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ACCELERATING EAST ASIAN CORPORATE CLIMATE ACTION

NIPPON STEEL'S INTERNATIONALISATION OF INTEGRATED STEEL OPERATIONS:

AN ANALYSIS OF EAF-BASED STEEL

April 2024

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OUR TEAM

Programme Manager and Investor Lead

Lauren Huleatt lauren@transitionasia.org

ESG Analysts

Kenta Kubokawa kenta@transitionasia.org

CONTENTS

KEY TAKEAWAYS

- Electric Arc Furnaces (EAFs) emerge as the most viable route to achieve decarbonised steel production by 2030, reflecting global demand for low-carbon steel products.

- International expansion becomes necessary for Japan's steelmakers, including Nippon Steel, seeking sustainable growth opportunities beyond domestic markets. Ovako's success in offering low-carbon steel, utilising renewable electricity, scrap inputs, and hydrogen, provides a blueprint for Nippon Steel's future endeavours.

- The positive headway made by Nippon Steel overseas can be replicated domestically and should be reflected in their domestic operations. There is a clear need for Japan to provide attractive mechanisms for renewable electricity procurement and increase its renewable electricity share to ensure Japan's heavy industry can align with the decarbonisation efforts exemplified by companies like Ovako.

INTRODUCTION

The Japanese steel market is experiencing a rapid decline, prompting large steelmakers to scale back their production levels domestically. To offset this downturn, these companies are actively pursuing investment and growth opportunities overseas. Nippon Steel, in particular, is successfully internationalising its production operations. In line with this strategy, they have increased their innovative and low-carbon electric arc furnace (EAF) steelmaking facilities. However, at the same time, the company is continuing the expansion of their fleet of highly polluting blast furnace-basic oxygen furnaces (BF-BOF).

As one of the world's largest steel companies, producing around 40 million tonnes of crude steel and generating over US$50 billion in revenue in FY2022, how Nippon Steel operates and its decarbonisation strategy is a key signal to the industry.[1] With scope 1 & 2 greenhouse gas (GHG) emissions amounting to 75 million tonnes CO_2 in FY2022, a serious shift in steel production methods is required to reach net zero by 2050. Nippon Steel has operations in both Japan and overseas, and there are significant differences in how this steel is produced. BF-BOF processes dominate steel production in Japan compared to EAF processes which dominate steel production overseas. But this is changing.

In this analysis, we provide a breakdown of Nippon Steel's overseas operations and recent investments and acquisitions that both expand total crude steel production and offer opportunities for green steel production. Whilst Nippon Steel maintains extensive downstream steel processing facilities globally, this analysis focuses on the production of crude steel via EAFs or BOFs. By doing this, we can differentiate between the current and future feedstocks, BF-based pig iron, scrap and direct reduced iron (DRI), and forecast Nippon Steel's ability to meet its climate targets while increasing total crude steel production toward 2050.

OVERVIEW OF NIPPON STEEL'S OVERSEAS INTEGRATED STEEL OPERATIONS

In 2023, as shown in Table 1, Nippon Steel's overseas assets constituted 28% of their total crude steelmaking capacity, reaching 19 million tonnes per annum (mtpa).

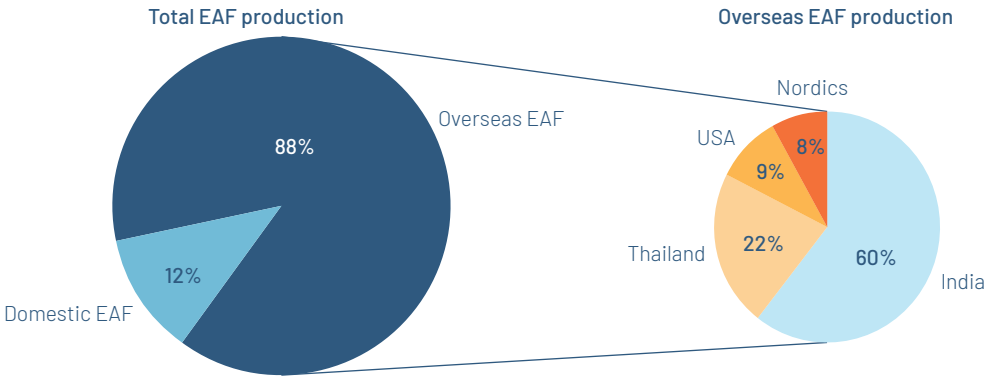
Table 1: Nippon Steel's Domestic and Overseas Steel Production Capacity and Share in 2023 (mtpa and% total)[2]

	mtpa	Regional Share	Total Share %
Domestic	**47.8**	**100%**	**72%**
- Domestic BOF	45.7	96%	69%
- Domestic EAF	2.1	4%	3%
Overseas	**18.8**	**100%**	**28%**
- Overseas BOF	4.4	23%	7%
- Overseas EAF	14.4	77%	22%

