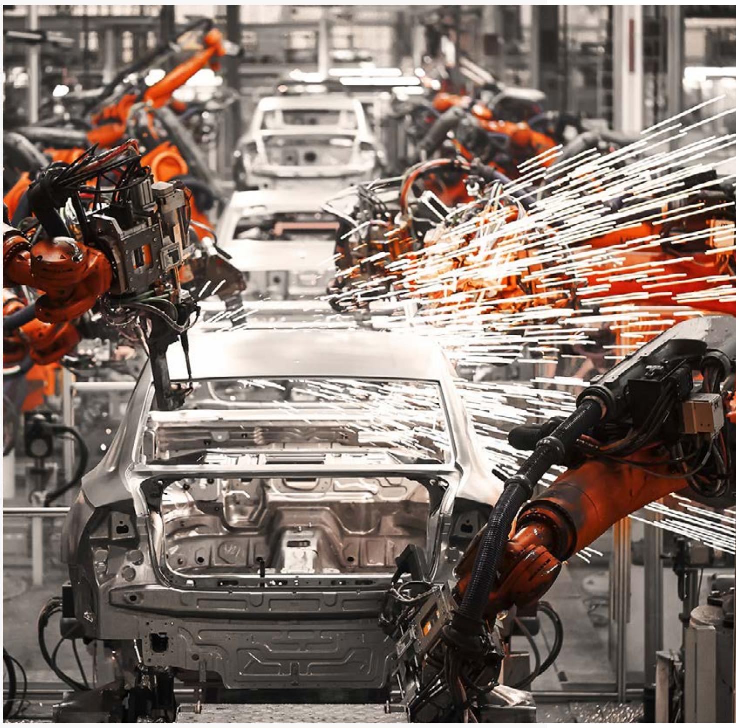
European automakers' progress towards steel decarbonisation

In February, Lead the Charge published the third edition of its annual leaderboard,125 which scores the efforts of 18 world-leading automakers in eliminating human rights violations, environmental abuses and fossil-fuels from their supply chains, including steel. This year's analysis found a disappointing lack of progress from European automakers on steel decarbonisation and circularity.

Volvo and Mercedes continue leading the board, with both automakers having set targets, signed advance purchase agreements and invested in circularity in order to reduce their steel emissions. Having actively engaged their steel suppliers regarding certification by ResponsibleSteel, both automakers improved their scores this year.[126] Volvo also published new lifecycle assessments for its EX30[127] and EX40[128] EVs, which include disaggregated emissions data from the steel used in the vehicles.

Other European automakers, however, trail far behind – and, worryingly, only Stellantis improved its performance this year. By disclosing the current quantity of scrap steel used in part of its annual production cycle, Stellantis caused the company's score to rise from 0% to a meagre 3%.

The remaining European automakers scored 9–15%, with only BMW and Volkswagen scoring points for signing advance purchase agreements with suppliers to incentivise greater investment in, and production of, fossil-free steel. Several automakers disclosed efforts to increase the use of scrap steel in their production cycles, but none could provide evidence of any initiatives to increase the recycling and reuse of post-consumer scrap steel specifically. Moving forward, the European automotive industry must do better if it is to play an integral role in accelerating the transition of the steel industry across the continent.



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Source: The Sunrise Project, Lead the Charge Campaign[129]

125 https://leadthecharge.org/scorecards-summary/
126 https://www.responsiblesteel.org
127 https://www.volvocars.com/files/cs/v3/assets/blt066aeed1a18c768c/blt9ada77d5d48e5607/66ea7f0a44ba33333f7f5992/volvo_ex30_carbonfootprintreport1.pdf?branch=prod_alias
128 https://www.volvocars.com/images/v/-/media/applications/pdpspecificationpage/my24/xc40-electric/pdp/volvo-cars-lca-report-xc40.pdf
129 https://leadthecharge.org

The role of private finance in steel transition

While governments have a crucial role to play in financing the steel transition, they cannot do it alone. Directed by strong regulation, private financial institutions like banks, insurers and investors (including asset owners and asset managers) are also needed to support the transition. Since 2019, just 7.2% of the total debt provided to the steel sector was earmarked for decarbonisation (i.e. classified as transition, green or sustainability-linked loans/bonds). While 43 global banks have set targets to decarbonise their steel lending portfolios, no bank has set a sustainable finance target for the steel sector.

