ACCR

May 2025

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Critical risks in blast furnace relining decisions

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Executive Summary

Within the next decade, global steelmakers - particularly across Europe and key Asian markets[1] - face major capital expenditure (capex) decisions about the relining of coal-based blast furnaces. ACCR's analysis of 13 major steelmakers - representing 17% of global steel production, or around 320 million tonnes per annum (Mtpa)[2] - shows that more than 60 coal-based blast furnaces require major relining decisions by the end of 2035. The implications for future carbon emissions are equivalent to the annual emissions of countries like Spain or Vietnam.

Steelmakers have a range of investment options available such as partial repairs, full relining, conversion to lower-emitting technologies, hot idling and permanent shutdown. The decisions made will have lasting implications for asset viability, emissions trajectories, and investor exposure to stranded assets and transition risk.

Investors have a limited but critical window for engagement with steelmakers on these decisions, yet many companies do not provide transparent and detailed disclosures on the status or timing of blast furnace plans. Without transparency on these inputs and associated costs, it becomes difficult for investors to assess whether companies are making strategic, future-fit investment decisions, or simply deferring transition risks.

As the steel sector approaches a decisive decade for blast furnace investment, investors have a critical role to play in ensuring capital is aligned with credible transition pathways. Strategic engagement now can help prevent emissions lock-in, reduce stranded asset risk and support a shift towards green production models.

[1] This analysis excludes Chinese steelmakers due to limited publicly available disclosure on blast furnace assets.
[2] Based on 2023 company and global crude steel production data from the World Steel Association.

Key Findings

- The steel sector is responsible for 7-9% of global greenhouse gas (GHG) emissions, and the use of the coal-based blast furnace-basic oxygen furnace process (BF-BOF) in global steel production is responsible for just under 90% of the steel sector's emissions.[3]

- Our research identified that 62 blast furnaces (BF) from 13 steelmakers are due for a relining decision by the end of 2035.[4]

    - More than 70% of relining decisions will occur between 2026 and 2035, providing a limited window for investors to influence capital allocation.

    - Asia (48%) and Europe (37%) have the most BFs due for relining.

    - Nearly all of Nippon Steel Corporation (73%) and JFE's (71%) BF assets are due for relining before 2035, while 56% of U.S. Steel and 53% of ArcelorMittal's BF assets are due.

- Based on the current global average emissions intensity of BF-BOF steelmaking (2.32 tonnes of CO_2 per tonne of steel produced), the reline and continued operation of the 62 furnaces will potentially lock in up to 310 $MtCO_2$/year[5] - equivalent to the annual emissions of countries like Spain or Vietnam.

- This emissions intensity poses a direct challenge to meeting company-specific pathways towards global net zero by 2050, increases exposure to emerging carbon pricing mechanisms such as the EU's Carbon Border Adjustment Mechanism (CBAM), and raises the risk of stranded assets for companies and investors.

- BF relining typically costs around $300 million,[6][7] but can cost up to nearly $1 billion,[8] with an average lifespan of 20 years.[9]

[3] Minerals Research Institute of Western Australia, 2023, *Western Australia's Green Steel Opportunity,* p. 32, https://mriwa.sharepoint.com/sites/FinalReports/Shared%20Documents/Forms/AllItems.aspx?id=%2Fsites%2FFinalReports%2FShared%20Documents%2FFinal%2DReport%5F10471%5FMRIWA%5FM10471%20%2D%20Full%20Report%2Epdf&parent=%2Fsites%2FFinalReports%2FShared%20Documents&p=true&ga=1

[4] ACCR has assumed a standard operational lifespan (also referred to as a "campaign life") of 20 years for each BF, based on the typical campaign lengths observed across the industry. See Appendix ("Methodology") for further information.

[5] Using World Steel Association's 2023 global average carbon intensity for BFs (2.32 tCO_2/t steel).

[6] All $ values are US Dollars unless otherwise specified.

[7] Vogl, V., Olsson, O., & Nykvist, B., 2021, "Phasing out the blast furnace to meet global climate targets", *Joule, 5*(10), 2646-2662, https://doi.org/10.1016/j.joule.2021.09.007

[8] For example: Fernandez, T., 24 Jan 2025, ABC News, *BlueScope Steel forges ahead with $1.15 billion blast furnace reline*, https://www.abc.net.au/news/2025-01-24/bluescope-steel-pushes-ahead-with-blast-furnace-reline/104846320

[9] Global Energy Monitor, July 2024, *Pedal to the Metal 2024*, p. 8, https://globalenergymonitor.org/wp-content/uploads/2024/07/GEM-Pedal-to-the-Metal-2024-steel-iron-report.pdf

- Alternative pathways to BF relining vary in technological readiness, emissions reduction potential and compatibility with different iron ore grades. Of the main options steelmakers are pursuing:
    - Processes involving green hydrogen and direct reduced iron (H2-DRI) paired with electric arc furnaces (EAFs) offer the most immediate combination of significant emissions reductions and commercial readiness.
    - Electrolysis of iron ore is extremely promising but will not be commercially ready until around 2040.
    - Traditional BF-BOF production, combined with carbon capture, utilisation and storage (CCUS), may offer some moderate emissions reductions, but faces significant cost, scalability and commercial readiness challenges.
- When strategic engagement drives transparent, detailed disclosure from companies on their BF strategies, investors are better equipped to evaluate financial and emissions risks. In turn, this supports informed advocacy for effective capital allocation decisions and risk mitigation against emissions-intensive asset lock-in.

1. Analysis of decision-making landscape

Across 13 major steelmakers in Europe and key Asian markets, we found that 62 major BF relining decisions are anticipated by the end of 2035, representing 52% of total company BF assets (119 total). Collectively, these 13 steelmakers represent 17% of global steel production.[10]

We identified all BFs requiring relining decisions by the end of 2035, including those that have already reached their assumed end-of-life. We assumed a standard operational lifecycle of 20 years for a BF, recognising that actual lifespans vary based on operating practices and market conditions.

Geographical distribution: The majority of BFs requiring relining decisions are in Asia (48%), closely followed by Europe (37%) (Figure 1).

Company exposure:

- Nippon Steel Corporation (NSC) and JFE Steel have the highest exposure, with nearly all their BFs reaching the 20-year relining threshold by the end of 2035 (Figure 2, Appendix Table 1).
- ArcelorMittal faces the largest absolute number of relining decisions (17 BFs, 33 Mtpa capacity), followed by Tata Steel (9 BFs, 19.3 Mtpa capacity) and NSC (8 BFs, 33.3 Mtpa capacity).
- 56% of U.S. Steel and 53% of ArcelorMittal's BF assets require relining within the next decade.