Nippon Steel's overseas BF-BOFs have a combined capacity of 4.4 million tonnes, representing 7% of Nippon Steel's overall capacity. Additionally, the company's EAFs have a total capacity of 14.4 million tonnes, contributing to 22% of Nippon Steel's total capacity.[3] This is far greater than domestic EAF capacity and positions EAF-based steel as a key driver of Nippon Steel's overseas expansion.

According to Nippon Steel's 2025 plan, as shown in Figure 1, 88.5% of Nippon Steel's EAFs capacity is situated overseas. This includes 22% in Thailand, 9.4% in the USA, 60.4% in India and 8.2% in the Nordics.

Figure 1. Nippon Steel's Weight of EAFs : Overseas v.s. Domestic in 2025



Specifically, Nippon Steel has several expansion plans: their JV with Acerlor Mittal in India (AM/NS India); mergers and acquisitions, including the announced US Steel acquisition; equity participation; and expanding existing steel mills. The overarching goal is for Nippon Steel's overseas assets to ultimately contribute to around 60% of the company's total crude steel capacity, outlining a long-term vision for the company's international expansion plans.[4] How much of this capacity can be used for green steel is crucial, where EAFs offer the best short-term production route for decarbonisation.

EAFS IN OVERSEAS OPERATIONS

Different types of steel are produced by each overseas operation, catering to specific industrial needs. In Thailand, G Steel and GJ Steel's operations focus on the manufacturing of lower grade, general-purpose steel, serving a broad spectrum of applications including non-specialty items, household appliances and construction steel.[5] Ovako, a Nordic subsidiary of Nippon Steel, specialises in the production of hot rolled products for automotive and industrial applications, and it is Europe's leading producer of bearing steel, supplying critical components for various mechanical systems. Sanyo Special Steel Manufacturing India (SSMI), a 100% subsidiary of Nippon Steel, excels in producing specialty steel with a focus on automobile and other transport applications, as well as industrial applications within the energy sector. Lastly, AM/NS India provides automotive steel, industrial steel for the energy industry (including components for wind turbines) and high-grade cold rolled electrical steel, signalling a diverse range of sectoral applications with demanding performance requirements.

Table 2. Nippon Steel's overseas EAF crude steel production facilities

Company	Country	EAF steelmaking Capacity	Feedstocks
G Steel Public Company Limited	Thailand	1.58 Mtpa[6]	90% Scrap, 10% Pig Iron
GJ Steel	Thailand	1.5 Mtpa	90% Scrap, 10% Pig Iron
ArcelorMittal Nippon Steel India (AM/NS India)	India	EAF: 4.6 Mtpa[7] Conarc: 5Mtpa[8]	5% Scrap, 95% DRI & Pig Iron
Ovako AB	Sweden and Finland	3 EAF (300-tonne total)[9]	97.2% Scrap
Sanyo Special Steel Manufacturing India Pvt. Ltd. (SSMI India)	India	1 EAF (50-tonne)[10]	65% Scrap
ArcelorMittal North America (AM/NS Calvert)	USA	1.5 Mtpa[11] (under construction, expected 2025)	

The type of iron or steel charged into EAFs is a key signifier of the carbon content of the end steel product. For Nippon Steel these vary widely, from high-grade obsolete scrap steel to coal-based DRI and pig iron from blast furnaces. These differences result in a variety of carbon intensities per tonne of steel. Ovako provides Nippon Steel with its lowest overseas carbon intensity of steel with an average of 0.09tCO_2/t whereas AM/NS India provides its highest at 2.23 tCO_2/t, albeit a reduction from 3.33 tCO_2/t in 2015.