Since 2019, just **7.2%** of the total debt provided to the steel sector was earmarked for decarbonisation.

However, increasing the volume of sustainable finance for the steel sector will not be effective if strong standards and regulations for what counts as sustainable finance are not in place. The European Bank Authority and the European Central Bank have a responsibility to ensure that banks' sustainable finance activities and actions are aligned with European Green Deal objectives. Otherwise, there is a material risk of greenwashing by financial institutions. Strengthening the implementation of incoming EU legislation like the Corporate Sustainability Reporting Directive and the Capital Requirements Directive is crucial to ensuring that financial institutions are only financing steel companies with credible transition plans and developing credible transition plans for themselves.[130]

Financial institutions have significantly reduced funding for thermal coal companies across the supply chain. Metallurgical coal, which is the source of most CO_2 created in the steel sector, is now becoming the last resort for an embattled coal industry. In its Coal Policy Tracker, Reclaim Finance lists 147 major financial institutions – including banks, asset managers, asset owners, and insurers – that have a policy on thermal coal. However, only 13 of these also have a policy to restrict finance for metallurgical coal, and just one financial institution, Dutch Bank ING, has adopted a policy to exclude new finance for unabated blast furnaces.[131]

Financial institutions were long concerned that the technology for steel transition simply did not exist. This is no longer the case. Finance is beginning to shift, but not at the speed required to get the steel industry to 1.5°C alignment. If financial institutions continue to fail to make the required transition to financing renewable-based steel, then regulators must be ready to step in and bring them into line with the wider goals of European countries' steel transition.

130 Reclaim Finance (2024) Steeling our future: the banks propping up coal-based steel. https://reclaimfinance.org/site/en/2024/03/26/steeling-our-future-the-banks-propping-up-coal-based-steel/
131 Coal Policy Tracker https://coalpolicytool.org/ [accessed on Feb 17 2025].

Chapter 3.

Recommendations

The EU's steel transition is on a knife-edge. The pipeline of green steel projects has stalled and stakeholders are questioning the viability of these projects in Europe. Steelmakers are calling for short-term relief on energy prices and more assertive trade defence policies in the face of growing overcapacity and trade tensions with the US and other international partners. Meanwhile rivals are racing ahead to capture green industrial growth markets.

The EU needs to make quicker and bolder decisions if it wants to retain a competitive edge on near-zero emissions steel, securing a future for the sector in Europe with decent jobs, and economic growth. The year 2025 will be critical for moving this agenda forward. With the recently released Clean Industrial Deal, the Commission has proposed a package of legislation to bolster the EU's competitiveness and accelerate industrial transition, including policies that will directly impact the steel sector. The Commission has also released a European Steel and Metals Action Plan and will be bringing forward a review of the CBAM. Further windows of opportunity to bolster the supply of steel scrap and create lead markets for green steel include the proposed Regulation on Circularity Requirements for Vehicle Design and on Management of End of Life Vehicles and the Revision of the Waste from Electrical and Electronic Equipment (WEEE) Directive, one of the key pillars of the proposed Circular Economy Act.

The EU needs to make quicker and bolder decisions if it wants to retain a competitive edge on near-zero emissions steel.

Ahead of this critical policy window, based on our analysis of the current state of the EU steel transition, we have identified the following priority policy interventions:

Phase out carbon-intensive steelmaking

EU Member States need to commit to not permitting or financing any new BF-BOF and end public investments to reline existing ones. The Steel and Metals Action plan or other relevant instruments should develop a framework that guarantees a transformation of the steel sector in Europe in line with a 1.5°C scenario, including measures to ensure that:

- BF-BOFs do not continue to run beyond a timeframe compatible with 1.5°C.
- There is a complete fossil fuel phase-out along the value chain, with use of renewable hydrogen being prioritised for applications that can deliver the largest CO_2 abatement, in particular DRI.
- All shutdowns are conducted with just transition measures in place years prior to a shutdown.
- Steel is produced and used in a more resource-efficient, circular way by implementing measures that enhance eco-design, reuse and waste management, and the use of scrap-based routes for high-quality steel applications.[132]
- Equity and inclusivity are prioritized, embedding diverse representation in decision-making, addressing barriers faced by marginalized groups, and ensuring fair access to resources, training and opportunities.[133]

Introduce transition plans for steel decarbonisation

Timely, ambitious, transparent and robust transformation plans are needed at both corporate and site level to ensure the future of steel production in Europe. These should align with and leverage existing requirements under various EU regulations, including but not limited to the Corporate Sustainability Due Diligence Directive (CSDDD) and the revised Industrial and Livestock Rearing Emissions Directive (IED 2.0), ensuring that plans:

- Are developed through active dialogue and adequate, timely and effective consultations with affected communities, workers, unions and civil society organisations.
- Provide a detailed 1.5°C aligned roadmap with short- and medium-term decarbonisation targets for phasing out fossil fuels and increasing renewable energy-based production. Plans must also incorporate a roadmap with concrete and timely measures to transition to pollution-free production, detailed investment plans and a robust system for tracking progress.
- Include tailored transition plans and measures per site, including social protection and training programmes for the affected workforce and communities.
- Take advantage of regional variation in resources, economic and social conditions.
- Include measures to respect and protect human rights, including indigenous peoples' rights, nature and communities, and provide redress for the human rights abuses and environmental and climate impacts linked to their operations and value chains, in line with the CSDDD.
- Promote equitable global investment, particularly for companies with operations outside Europe.

132 IED (https://environment.ec.europa.eu/topics/industrial-emissions-and-safety/industrial-and-livestock-rearing-emissions-directive-ied-20_en), BREF on Iron & Steel (https://eippcb.jrc.ec.europa.eu/reference/iron-and-steel-production), BREF on Ferrous Metal Processing (https://eippcb.jrc.ec.europa.eu/reference/ferrous-metals-processing-industry), ESPR (https://commission.europa.eu/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/ecodesign-sustainable-products-regulation_en) and in general product legislation.

133 Ibid.

Keep H2-DRI projects on track

Keep existing H2-DRI projects that have been supported with state aid on track to deliver the first generation of new iron making facilities in Europe. European countries including Belgium, France, Germany, Spain and Sweden have given support to private companies to achieve 10 projects across the continent that would build DRI plants running on green hydrogen. These projects are the only way to completely decarbonise ironmaking. If Europe is going to keep ironmaking onshore, this first generation of near-zero emissions ironmaking plants has to succeed.

- Existing conditions for phasing in green hydrogen at the earliest opportunity should be maintained, with provisions for claw back mechanisms if money is misspent and timelines are not respected.
- Companies that have benefited from these state-backed projects should share their technical expertise with donor governments, who will then be able to share technical understanding of this new generation of ironmaking technology with other countries.
- Where hydrogen-based DRI ironmaking does not make sense because of a lack of access to affordable renewables, policymakers should support green iron trade within the EU and with other countries by fostering international cooperation and aligning regulatory frameworks to harmonise standards for carbon emissions and certification processes. Mutually beneficial strategic partnerships should be fostered between companies in the EU27 and with other countries using joint financial incentives and capacity-building initiatives.

Scale renewable-powered electrification

Policymakers should prioritize the decarbonisation of the steel sector by advancing renewable-powered electrification and harmonising grid decarbonisation across Member States. This includes:

- Incentivising investments in renewable energy capacity, grid infrastructure, renewables-based hydrogen production and storage to meet the growing electricity demand from renewables-based steelmaking technologies.
- Policymakers must also support industries in securing long-term renewable energy agreements.

Ensure a just transition

Europe needs a just transition to stabilise economic activity in steel regions, maintain public buy-in for the steel transition and ensure prosperity for workers. To protect steel workers in Europe, policymakers must implement robust social safety nets, such as a reinforced Just Transition Fund, and reskilling programs to ensure workers are part of and benefit from the transition to a low-carbon economy.