Timing of relining decisions: More than 70% of BFs flagged for relining will require the decision to be made between 2026 and 2035, providing a limited window for investors to influence capital allocation. Of the BFs flagged for relining:

- More than one third (23 BFs) will require decisions to be made between 2026 and 2030, and another 35% (22 BFs) require decisions between 2031 and 2035 (Figures 3 & 4).
- ArcelorMittal (12 BFs), Tata Steel (7 BFs) and NSC (5 BFs) have the most relining decisions concentrated in the period between 2026 and 2035.

Just under 30% of BFs were flagged for a relining decision to be made by 2025 or earlier. While some may continue operating beyond the typical 20-year campaign life, relining or shutdown is generally required to ensure safe and efficient operation. Extended use without relining often leads to reduced efficiency or production capacity, meaning these decisions are likely imminent. In some cases, where disclosure was limited, BFs may have already been relined. It is also possible that partial relines – less costly and less publicly reported – have occurred without clear disclosure. This underscores the

[10] Based on 2023 company and global crude steel production data from the World Steel Association.

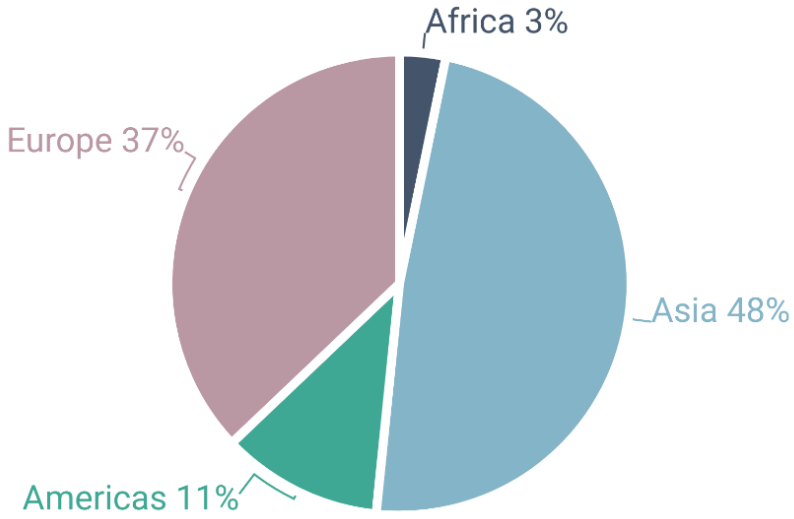
critical need for greater transparency from steelmakers on the status and nature of BF investment decisions.

To the best of ACCR's knowledge, eight of the 17 BFs flagged for relining between 2020 and 2025 have disclosed plans.

- ArcelorMittal (Ghent, Belgium): BF "B" underwent $218 million (€195 million) full reline, completed early 2021.[11]
- ArcelorMittal (Hamilton, Canada): The Dofasco site is transitioning to DRI-EAF production with $646 million (C$900 million) in public subsidies and is scheduled to be complete by 2028.[12]
- JFE Steel (Chiba, Japan): BF No.6 was fully relined following a 2020 FID and restarted operations in January 2023.[13]
- JFE Steel (Kurashiki, Japan): BF No.2 will be shut down and switched to electric arc furnace in 2028.[14]
- JFE Steel (Fukuyama, Japan): BF No.4 will be shut down in 2027.[15]
- Nippon Steel Corporation (Kashima, Japan): BF No.3 and related upstream facilities to be shut down by end of March 2025.[16]
- POSCO (Gwangyang, South Korea): Reline planned, but under legal and environmental review after a civil lawsuit was filed in February 2025.[17]
- Tata Steel (Jamshedpur, India): Reline of BF "G" underway in 2025.[18]

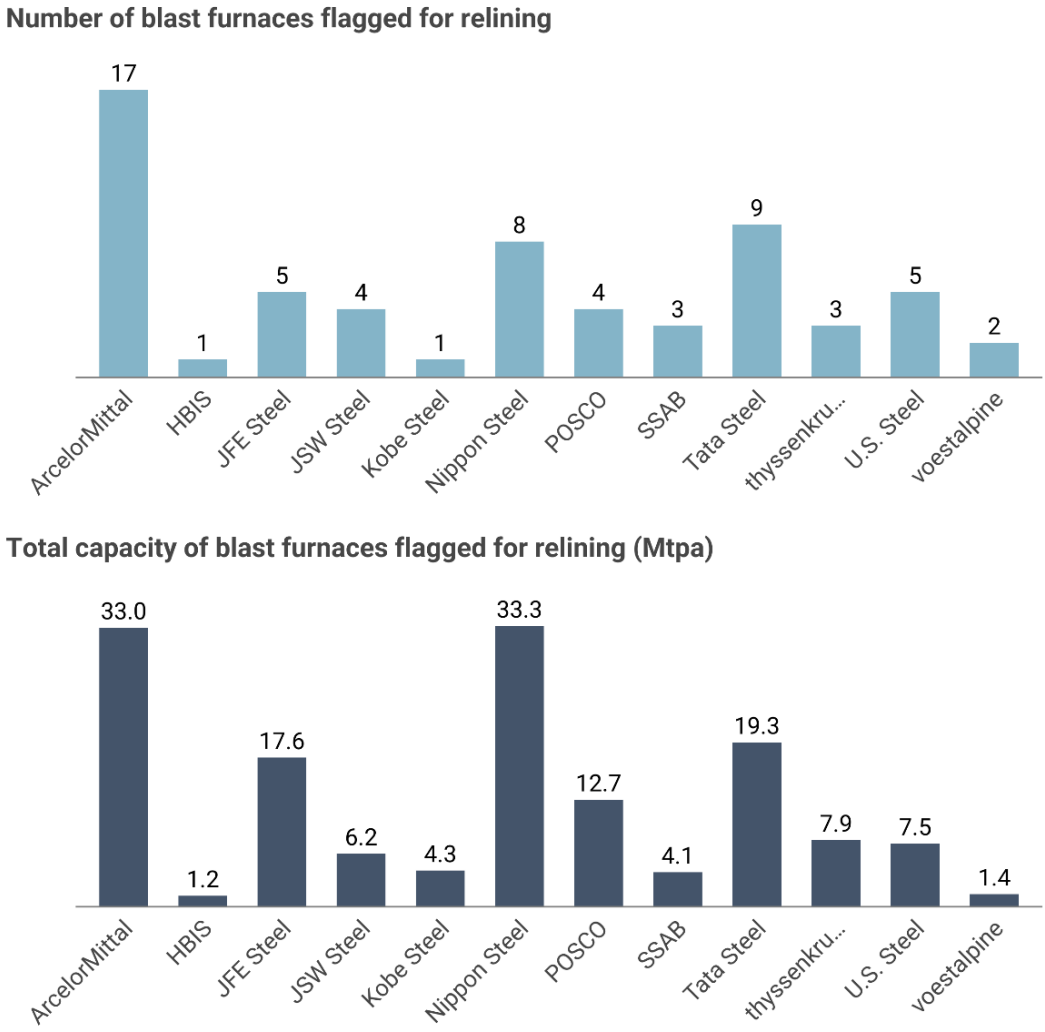
[11] ArcelorMittal, n.d., *Belgium: Showcasing the full spectrum of our decarbonisation technologies*, https://corporate.arcelormittal.com/climate-action/decarbonisation-investment-plans/belgium-showcasing-the-full-spectrum-of-our-decarbonisation-technologies
[12] ArcelorMittal, 13 October 2022, *ArcelorMittal breaks ground on first transformational low-carbon emissions steelmaking project,* https://corporate.arcelormittal.com/media/press-releases/arcelormittal-breaks-ground-on-first-transformational-low-carbon-emissions-steelmaking-project
[13] JFE Steel Corporation, 9 November 2020, *No. 6 Blast Furnace at East Japan Works (Chiba) to be Revamped,* https://www.jfe-steel.co.jp/en/release/2020/201109_02.html
[14] Lin, J., 14 April 2025, *JFE Steel invests 329.4 billion yen in building new EAF at Kurashiki site,* https://yieh.com/en/jfe-steel-invests-3294-billion-yen-in-building-new-eaf-at-kurashiki-site/153925
[15] JFE, May 8 2025, *JFE Issues Long-term Vision (JFE Vision 2035) and Eighth Medium-term Business Plan,* https://www.jfe-holdings.co.jp/uploads/2024-chuukie.pdf
[16] Nippon Steel, 5 March 2021, *Nippon Steel Corporation Announces Medium- to Long-term Management Plan*, https://www.nipponsteel.com/en/factbook/05-01.html; Kyodo News, 27 March 2025, *Nippon Steel to suspend operations at Kashima No. 3 blast furnace on 31st, finalizing reduction in domestic production*, https://nordot.app/1277885510443975512?c=302675738515047521
[17] Solutions for Our Climate, 27 February 2025, *POSCO's blast furnace expansion accelerating climate crisis: future generations take it to court*, https://forourclimate.org/newsroom/1038
[18] TATA Steel India, 2025, *TATA Steel Q4 FY2025 and FY2025 Provisional Production and Delivery Volumes*, https://www.tatasteel.com/newsroom/press-releases/india/2025/tata-steel-4qfy2025-and-fy2025-production-and-delivery-volumes-provisional/