The use of renewable electricity is also a key driver of carbon intensity for Nippon Steel's overseas assets with renewable electricity driving emissions down by 58% in Ovako and 25% at SSMI India.[12] [13] In countries like India and Thailand, where grid emission factors are notably high, the EAF steel products experience a greater carbon intensity than its potential. Where Ovako has purchased renewable electricity for its assets, emissions have dropped significantly and are now close to zero emissions.[14] To achieve full decarbonisation of Nippon Steel's EAF assets, a transition to renewable electricity sources must occur, highlighting the need for robust and reliable renewables access.

The global steel industry is currently grappling with challenges stemming from the rise of scrap steel market protectionism. With an increasing emphasis on decarbonisation and resource efficiency and the demand for low carbon steel rising, many countries are imposing restrictions on the export of scrap metals. This protectionist approach aims to retain valuable resources within their borders to meet the growing needs of domestic industries, particularly those utilising EAFs for steel production.

One of the primary issues exacerbating this situation is the scarcity of scrap steel in some countries and in particular, high-quality scrap. Efforts to overcome this challenge involve the expansion of scrap steel procurement networks and the exploration of possibilities to increase the supply through collaboration with existing suppliers. Strengthening these networks is crucial to ensure a steady influx of scrap steel, supporting Nippon Steel's transition toward net zero. Simultaneously, the advancement of scrap steel processing centres becomes vital to effectively handle increasing volumes and grades of scrap steel. The development of cutting-edge technologies and processes is vital to ensure that various scrap steel grades are appropriately sorted and processed and are effectively removing unwanted contaminants such as tramp elements.

As the industry explores solutions on low carbon feedstocks for EAFs, Nippon Steel should seek to develop H2-HBI supply chains as a future alternative to address scrap scarcity. This approach not only promises to alleviate the dependence on traditional scrap but also maintains the production of low carbon steel. However, Nippon Steel has not yet made significant progress in the developing international HBI supply chains or securing high-grade ores needed for DRI. This stands in contrast to the advancements made by some of its Japanese counterparts in adapting to evolving trends in the steel industry.

CLIMATE TARGETS

Nippon Steel's overseas assets have adopted different climate targets such as intensity targets and absolute emission reductions of varying ambition, suggesting room for alignment across Nippon Steel Group where targets are less ambitious than Nippon Steel's domestic targets. Although Nippon Steel publicly states that its climate targets are extended to majority-owned assets, minority-owned assets, notably AM/NS India where Nippon Steel owns 40% of the JV, are impeding Nippon Steel's ability to limit its global emissions. Nippon Steel should seek to show good stewardship to its minority-owned assets by targeting the alignment of its climate targets across all of its majority- and minority-owned assets where these are currently falling short. AM/NS India has set targets of 20% reduction in carbon intensity by 2030 from 2021 levels and net zero carbon emissions by 2050. Notably, there has already been a 33% reduction in carbon intensity since 2015, decreasing from 3.33 tCO_2/t in FY 2015 to 2.28 tCO_2/t in FY 2022.[15] However, despite intensity targets, the expansion of BF-BOF processes and production levels at the AM/NS India mill is expected to lead to a significant absolute increase in emissions toward 2030.[16]

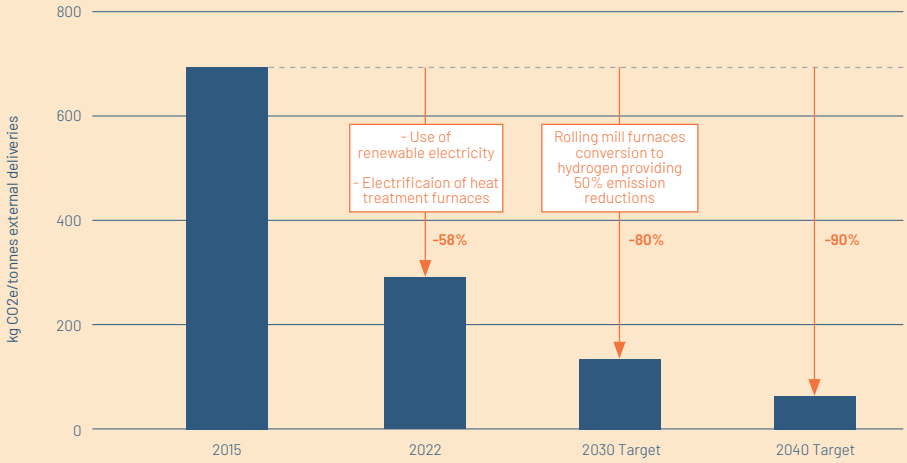
SSMI has reduced its emissions by approximately 25% in special steel manufacturing processes, with a maximum potential reduction of 42.5ktCO_2 per year through the use of renewable electricity.[17] Despite this, the company currently lacks explicit emissions targets. Meanwhile, Ovako has made substantial progress in emissions reduction, achieving a 58% decrease in CO_2e emissions from their operations since 2015. The company has further set targets to reduce CO_2e emissions by 80% by 2030 and 90% by 2040.[18] Nippon Steel's group targets should be extended to G Steel and GJ Steel in Thailand; however, the entities have not made any notable progress toward reducing emissions, despite the availability of renewable electricity procurement instruments in Thailand.