- Industrial companies should disclose impact analysis of their transition plans on jobs and skills, with gender disaggregated data. This will help to give workers early notice of plans, build in time for retraining and allow for safety nets to be negotiated with trade unions, smoothing the transition.
- Ensure job security through transition measures (job-to-job transition) and providing financial support for those affected by industry changes until they achieve their reskilling process and access a new job. This would mean placing an emphasis on local job replacement, ensuring that company transition plans favour territories reliant on steel manufacturing. Additionally, fostering strong labour rights and involving unions in decision-making processes will help safeguard workers' interests and promote fair working conditions.

- Ensure that learning, up-skilling and re-skilling schemes are accessible to all, mobilise adequate public and private investment in community revitalisation and commit to creating sustainable, high-quality jobs.

Attach stricter conditions to state aid and provide more transparency

State aid should be seen as an accompanying measure, complementary to private investments; part of a suite of policy measures alongside the enforcement of pollution prevention measures, in line with the polluter pays principle, that can help drive steel decarbonisation. State aid needs to come with strict conditionalities to maximise public benefits.

- A coherent legislative framework, striking the right balance between transforming production processes (IED, EU ETS and CBAM), ramping up transition enablers (support for renewable energy and infrastructure), and addressing consumption via demand-side/product policies to stimulate the uptake of clean steel and lower its footprint is needed to provide the long-term regulatory and market signals to incentivise emissions reductions in the European steel sector. This should happen in the context of supportive demand-side policies such as the ESPR and current and upcoming policy initiatives such as the revisions of the End-of-Life Vehicles Directive and the WEEE Directive to stimulate the uptake of green and recycled steel.
- The provision of state aid can be an important tool to help bridge the gap between the cost of conventional and green steel and ensure the business case for private investments. Nevertheless, state aid should not be used to fix policy failures (e.g. the ineffectiveness of the EU legislation to provide a strong price and regulatory signal for negative externalities), but instead as a last resort measure after policies are strictly applied and externalities are considered (e.g. full cost of CO_2 emissions). Core principles including 'proportionality', 'incentive effect', and 'necessity' tests should be interpreted as 'Union-wide' to prevent a race for subsidies that undermines the single market. These tests would also help to mitigate an inefficient allocation of public resources to simply keep historical value chains alive regardless of their economic soundness. These instruments need to work together in an integrated approach to achieve the decarbonisation and depollution of the European steel sector.
- Instruments, both at national and EU level, to financially support industries to decarbonise should take into account whether or not these projects could be supported via private finance and should mitigate the risk of gaps widening between countries in moving forward with their industrial transformation.
- To maximise public benefits of state support, strong social and sustainability conditions should be included to safeguard quality jobs and a clean environment.
- Transparency of state aid decisions must be ensured by publishing the aid text within six months of approval and regularly updating the project status on open websites.
- Prompt implementation of measures should be linked to final investment decisions and strictly monitored by Member States. Clauses for total reimbursement through claw backs of aid should be included if companies veer off agreed timelines, or renege on the use of 100% renewable or renewables-based hydrogen for reasons outside of the scope of the agreed conditionalities.
- For DRI projects, establish a clear timeline for the uptake of 100% renewable or renewables-based hydrogen as soon as it is available.

Build lead markets of near-zero emissions steel

Policymakers should adopt a standard for near-zero emissions steel production as well as create an enabling environment for lead markets for steel using recycling and scrap targets. Standards and definitions form the basis of lead market policies for near zero-emissions steel. The EU should establish a clear, European-wide definition of green steel that incentivises enhanced recycling and transition of primary steel production.