Figure 1: Geographical distribution of blast furnaces requiring relining decisions by the end of 2035



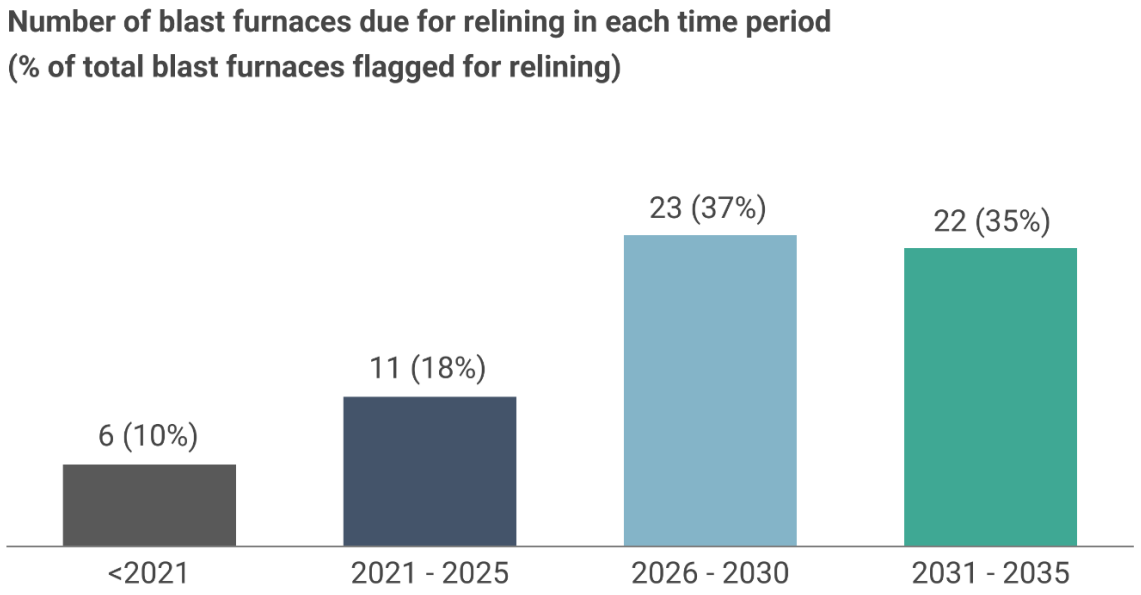
Note: Based on a 20-year campaign life. Percentages are rounded to the nearest whole.

Figure 2: Number and total capacity of blast furnaces due for relining by the end of 2035