US Steel would also be gathered under Nippon Steel as a subsidiary should the transaction be approved, meaning emission reductions targets should be 30% absolute emission reductions by 2030 from 2010, and net zero by 2050. Currently, US Steel has only set an intensity target of 20% reduction per tonne of steel by 2030 compared to 2018.

CASE STUDY: OVAKO—THE BLUEPRINT FOR SCALABLE GREEN STEEL PRODUCTION

Ovako is one of the largest recyclers of scrap steel in the Nordics utilising scrap steel in their three EAFs in Sweden and Finland. Recycled steel accounts for 97% of the content in Ovako's products.[19] With clear climate ambitions to reduce their Scope 1 and 2 emissions by 90% by 2040 and demonstrable progress in meeting their targets, the company is well positioned to continue its low carbon operations in the Nordic region. Most of the steel, primarily sourced domestically, comes from well-established recycling systems. In certain instances, Ovako maintains a supply chain with customers that involves the return of their scrap for repurposing.

Figure 2. Ovako decarbonisation roadmap [20]



Most recently, Ovako has garnered attention for their electrolyser-based hydrogen facility used to heat steel in the rolling mill, one of the largest hydrogen plants in Europe. Replacing propane as the fuel source to heat the steel, the alkaline electrolyser will produce hydrogen via renewable electricity, enabling Ovako to reduce their CO_2 footprint by up to 50% from 2023 levels. The 20MW electrolyser, Sweden's largest, has been developed with 4 other key partners, including Nel Hydrogen, Volvo Group, Hitachi Energy and H2 Green Steel.[21] Apart from its application in heating steel, the hydrogen will serve as fuel for trucks, with surplus energy being utilised for district heating. Furthermore, in September 2023, Ovako committed to collaboration with the EV-producing Polestar, to produce a climate-neutral car by 2030.[22]

BF-BOF EXPANSIONISM IS CAUSE FOR CONCERN

Nippon Steel has ambitious plans for steel production in the long-term, forecasting sustained growth of steel consumption into 2030. The group is aiming for 100-million tonnes global crude steel capacity, by actively pursuing an expansion of its integrated production framework in regions with demand, aiming to capitalise on localities with strong growth projections.[23] Where historical expansion has included mainly EAF-based steel technologies, Nippon Steel is demonstrating a concerning trend in expanding plants with BF-BOF technologies and acquiring BF-BOF-overweight companies, best demonstrated through AM/NS India expansion and the US Steel acquisition.

CASE STUDY: EXPANSION OF THE HAZIRA PLANT

The AM/NS India JV has begun the aggressive expansion of their Hazira plant, which involves significant upgrades to both ironmaking and steelmaking processes, but incorporates the most carbon intensive production technologies, the BF-BOF route. Expansions in the ironmaking process include the addition of two BFs, two sintering facilities, and three coke ovens, among other expansions. In terms of steelmaking, the expansion involves the integration of three BOFs and two continuous casting machines. Electricity for the steel mill is currently being provided by a captive 500 MW gas power plant ensuring that steel produced from the new additions to the Hazira plant will be produced with an extremely high carbon intensity.[24] The financing for this expansion is facilitated by a mainly Japanese consortium, which includes JBIC, SMTB, SMBC, Mizuho, and Mizuho Europe.[25] This expansion demonstrates a notable shift away from the often lower carbon intensity HBI/DRI and EAF and iron and steelmaking technologies that have defined the plant prior to the AM/NS India expansion plans. Although AM/NS India plans to reduce its emissions intensity by 20% by 2030 across its value chain, the construction of BF-BOF suggests that Nippon Steel will be unable to extend emission reduction targets to these assets with lack of progress on abatement technology for BF-BOF technologies.