- The European Commission should adopt clear and ambitious definitions for lower-emission and net-zero steel, which are interoperable with other international standards and fully transparent on the steel GHG emissions accounting methodologies on which these are based.
- This standard should be articulated in the upcoming ESPR secondary legislation, which will likely be adopted by 2026 for a set of priority products including iron and steel.
- The European Commission should develop a green lead market with recycled content targets and green steel quotas for carmakers to use an increasing amount of green and recycled steel in new cars, applicable from 2030.
- Carmakers should be required to use a minimum of 40% green steel (primary H2-DRI) or recycled steel in new cars from 2030, increasing to 75% in 2035, until all steel used in cars is required to be green by 2040.[134] (Green steel covers both recycled scrap and low-carbon primary DRI.)
- Closed-loop recycling should be incentivised. Ensure targets promote the use of recycled steel in all new cars registered in the EU and are aimed at replacing flat steel, particularly through closed-loop recycling systems (e.g. secondary flat steel from end-of-life vehicle treatment used in new cars).
- Explore dual quotas: if there is no unified definition of green steel, consider establishing separate targets – one for green steel and another for recycled content.
- Enhance recycled steel scrap quality through the Proposed Regulation on Circularity Requirements for Vehicle Design and on Management of End-of-Life Vehicles:
  - Mandate comprehensive disassembly of ELVs and their components, facilitating reuse and more efficient recycling.
  - Establish mandatory quality standards under this regulatory instrument to increase the supply of high-quality scrap steel. For example, quality requirements on steel recycled from ELVs should be introduced, so that it meets the quality standard required for reuse in automotive applications with a maximum copper content of 0.06%.
  - Support demand for high-quality recycled steel by incorporating Product Carbon Footprint disclosure requirements for vehicle production and end-of-life management, while setting performance requirements for vehicles to be placed in the market.
  - Introduce a new vehicle eco-score to reduce the carbon impact of electric vehicles beyond the tailpipe. A new methodology and framework for an environmental score for electric vehicles should combine energy efficiency and material carbon footprint, including steel. Such a score would incentivise manufacturers to reduce the environmental impact of electric vehicles by encouraging improvements in not only vehicle efficiency and the use of low-carbon and smaller batteries, but also through procurement of green steel or aluminium. The eco-score should complement, not weaken, existing CO_2 fleet targets. Auto manufacturers must not use it to offset tailpipe emissions or gain extra credits to achieve CO_2 fleet targets.

134 https://www.transportenvironment.org/uploads/files/Green-steel-in-cars-briefing_July-2024.docx.pdf

Use public procurement to accelerate the steel transition

The EU must seize the opportunity to align public procurement with climate protection and zero pollution goals. By making green public procurement the norm, the EU can increase the competitiveness of its industry, create local green jobs and reduce emissions. In this way, public money should be used to support frontrunners in climate-neutral innovations.

EU Commission:

- Ultimately, green public procurement will be enacted on a Member State level. To ensure Member States prioritise it, the Commission should translate the Public Procurement Directive into a regulation.
- The legislation should state a phase-out target for fossil fuel products in public procurement that is in keeping with wider EU climate goals. By 2045 at the latest, all public procurement in all Member States should take into account strict environmental and climate conditions to ensure public funds only support net-zero and zero-pollution products. The transition should be gradually implemented, in line with existing and upcoming sectoral legislation (e.g. ESPR, Construction Products Regulation, Industrial Decarbonisation Accelerator Act).
- The legislation should create standardised rules and procedures across Member States. Making things easier for authorities in charge of tenders should be a priority, using digital tools, online templates and databases to share information about tenders.
- Legislation should enforce monitoring systems for all public procurement to track progress on how green public procurement has contributed to the achievement of the zero-pollution ambition.[135] Reporting tools need to be enforced at the EU level to create a level playing field and allow comparative analysis. Systems should also be inter-operational with other databases that promote environmental benchmarking and compliance promotion.
- Mandatory emissions calculations and reporting tools (e.g. Environmental Products Declarations or Life Cycle Assessments) should be brought in during the pre-bidding stage and should be the basis for awarding a public procurement contract complying with the 'most advantageous tender' requirements of the public procurement directive. This will incentivise bidders to provide environmental impact assessment data and reduce the burden on small- and medium-size enterprise participation in green public procurement.
- The European Commission should improve capacity-building in terms of implementation tools, enforcement systems and emissions calculation and reporting tools through a technical support instrument.