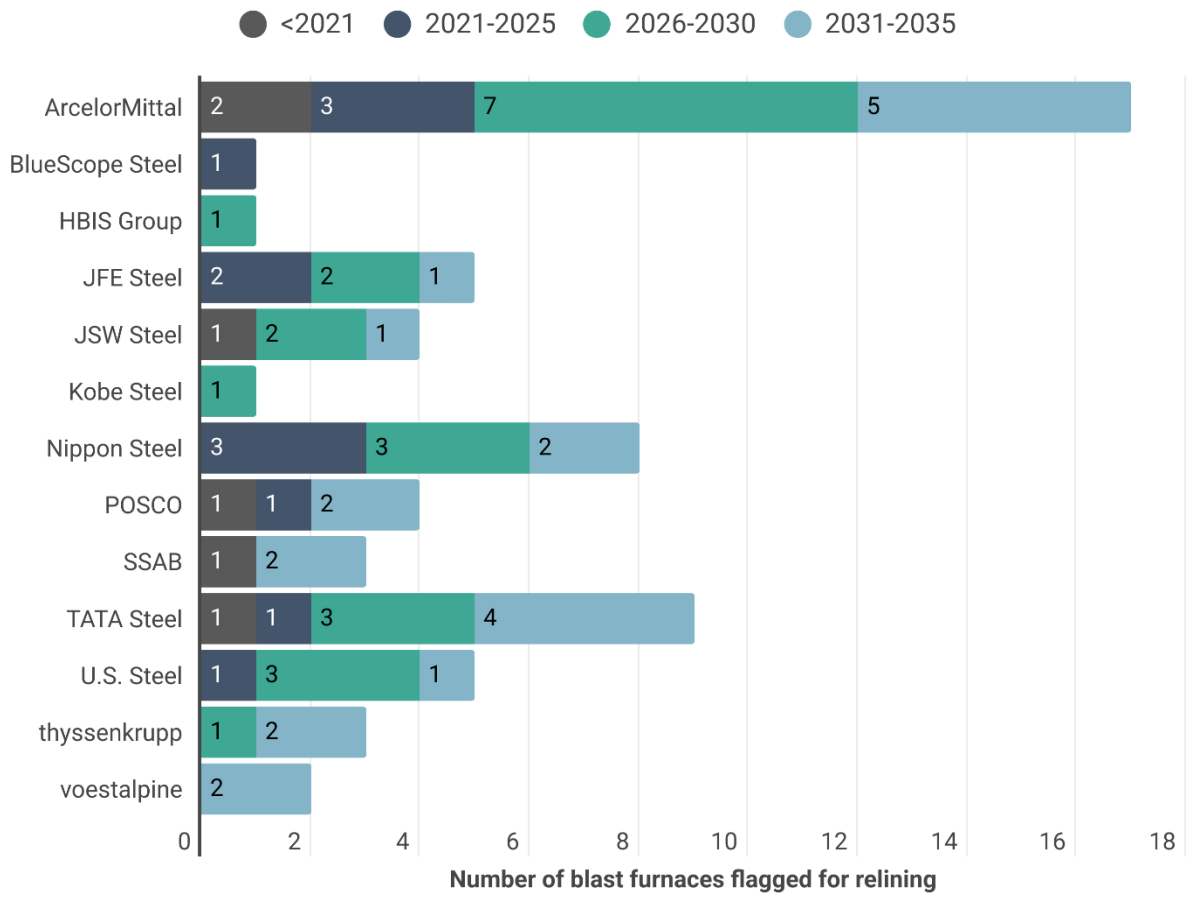
Note: Based on a 20-year campaign life

Figure 3: Blast furnace relining decisions by 5-year period



Note: Based on a 20-year campaign life

Figure 4: Blast furnace relining decisions by company and 5-year period



Note: Based on a 20-year campaign life

The full table of results, as analysed by ACCR, is available in the appendix.

2. The implications of upcoming relining decisions

Emissions impacts

If all identified BFs are relined and continue operating, it is expected that 2.32 tonnes of CO_2 will be emitted for every tonne of steel produced – a rate consistent with conventional steel production to date. For the companies analysed, this could lock in up to 310 $MtCO_2$/year[19] of emissions - equivalent to the annual emissions of countries like Spain or Vietnam.

The emissions intensity of BFs poses a direct challenge to meeting company-specific and global climate commitments. Further, when considered in the context of carbon pricing mechanisms like the EU's Carbon Border Adjustment Mechanism (CBAM), BFs face an elevated stranded asset risk.

The window for preventing fossil fuel lock-in

The timeframe for BF relining – including planning, reaching a final investment decision (FID) and completion - typically spans between 2-5 years, though timelines can change depending on regional regulation, company-specific strategies and market conditions.[20]

It is critical that investors understand the time window they have for effective engagement to prevent emissions lock-in. Companies should publicly disclose detailed timelines for these decisions, enabling investors to engage proactively rather than reactively.

Recent blast furnace relining projects across key markets include:

- **Asia**: JFE Steel announced its FID for the No.6 blast furnace revamping at East Japan Works (Chiba) in November 2020, targeting completion by late 2022. Completion of the reline was announced in January 2023, reflecting a planning and approval process of just two years, followed by a four-month construction phase.[20]

- **Europe**: ArcelorMittal Belgium announced in January 2020 it would reline blast furnace B in Ghent in September the same year.[21] The BF was brought back online 6 months later in March 2021. [22]

[19] Using World Steel Association's average carbon intensity for BFs (2.32 tCO_2/t steel).
[20] JFE Steel, 9 November 2020, *Renovation of East Japan Works (Chiba area) No. 6 Blast Furnace*, https://www.jfe-steel.co.jp/release/2020/11/201109_02.html; JFE Steel, 16 January 2023, *JFE Steel Resumes Operating No. 6 Blast Furnace at East Japan Works (Chiba)*, https://www.jfe-steel.co.jp/en/release/2023/230116.html
[21] SteelOrbis, 22 January 2020, *ArcelorMittal to reline a furnace in Ghent, Belgium,* https://www.steelorbis.com/steel-news/latest-news/arcelormittal-to-reline-a-furnace-in-ghent-belgium-1129203.htm
[22] ArcelorMittal, 3 March 2021, *ArcelorMittal Belgium inaugurates blast furnace of the future,* https://belgium.arcelormittal.com/en/inauguration-blast-furnace/

- **North America**: Cleveland-Cliffs announced plans to reline a BF at its Burns Harbor Works steel mill during its first-quarter earnings call in May 2023.[23] The relining was initially scheduled for 2025, reflecting a multi-year planning and feasibility phase, including: operational assessments, financing strategies, and alignment with federal and state regulatory frameworks. The project was later deferred to 2026 following a reassessment of the furnace's condition.[24]

- **Australia**: BlueScope's Port Kembla relining decision process spanned two years, from pre-feasibility in 2021[25] to decision-making in 2023.[26] The relining and upgrades are now underway, with expected completion in 2026.[27]

Relining vs shutdown: Gradations of investment

Not all BFs will necessarily undergo full relining. Steelmakers have a gradation of investment options available to them, including full relining, partial relining, conversion to lower-emitting technologies, hot idling and/or shutdown. The feasibility and attractiveness of each option is influenced by financial constraints, regulation, market conditions and the company's decarbonisation strategy.

- A full relining is a major refurbishment or rebuild of furnace components, extending furnace life by approximately 20 years and maintaining emissions intensity at approximately 2.0-2.5 tCO_2/t steel. Costs vary depending on size and scope, typically between $300 million to $1 billion.

- Partial relining involves targeted repairs, extending furnace life by 3-10 years at lower cost, with little to no emissions reductions. This is increasingly used as a short-term fix when companies face financial, strategic or policy uncertainty.

- Shutdown[28] decisions become viable where market or policy conditions favour capacity reduction. Companies may choose to decommission BFs if demand shifts or carbon costs rise, while policy incentives and/or climate regulation could push companies towards early

[23] Pete, J., 31 May 2023, *Cleveland-Cliffs to reline blast furnace in 2025*, https://www.nwitimes.com/news/local/business/cleveland-cliffs-to-reline-blast-furnace-in-2025/article_25131a98-ffdf-11ed-8393-7f5bd7ca2248.html
[24] ArgusMedia, 26 July 2023, *Cliffs pushes Burns Harbor reline to '26*, https://www.argusmedia.com/en/news-and-insights/latest-market-news/2472769-cliffs-pushes-burns-harbor-reline-to-26
[25] BlueScope, 22 February 2021, *Re: Compliance with Listing Rule 4.2A for the six months ended 31 December 2020*, https://www.bluescope.com/content/dam/bluescope/corporate/bluescope-com/investor/documents/2021_BlueScope_1H_Results_Appendix_4D_&_Half_Year_Report.pdf
[26] Roberts, P., 21 February 2022, *BlueScope moves to reline blast furnace*, https://www.aumanufacturing.com.au/bluescope-moves-to-reline-blast-furnace
[27] Gateway, n.d., *BLUESCOPE NO. 6 BLAST FURNACE RELINE PROJECT*, https://gateway.icn.org.au/projects/4827
[28] Shutdown generally indicates permanent decommissioning. The furnace is retired from service, often dismantled and the site may be repurposed. Restart is not anticipated.

shutdowns. Companies may also strategically shut down BFs to facilitate conversion to green steel technologies.