CASE STUDY: U.S. STEEL ACQUISITION

In late 2023, Nippon Steel announced the acquisition of US Steel subject to relevant regulatory approvals. The American steel sector is a mature market, with numerous mini-mills and high-quality EAF steel.[26] Over 70% of steel produced in America is via EAFs with a developed scrap steel market allowing for high levels of recycled steel availability. However, Nippon Steel's strategic move to absorb US Steel's production facilities demonstrates the purchase of one of the most BF-BOF-dominant steel companies in America. US Steel currently owns some EAFs, with an annual production of 4.2mtpa; however, it operates BFs with annual production of 18.2mtpa.[27] Where low carbon products have been developed by US Steel, notably their VerdeX steel which utilises 90% scrap steel, questions remain on how Nippon Steel will decarbonise its BFs in the future while maintaining its decarbonisation targets. Should the acquisition fail, it would be a short-term hindrance; however, there are numerous well-placed, less carbon intensive American steelmakers who are better positioned to produce future-proof, low carbon steel should Nippon Steel seek to continue its expansion into the American market beyond the AM/NS Calvert site.

RECOMMENDATIONS

OVERSEAS EXPANSION WITH LOWER CARBON INTENSITIES

Nippon Steel must adhere to a trajectory of lower carbon intensity while expanding their overseas operations. This involves making sure all mergers, acquisitions and direct investments involving steel production process align with Nippon Steel's near-term absolute emission reduction targets, as well as achieving net zero by 2050. With relatively low BF-BOF emissions intensity compared to global steelmakers, Nippon Steel faces a challenge that all new operations need to have lower emissions intensity to effectively decouple increasing production levels and emissions. By focusing only on cleaner technologies such as EAFs and renewable energy sources, Nippon Steel can contribute meaningfully to its climate commitments as well as to global efforts in reducing carbon emissions in the steel industry.

COLLABORATIVE DECARBONISATION TARGETS FOR OVERSEAS ASSETS

Collaborative efforts with industry partners such as ArcelorMittal are essential for setting and developing decarbonisation targets for Nippon Steel's overseas assets. By working to establish clear goals such as integrating renewable energy sources into the steel production process for EAFs and having targets for reducing the emissions intensity of iron charged into EAFs, Nippon Steel can extend their domestic targets for decarbonisation overseas, and align with a net zero target across all of its portfolio.

LEVERAGING OVERSEAS EXPERTISE FOR EAF STEEL MILL DEVELOPMENT IN JAPAN

Nippon Steel should actively leverage the expertise of its overseas companies with proven success in EAF technology to develop and implement similar facilities within Japan, focusing on the production of high-grade steel products for demanding sectors such as the automotive sector. Collaborating with their overseas partners allows for efficient transfer of knowledge, technological advancements, and best practices, enabling Nippon Steel to enhance its capabilities in EAF-based steel production in Japan. In particular, Nippon Steel should collaborate with Ovako to utilise their expertise producing automotive grade steel.

CAPITALISING ON OVAKO'S HYDROGEN ELECTROLYSER EXPERIENCE

Building on the experience gained from Ovako's hydrogen electrolyser, Nippon Steel should spearhead the development of infrastructure and supply chains for H2-HBI and downstream steel processing. By capitalising on Ovako's expertise, Nippon Steel can expedite the incorporation of hydrogen-based processes to establish low carbon iron supply chains to charge into EAFs and transform downstream steel processing. Reducing iron using hydrogen is unlikely to occur in many established steelmaking countries redrawing global steel supply chains. Nippon Steel can play a proactive role in developing H2-DRI infrastructure in regions where this is likely to be more cost competitive compared to domestic Japan, ensuring Nippon Steel retains vertical integration of the iron-to-steel process, while maximising cost efficiency through supply chain diversification.

GLOSSARY

BF- BOF— Blast Furnace-Basic Oxygen Furnace

EAF — Electric Arc Furnace

DRI — Direct Reduced Iron

H2-HBI — Hydrogen Hot Briquetted Iron

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