Member States:

- Member States must ensure that national public procurement legislation (if the EU keeps the Public Procurement Directive as a directive not a regulation) prohibits price-only criteria in tenders, based on an EU-wide legal mandate. Instead, a required percentage of public procurement should have environmental and climate conditionality as a non-price criterion. Member States should be encouraged to set minimum binding targets (e.g. 25% by 2026 and 50% by 2030) in the interim period, in order to gradually phase out fossil-based products over the next 20 years.
- Member States should use their own publicly owned companies to create 'lighthouse' projects that only source climate neutral products. In this way Member States can be pioneers of the

135 Suggested: The Commission's Public Procurement Score Board should be expanded to also monitor the share of public contracts awarded by the lowest greenhouse gas footprint.

transition, demonstrating to private companies that they are also bearing risk and showing confidence in net-zero products.

- Member States should expand and strengthen the capacity-building needed to design and implement a green public procurement system. This could be done by a central body dedicated to federal level public procurement. Governments should also focus on targeting capacity development for procurement officers and economic operators so that they are able to deftly navigate the complexities of green public procurement. A European Standard for Green Steel would help procurement authorities in a non-bureaucratic way to find out what products are available, and their footprint.

Annex 1.

Methodology

1.1 European Steel Plant Database

The database encompasses steel plants located in Member States of the European Union as well as in the United Kingdom, Türkiye, Serbia, and Bosnia and Herzegovina. Data is primarily sourced from GEM Trackers and complemented by a variety of reliable channels, including company websites, annual reports, press releases and industry news outlets, ensuring comprehensive coverage of operational status, capacity, decarbonisation projects and associated infrastructure. Retirement dates are meticulously tracked using the GEM database accompanied by additional research. Updates to the database occur every few months to reflect the latest developments, with the most recent update completed in January 2025. Emissions data is incorporated from reputable sources such as the Climate Trace.

1.2 Relining methodology of the blast furnace database

The methodology for assessing relining risk works by evaluating the time elapsed since the most recent relining of a blast furnace. If 13 or more years have passed since the last relining, the status of the blast furnace is reviewed to check if retirement has been announced or if it has been 'mothballed', meaning the plant has: 1) been deactivated or put into an inactive state but is not retired; or 2) has been damaged and is not in use. If it has a retirement date it is added to the category 'operating, retirement announced'. If it is mothballed it is added to the category 'mothballed'. If neither of these conditions apply it falls into the category 'operating, at risk of relining', indicating that the blast furnace is at risk of an investment decision being taken for lifetime extension. In this category we also include blast furnaces for which the last relining date is unknown. Blast furnaces for which it has been less than 13 years since relining, and for which there is no retirement date, are categorised as 'Operating, no retirement date, no imminent relining risk'. The basis for the analysis is the GEM Steel Plant and Blast Furnace Trackers, with additional research to check on more recent retirement dates or relining announcements.

1.3 Country specific steel production levels and the carbon intensity of each national grid

EAF crude steel production figures by country were sourced from the World Steel Association's World Steel in Figures 2024. To estimate electricity consumption, an industry benchmark of 500 kWh per tonne of crude steel was applied. Total electricity demand for EAF production in each country was then calculated and multiplied by national grid electricity carbon intensity data, obtained from Ember and national electricity statistics. This approach provides a broad estimate of emissions associated with EAF electricity use. While the methodology offers a useful high-level perspective, greater accuracy could be achieved by incorporating plant-specific energy consumption, efficiency variations, and the impact of digitalisation and automation, which can reduce electricity demand by at least 10%. Additionally, refining the analysis with real-time grid intensity fluctuations, plant utilisation rates, and existing power purchase agreements would offer a more precise assessment of emissions linked to EAF electricity consumption.

1.4 SteelWatch blast furnace emissions calculation tool

The CO_2 emissions calculator is based on data from Global Energy Monitor and operates under several key assumptions. It considers a carbon intensity of 2.3 tCO_2 per tonne of crude steel (tcs), a utilisation rate of 100%, and a lifetime of 20 years. Additionally, it assumes that 1 tonne of iron produces 1 tonne of steel.

Annex 2.