- Hot idling[29] is an option that is considered in lieu of shutdown. Like shutdowns, hot idling responds to the need for capacity reduction due to short-term shifts in demand or market conditions.[30] While emissions are lower than during full production, maintaining BFs in a "hot idle" state requires the continual use of coal or other fossil fuels, creating ongoing emissions, maintenance and operation costs. This adds further complexity to investment decisions.

Lack of disclosure

Companies rarely disclose detailed relining, decommissioning or hot idling costs, creating uncertainty for investors when assessing the true economic viability of these investment decisions.

In addition, key operational factors including the condition and remaining life expectancy of coke batteries (which produce metallurgical coke, the primary fuel and reductant used in BFs), or options and costs for sourcing coke externally, are often omitted from disclosures, despite being central to relining assessments. As companies plan for future production, decisions around whether to invest in DRI infrastructure or secure green iron feedstock also become increasingly material.

Without transparency on these inputs and associated costs, it becomes difficult for investors to assess whether companies are making strategic, future-fit investment decisions – or simply deferring transition risks. This is particularly concerning given declining long-term demand projections for metallurgical coal from the IEA[31] and the Australian government,[32] which suggest the growing risk of underutilisation or premature closure of coal-based assets. A lack of visibility on these transition considerations may obscure substantial hidden costs and increase the risk of stranded assets.

[29] Hot idling refers to maintaining a BF in a warmed, non-operational state to enable rapid restart. This requires ongoing energy input, labour and maintenance, and can be costly to sustain. This is distinct to mothballing, which involves shutting down a BF while preserving its infrastructure for potential future use. The furnace is cooled and kept offline with minimal maintenance, and restart requires significant time and investment.

[30] In May 2024, Liberty Steel hot idled a BF in Romania due to 'difficult market conditions' (See: EuroMetal, 31 May 2024, *Liberty Steel hot idles its Galati blast furnace in Romania*, https://eurometal.net/liberty-steel-hot-idles-its-galati-blast-furnace-in-romania/). More recently, JFE Steel announced a temporary shutdown of a BF in response to a 'shaper than expected decline in steel demand in Japan and overseas' (See: BigMint, 3 April 2025, *Japan's JFE Steel to temporarily shut down blast furnace amid weak demand*, https://www.bigmint.co/insights/detail/japan-s-jfe-steel-to-temporarily-shut-down-blast-furnace-amid-weak-demand-635013).

[31] IEA, World Energy Outlook (WEO) 2024, October 2024, p. 318

[32] Australian Government, March 2024, *Resources and Energy Quarterly*, p. 53, https://www.industry.gov.au/publications/resources-and-energy-quarterly-march-2024

Given the volume and timing of critical BF decisions this decade, detailed cost and transition disclosures are essential for investors to assess long-term viability, avoid misallocated capital, and support informed, strategic engagement with companies on their future investment decisions.

Shutdown and conversion

While some companies have disclosed plans to shut down BFs or convert to green technologies, the future of most BFs remains unclear. Of the 119 BFs included in this study, regardless of relining status, less than 25% have plans for conversion or closure in the near-term.[33]

- **Most conversion and closure plans come from European steelmakers, with all European-based steelmakers having disclosed plans to convert at least some of their assets**. SSAB, a leader in the transition to green steelmaking, has announced plans to convert all five of its BFs to fossil-free technologies, with the first two scheduled for replacement in 2026.[34] However, the pace of full-scale, fossil-free production will depend on the commercial availability of green hydrogen and supporting renewable infrastructure – factors that investors can play a role in influencing through active stewardship and advocacy.

- **Closure and conversion plans are more limited in Asia**. In Japan, Nippon Steel has announced the closure and conversion of one BF but is yet to provide investors with concrete plans for its nine remaining BFs.

- While these conversion plans are a positive signal, they are subject to change. For example, ArcelorMittal has announced plans to convert 12 of its BFs to EAF steelmaking but has since delayed FID for most of these despite securing approximately $3.4 billion (€3 billion) in public subsidies to support these. The company cited high energy operating costs as the reason for delay, even in the context of rising carbon costs under the European Emissions Trading Scheme (ETS).[35]

Clearer policy frameworks, supportive incentives and greater corporate transparency will be critical to mitigating delays in the conversion of BFs to EAFs. Investors have a key role to play in driving progress through public policy advocacy and pushing for companies to provide credible transition plans and detailed disclosures on timelines, technologies and associated risks.

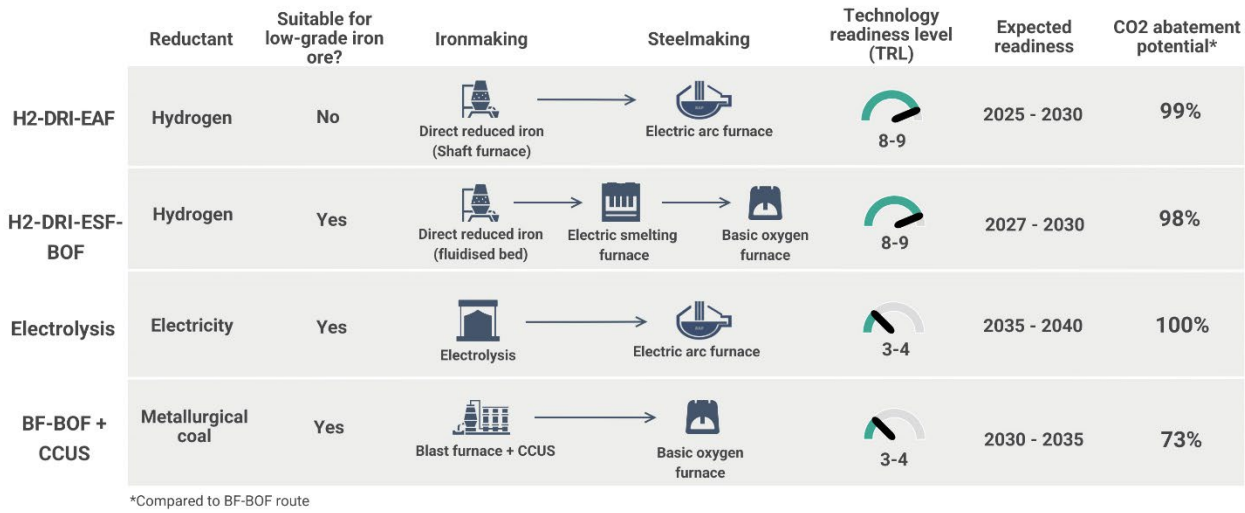
[33] See Appendix, Table 1, for more details on company conversion and/or closure announcements.
[34] SSAB, 7 March 2025, *New electric arc furnace in SSAB Oxelösund will shorten SSAB Zero™ lead times,* https://www.ssab.com/en/news/2025/03/new-electric-arc-furnace-in-ssab-oxelsund-will-shorten-ssab-zero-lead-times
[35] Pfeifer, S., 7 November 2024, Financial Times, *ArcelorMittal delays green investments in Europe over policy uncertainty,* https://www.ft.com/content/94c174d0-cfde-4ef9-9d92-a16792232fd7

3. Alternatives to blast furnace relining

Capital investment, supported by government subsidies, into genuine green steel processes is urgently required to prevent locking in coal-based methods. The available pathways vary in their technological readiness, emissions reduction potential and compatibility with different grades of iron ore. This presents opportunities and challenges for companies aiming to transition to low-carbon steelmaking.

Steelmakers are pursuing four main steel decarbonisation options (Figure 5):

Figure 5: Key decarbonisation pathways for the steel sector[36]



NB: H2 - hydrogen; DRI - direct reduced iron; EAF - electric arc furnace; ESF - electric smelting furnace; MOE - molten oxide electrolysis; BF - blast furnace; BOF - basic oxygen furnace.

Hydrogen Direct Reduced Iron + Electric Arc Furnace (H2-DRI + EAF)

- This technology achieves a near total emissions reduction (99%) and is expected to be commercially ready by 2025-2030.
- While some DRI configurations currently operate using natural gas, particularly where green hydrogen is not yet available at scale, hydrogen-based DRI is the only viable long-term

[36] ACCR chart using data from Agora Industry, Wuppertal Institute and Lund University, 2024, *Low carbon technologies for the global steel transformation*, https://www.agora-industry.org/fileadmin/Projekte/2021/2021-06_IND_INT_GlobalSteel/A-IND_324_Low-Carbon-Technologies_WEB.pdf

solution aligned with the goals of the Paris Agreement. Technologies such as Midrex[37] and Tenova[38] can accommodate a fuel switch without major infrastructure changes.

- H2-DRI + EAF is best suited to regions with high-grade iron ore, as well as abundant renewable energy and hydrogen.

Current examples include:

- SSAB's HYBRIT project in Sweden aims for fossil-free steel by 2026.[39] The company developed its focus on integrating green hydrogen into the steel production process after initially conducting and then abandoning trials of CCS, which it likened to "giving a Band-Aid to a patient with a broken leg."[40]

- JFE Steel is advancing plans to replace its No. 2 blast furnace at the Kurashiki plant with a large-scale EAF, scheduled for commissioning in 2027. This transition is part of JFE's broader decarbonisation strategy and is expected to reduce CO_2 emissions by approximately 2.6 million tonnes annually.[41]

Hydrogen Direct Reduced Iron + Electric Smelting Furnace + Electric Arc Furnace/Basic Oxygen Furnace (H2-DRI + ESF + EAF/BOF)

- Commercialisation for this technology is expected by 2027-2030 and it offers significant emissions reductions (98%).[42] This pathway enables the use of lower-grade iron ores in DRI processes by integrating a smelting step prior to steelmaking.

- The addition of an electric smelting furnace increases energy requirements when compared to the direct use of high-grade DRI in an EAF, but this process broadens applicability and can reduce near-term capex by retaining BOFs.

[37] Midrex, *Midrex H2: The Future of Ironmaking,* https://www.midrex.com/midrex-process/midrex-h2/
[38] Tenova, 9 January 2024, *First-ever DRI production for Baowu in China*, https://tenova.com/newsroom/latest-tenova/first-ever-dri-production-baowu-china
[39] SSAB, *HYBRIT®. A new revolutionary steelmaking technology*, https://www.ssab.com/en/fossil-free-steel/insights/hybrit-a-new-revolutionary-steelmaking-technology
[40] De La Garza, A., 28 April 2022, TIME, *The World's Steel Comes at a Steep Climate Cost. A Swedish Company is Trying to Change That*, https://time.com/6171369/ssab-sweden-green-steel/
[41] Reuters, 8 November 2023, *JFE aims to build electric arc furnace in 2027 to replace blast furnace,* https://www.reuters.com/sustainability/climate-energy/jfe-aims-build-electric-arc-furnace-2027-replace-blast-furnace-2023-11-08/
[42] Agora Industry, 11 April 2024, *Low-carbon technologies for the global steel transformation*, https://www.agora-industry.org/publications/low-carbon-technologies-for-the-global-steel-transformation

- Companies who have adopted this process include BlueScope with Rio Tinto and BHP,[43] Nippon Steel Corporation, thyssenkrupp,[44] ArcelorMittal,[45] voestalpine with Fortescue,[46] and POSCO.[47]

Current examples include:

- In 2022, thyssenkrupp announced plans to construct a green hydrogen-based Direct Reduced Iron (H_2-DRI) plant with melters at its Duisberg Plant, while retaining basic oxygen furnaces for steelmaking. Operations are expected to begin in 2026.[48] The company initially explored hydrogen injections into BFs as a decarbonisation measure but ultimately revised its approach to enable deeper emissions reductions.[49]

Electrolysis of iron ore

- Iron ore electrolysis has a 100% decarbonisation potential by directly reducing iron ore with electricity, eliminating the need for coal or hydrogen.
- It is in early development (TRL 3-4) and is expected to be commercially ready by ~2040.[50]
- The major challenge is the need for large-scale, continuous renewable energy supply, which remains a key barrier to commercial deployment.
- Boston Metals,[51] ArcelorMittal[52] and Salzgitter AG's SALCOS project[53] are among those exploring this option.