State aid to steel companies to decarbonise facilities across Europe

Country	Date accepted	Company	Location	Amount (€)	Brief project description	Conditions	Avoided emissions
Germany	July 2023	thyssenkrupp SE	Duisburg	2.3 billion	Construction and installation of DRI unit and 2 melting units. Support for the first 10 years for hydrogen price until 2037.	Subject to monitoring on CO_2 emissions savings and phasing out gas in favour of renewable-based hydrogen. Clawback mechanism for profits to go back to German State. Technological know-how to be shared.	
Germany	December 2023	Stahl-Holding-Saar (SHS)	Saarland	2.6 billion	Construction of a DRI unit and 2 EAF facilities. Using gas to start and later renewable hydrogen when available.	Subject to monitoring on CO_2 emissions savings and phasing out gas in favour of renewable based hydrogen. Clawback mechanism for profits to go back to German State. Technological know-how to be shared.	53 Mt (over the course of the project lifetime)
Germany	March 2023	ArcelorMittal	Bremen and Eisenhütten-stadt	1.3 billion	Construction of a DRI unit and 3 EAF facilities. The DRI unit will use gas and later renewable Hydrogen.		70 Mt (over the course of the project lifetime)

Country	Date accepted	Company	Location	Amount (€)	Brief project description	Conditions	Avoided emissions
Germany	February 2023	ArcelorMittal	Hamburg	55 million	Demonstration production facility using 100% hydrogen.	Extra net revenues will be returned to the government. Technological know-how to be shared.	715kt (over 15-year lifespan of the project)
Germany	October 2022	Salzgitter	Lower Saxony	1 billion	DRI unit and EAF unit. The DRI unit will run initially on gas and later on RES hydrogen.	Claw-back mechanism from some of the net revenues if project is successful.	
Sweden	June 2024	H2 Green Steel/ Stegra	Boden	0.26 billion	The measure will support H2GS's project to establish a large-scale green steel plant in Boden, Sweden. This plant will feature one of the world's largest electrolysers with a 690 MW capacity, a direct reduction plant using renewable hydrogen, two EAFs, and cold rolling and finishing facilities.	Extra net revenues will be returned to the government. Technological know-how to be shared.	87% compared to traditional manufacturing processes
Sweden	Swedish support December 2023 EU innovation fund agreed April 2022	HYBRIT Project SSAB, LKAB and Vattenfall	Luleå	€65-70m from Swedish government + R&D support from Swedish Energy €143 EU Innovation Fund	Direct Reduction Plant: For reducing iron ore using hydrogen. Hydrogen Electrolysers to produce hydrogen using fossil-free electricity. Hydrogen Storage Facility: For large-scale storage of hydrogen gas. Plan for commercial production by 2030.		

Country	Date accepted	Company	Location	Amount (€)	Brief project description	Conditions	Avoided emissions
France	July 2023	ArcelorMittal	Dunkirk	0.85 billion	The aid will support building a direct reduction plant (DRP) and two EAFs, replacing two of the three existing blast furnaces and basic oxygen furnaces. Initially using natural gas, the DRP will transition to renewable or low-carbon hydrogen, biogas, and electricity.	Subject to monitoring on CO_2 emissions savings and phasing out gas in favour of renewable based hydrogen. Clawback mechanism for profits to go back to French State. Technological know-how to be shared.	
Belgium	June 2023	ArcelorMittal	Ghent	0.28 billion	The aid will support building a direct reduction iron plant and a new EAF, replacing one of the two existing blast furnaces. Initially using natural gas, the plant will transition to renewable hydrogen, supplemented by low-carbon hydrogen if needed.	Subject to monitoring on CO_2 emissions savings and phasing out gas in favour of renewable based hydrogen. Clawback mechanism for profits to go back to Belgian State. Technological know-how to be shared.	
Spain	February 2023	ArcelorMittal	Gijon	0.46 billion	The aid will help decarbonise steel production in Gijón by building a renewable hydrogen-based direct reduced iron plant and a new EAF, replacing the current blast furnace. Natural gas will be phased out, and the plant will use renewable hydrogen and syngas from waste and metallurgical gases.	Subject to monitoring on CO_2 emissions savings and phasing out gas in favour of renewable based hydrogen. Clawback mechanism for profits to go back to Belgian State. Technological know-how to be shared.	

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