[43] ABC News, 9 February 2024, *BlueScope, Rio Tinto and BHP join forces on plan for low carbon steel future,* https://www.abc.net.au/news/2024-02-09/green-steel-push-bluescope-bhp-rio-tinto-join-forces-carbon-plan/103447174
[44] thyssenkrupp, 19 August 2024, *Cooperation for low-carbon steel production: thyssenkrupp Steel is working with international partners on carbon-neutral steel production with a focus on smelter technologies*, https://www.thyssenkrupp-steel.com/en/newsroom/press-releases/cooperation-for-low-carbon-steel-production-thyssenkrupp-steel-is-working-with-international-partners-on-carbon-neutral-steel-production-with-a-focus-on-smelter-technologies.html
[45] ArcelorMittal, 3 January 2023, *ArcelorMittal Belgium and North Sea Port are to build industrial estate the North-C Circular*, https://belgium.arcelormittal.com/en/arcelormittal-belgium-and-north-sea-port-are-to-build-industrial-estate-the-north-c-circular/
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[47] POSCO, n.d., *Breakthrough hydrogen reduction ironmaking technology with near-zero emission*, https://www.posco.co.kr/homepage/docs/eng7/jsp/hyrex/
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[50] Agora Industry, Wuppertal Institute and Lund University, 2024, *Low-carbon technologies for the global steel transformation*, https://www.agora-industry.org/publications/low-carbon-technologies-for-the-global-steel-transformation
[51] Boston Metal, n.d., *Decarbonising Steelmaking for a Net-Zero Future*, https://www.bostonmetal.com/green-steel-solution/
[52] ArcelorMittal, 14 June 2023, *ArcelorMittal and John Cockerill announce plans to develop world's first industrial scale low temperature, iron electrolysis plant,* https://corporate.arcelormittal.com/media/press-releases/arcelormittal-and-john-cockerill-announce-plans-to-develop-world-s-first-industrial-scale-low-temperature-iron-electrolysis-plant
[53] Salzgitter AG, n.d., *Our program SALCOS®*, https://salcos.salzgitter-ag.com/de/salcos.html

Blast Furnace – Basic Oxygen Furnace + Carbon Capture, Utilisation and Storage (BF-BOF + CCUS)

- This process may provide moderate emissions reductions (up to 73%) but faces significant technical, financial and scalability challenges.[54][55]
- Compared to hydrogen-based alternatives, it is less viable, with commercialisation uncertain and unlikely before 2035.
- The approach is capital-intensive and highly site-specific, with limited adoption to date and a growing preference across the sector for hydrogen-based pathways.
- Since May 2024, ArcelorMittal has operated a pilot carbon capture unit at its Ghent facility in Belgium, with a potential capacity to capture around 125,000 tonnes of CO_2 per year - a mere fraction of the site's annual emissions (more than 12 million tonnes).[56] The company plans to trial the technology for 1-2 years before determining scalability and has not yet provided performance updates.

[54] Institute for Energy Economics and Financial Analysis, April 2024, *Carbon capture for steel?* https://ieefa.org/resources/carbon-capture-steel

[55] Institute for Energy Economics and Financial Analysis, November 2024, *Steel CCUS update: Carbon capture technology looks ever less convincing*, https://ieefa.org/resources/steel-ccus-update-carbon-capture-technology-looks-ever-less-convincing

[56] ArcelorMittal, 21 May 2024, *Trial carbon capture unit begins operating on blast furnace at ArcelorMittal Gent, Belgium*, https://corporate.arcelormittal.com/media/news-articles/trial-carbon-capture-unit-begins-operating-on-blast-furnace-at-arcelormittal-gent-belgium#

4. Why blast furnaces are a critical risk for investors

Blast furnace relining is a significant capital expense for steelmakers, typically costing around $300 million but potentially reaching up to nearly $1 billion per furnace.[57] For example, BlueScope Steel's No. 6 blast furnace relining in Port Kembla, Australia, is expected to cost approximately $730 million (~AU$ 1.15 billion).[58]

In addition to the direct costs, relining requires halting production for approximately three months, which can lead to substantial revenue losses. For large BFs with a capacity of 4 Mtpa, these losses could reach up to $1 billion.[59] While some companies mitigate this by reactivating mothballed furnaces or increasing production at other facilities, these strategies introduce additional costs and operational challenges.

The decision to reline exposes investors to significant financial, governance and strategic risks within the context of a rapidly evolving regulatory landscape and the transition to low-carbon and green steelmaking processes.

Financial risks

- Stranded assets: Carbon-intensive operations face increasing regulatory and market pressures, which could render relined BFs unviable, leaving assets underutilised or prematurely retired.
- A decline in demand for high-carbon steel: Key consumer sectors, including automotive and construction, are increasingly committing to low-carbon materials, which could significantly reduce demand for traditional high-carbon steel.
- Capital misallocation of shareholder funds: Investments in high-emissions BFs with 20-year asset lives may limit a company's ability to pursue green technologies, jeopardising long-term competitiveness and value creation for shareholders.
- Carbon pricing and policy costs: In Europe, carbon pricing under the ETS imposes direct costs on emissions, while the CBAM adds charges for products imported from emissions-intensive operations, eroding the profitability of high-carbon steel.
- Uncounted methane emissions: Metallurgical coal supply is also under scrutiny. Coal mine methane (CMM) emissions – currently excluded from most steelmakers' scope 3 disclosures

[57] Vogl, V., Olsson, O., & Nykvist, B., 2021, "Phasing out the blast furnace to meet global climate targets", *Joule*, 5(10), 2646-2662. https://doi.org/10.1016/j.joule.2021.09.007
[58] BlueScope Steel, August 2023, *FY2023 Financial Results Presentation*, p. 12, https://www.bluescope.com/content/dam/bluescope/corporate/bluescope-com/investor/documents/2023_BlueScope_FY_Results_Investor_Presentation.pdf
[59] Ibid.

– pose growing financial and reputational risks.[60] As methodologies evolve, a more complete count of methane emissions could raise the emissions intensity of BF production to nearly 3 tCO_2e/ t steel, significantly impacting emissions liabilities and investor assessments.

Governance risks

- The insufficient disclosure of emissions implications and BF relining's long-term viability leaves investors unable to fully assess risks.
- The short-term prioritisation of cost savings can delay investment in green technologies that are essential for future competitiveness, and meeting company and global climate targets.
- Boards' accountability and ability to evaluate relining decisions against a comprehensive scenario analysis, including policy shifts and market dynamics, is often lacking.

Broader strategic risks

- Some global supply chains are moving towards requiring low-carbon materials to meet regulatory and consumer demands - steelmakers that fail to adapt may miss out on major procurement opportunities.
- Steelmakers that continue to rely on coal as a reductant may expose themselves to price volatility and supply chain disruptions in fossil fuel markets.[61] This risk is particularly acute in regions where governments are phasing out coal subsidies or transitioning energy markets towards renewables.

[60] For example: Bloomberg, 25 March 2025, *Glencore Mine Spews More Methane Than It Reports, Study Finds,* https://www.bloomberg.com/news/articles/2025-03-25/a-glencore-coal-mine-in-australia-spews-out-much-more-methane-than-it-reports

[61] Russia's invasion of Ukraine has led to significant disruptions in global coking coal supply chains, highlighting the vulnerabilities associated with a dependence on fossil fuels. See: Reuters, 7 February 2023, *Coking coal price surge backed by demand as supply woes add froth*, https://www.reuters.com/markets/commodities/coking-coal-price-surge-backed-by-demand-supply-woes-add-froth-russell-2023-02-07/

5. Key stewardship questions for investors

As the steel sector approaches a decisive decade for BF investment, investors have a critical role to play in ensuring capital aligns with a credible transition pathway. Strategic engagement now can help prevent emissions lock-in, reduce stranded asset risk and support a shift towards green production models.

However, engagement is only effective if informed by the right questions.

We recommend investors prioritise the following areas when assessing company alignment and engaging with boards, executives and sustainability teams:

Visibility on blast furnace assets and timelines

- How many BFs does the company operate, and where?
- When is each furnace expected to be relined, converted, hot idled, or shut down?
- Has the company disclosed a public schedule or roadmap for these decisions?

Why it matters: Timely, site-specific disclosures allow investors to assess exposure to emissions and stranded asset risk, and to intervene during critical decision windows.

Transparency on costs, emissions and transition risks

- Has the company disclosed the estimated financial and emissions impact of relining versus alternative pathways (e.g. DRI-EAF conversion or a shutdown?)
- Are lifecycle costs such as decommissioning, hot idling, or coke battery refurbishment included in disclosures?
- Is the company factoring in carbon pricing, methane emissions liabilities, or shifting procurement standards in its decision-making?

Why it matters: Poor transparency can obscure material risks. Investors need clarity on the full economic picture, not just upfront capex.

Evidence of forward-looking scenario planning and capital allocation

- What scenario analysis has been conducted to compare full relining, partial repair, shutdown and conversion options?
- Are these scenarios aligned with the company's stated decarbonisation targets and long-term strategy?
- Is capital allocated in line with these forward-looking assessments?

- Is the company factoring in access to renewable energy, hydrogen or green iron feedstock?

Why it matters: Scenario planning and aligned capital allocation indicate whether companies are strategically preparing for a low-carbon future or deferring transition risks.

Appendix: How many decisions are due by the end of 2035?

Table 1: The number, region, annual emissions and decision timelines of blast furnaces that are due for relining by 2035 across the companies analysed by ACCR.

Company	HQ Region	Annual emissions ($MtCO_2e$)	Total operating BFs	BFs flagged for relining	Relining timelines	BFs slated for conversion / closure*
Nippon Steel	Asia	92.1	11	8	2021 – 2025: 3 2026 – 2030: 3 2031 – 2035: 2	Shutdown: 1 Conversion: 1
JFE Steel	Asia	77	7	5	2021 – 2025: 2 2026 – 2030: 2 2031 – 2035: 1	Conversion: 1
POSCO	Asia	91.5	9	4	<2021: 1 2021 – 2025: 1 2031 – 2035: 2	Conversion: 0**
HBIS Group	Asia	ND	9	1	2026 – 2030: 1	Conversion: 0
ArcelorMittal	Europe	120.9	32	17	<2021: 2 2021 – 2025: 3 2026 – 2030: 7 2031 – 2035: 5	Conversion: 12
TATA Steel	Asia	48.9	18	9	<2021: 1 2021 – 2025: 1 2026 – 2030: 3 2031 – 2035: 4	Conversion: 2
JSW Steel	Asia	65.4	8	4	<2021: 1 2026 – 2030: 2 2031 – 2035: 1	Conversion: 0

thyssenkrupp	Europe	27.4	4	3	2026 – 2030: 1 2031 – 2035: 2	Conversion: 2
voestalpine	Europe	14.6	5	2	2031 – 2035: 2	Conversion: 4
SSAB	Europe	33.4	5	3	<2021: 1 2031 – 2035: 2	Conversion: 5
Kobe Steel	Asia	42.6	2	1	2026 – 2030: 1	Conversion: 0
U.S. Steel	Americas	45.5	9	5	2021 – 2025: 1 2026 – 2030: 3 2031 – 2035: 1	Conversion: 0
BlueScope Steel	Oceania	22.6	1	1	2021-2025: 1	Shutdown: 1 Conversion: 0

*Announced plans for the conversion or permanent closure of a BF asset were recorded for all BFs included in the study, regardless of relining status.

**POSCO is currently constructing an EAF at its Gwangyang works but has not disclosed closure or replacement plans for any BFs. Due to the lack of transparency, ACCR has not categorised this project as a conversion.

NB: Data for Ansteel and China Baowu was unavailable through World Steel Dynamics. Nucor is an electric arc furnace operator. BlueScope Steel has not been counted in overall relining statistics as its 2023 FID involved relining a previously mothballed furnace (No. 6 BF) rather than an operating asset. BF No. 5 (currently operating) is due to reach end of operating life between 2026 and 2030. See: https://www.bluescope.com/illawarra/environmental-responsibility/blast-furnace-reline.

Methodology

We examined the BF infrastructure (119 BFs in total) of 13 major steelmaking companies to identify upcoming relining decisions due by the end of 2035.

Data collection and verification

- **Primary source:** We sourced BF data on the target companies from World Steel Dynamics (WSD) and Global Energy Monitor (GEM), providing comprehensive information on furnace capacities, operational statuses and commissioning dates.

- **Cross-verification:** The data we collected was cross-referenced with public disclosures from each company - including annual reports, sustainability reports and investor presentations - to ensure accuracy and completeness.

Target companies

The analysis focuses on the following 13 steelmaking companies:

- **Asia:** Nippon Steel Corporation (NSC), JFE Steel, POSCO, Tata Steel, JSW Steel, HBIS Group, Kobe Steel.
- **Europe:** ArcelorMittal, thyssenkrupp, voestalpine, SSAB.
- **Americas:** United States Steel Corporation (U.S. Steel).
- **Oceania:** BlueScope Steel.[62]

This analysis draws on the same broader list of 16 steel producers reviewed in ACCR's report, *Forging Pathways*, and ACCR's Steel Decarbonisation Announcement Tracker. However, comprehensive BF data was unavailable for the following companies:

- **Ansteel, China Baowu**: The required data was not available through WSD, while public disclosures provided limited supplementary insights.
- **Nucor Corporation:** The company exclusively uses EAF technology, meaning its operations were beyond the scope of this analysis.

Blast furnace lifespan and relining schedule

- **Operational lifespan:** A standard operational lifespan of 20 years was assumed for each BF. The global median campaign life is estimated to be closer to 17 years.[63] This assumption therefore reflects a conservative approach to identifying potential relining timelines. ACCR recognises that actual furnace lifespans vary, influenced by operating conditions, maintenance, market factors and regional regulatory settings.
- **Relining identification:** Furnaces commissioned or relined prior to 2015 were identified as candidates for relining by the end of 2035.

[62] BlueScope Steel has not been counted in overall relining statistics as its 2023 FID involved relining a previously mothballed furnace (No. 6 BF) rather than an operating asset. BF No. 5 (currently operating) is due to reach end of operating life between 2026 and 2030.

[63] Vogl, V., Olsson, O., & Nykvist, B., 2021, "Phasing out the blast furnace to meet global climate targets", *Joule, 5*(10), 2646-2662, https://doi.org/10.1016/j.joule.2021.09.007

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