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ACCELERATING EAST ASIAN CORPORATE CLIMATE ACTION

PRIORITISING RENEWABLE ELECTRICITY FOR STEEL IN JAPAN'S 7TH STRATEGIC ENERGY PLAN

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KEY TAKEAWAYS

- Renewable electricity (RE) is essential for decarbonising Japan's steel industry. The 7th Strategic Energy Plan (SEP) should allocate RE for electric arc furnace (EAF) steel production, and provide competitive electricity pricing for steel companies aiming to decarbonise.
- Decarbonising the steel industry would require RE additions amounting to 0.5% of Japan's total electricity generation by 2030 and 5-7% by 2050 to reach near zero emissions steel production. This represents a relatively small amount of Japan's total electricity production for such a transformational change.
- A manageable target of 4.5 mtpa of EAF steel connected to greenfield RE can achieve the 2030 steel industry decarbonisation target. This would replace an equivalent amount of BF-BOF steel and steer the industry toward carbon neutrality by 2050.

RENEWABLE ELECTRICITY IS KEY FOR FOR THE TWIN TRANSITION OF GRID AND HEAVY INDUSTRY DECARBONISATION

"There is no room for debate that a robust supply system for green power is essential," Eiji Hashimoto, Chairman and CEO of Nippon Steel Corporation, July 2024, discussing the next Strategic Energy Plan at the Basic Policy Subcommittee of the Advisory Committee for Natural Resources and Energy.

Japan's Strategic Energy Plan informs the steps to be taken for the country's long-term energy policy, aiming to ensure a stable supply of energy while addressing environmental and economic challenges. For the steel industry, the most recent version of the plan, the 6th edition revised in 2021, highlighted improving utilisation of current blast furnaces (BF), reducing iron ore using hydrogen (H_2) and separating and recovering CO_2 from BF exhaust gas.[1] Little progress has been made since 2021 with no commercial-scale hydrogen reduction technology or Carbon Capture and Storage (CCS) technology in operation. Furthermore, utilisation of BFs has decreased as demand for Japanese steel has reduced.

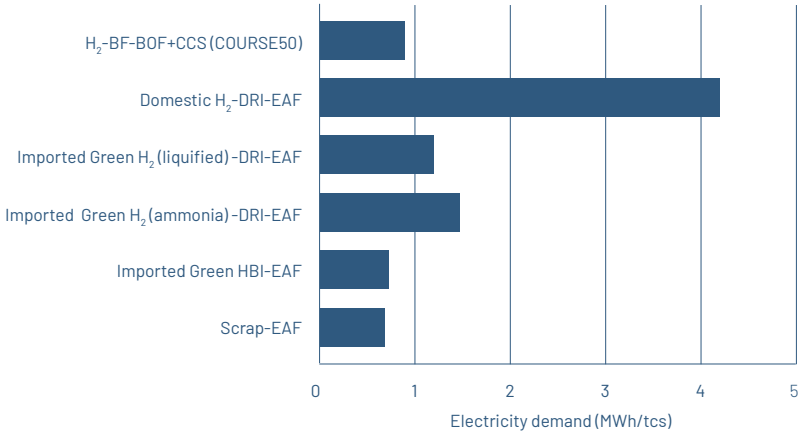
Primary steel production is particularly energy-intensive but can be decarbonised with RE. Thus, the decarbonisation challenge facing the three primary steelmakers in Japan (Nippon Steel, JFE, Kobe Steel) must be met within the context of Japan's 7th SEP, specifically focusing on providing RE for the steel industry. Policymakers in METI must seek to build and provide more RE to decarbonise both Japan's grid and the steel sector, alongside advocating for financial incentives to assist the steel sector in decarbonising.

1 https://www.meti.go.jp/press/2021/10/20211022005/20211022005-1.pdf

ELECTRICITY REQUIREMENTS FOR STEEL TECHNOLOGIES

Charging green hot briquetted iron (HBI) or scrap steel in an EAF is the least electricity-intensive domestic steelmaking process, accounting for approximately one-sixth of the electricity that domestic H_2-DRI-EAF processes demand due to the electricity needs for H_2 electrolysis. The ability to produce steel at such low electricity usage makes these two inputs particularly attractive due to electricity constraints in Japan. Furthermore, Japan has a mature scrap-EAF industry but remains a net exporter of scrap, indicating potential for organic EAF expansion within the industry. The import of HBI into Japan has already begun with steelmakers Kobe Steel and JFE utilising international supply chains to their benefit. Leveraging international supply chains like this opens Japanese steelmakers up to spatial decarbonisation possibilities where electricity-intensive processes can be outsourced to countries with plentiful RE resources to, for example, processing iron ore into HBI.

Figure 1. Electricity demand per tonne of crude steel production



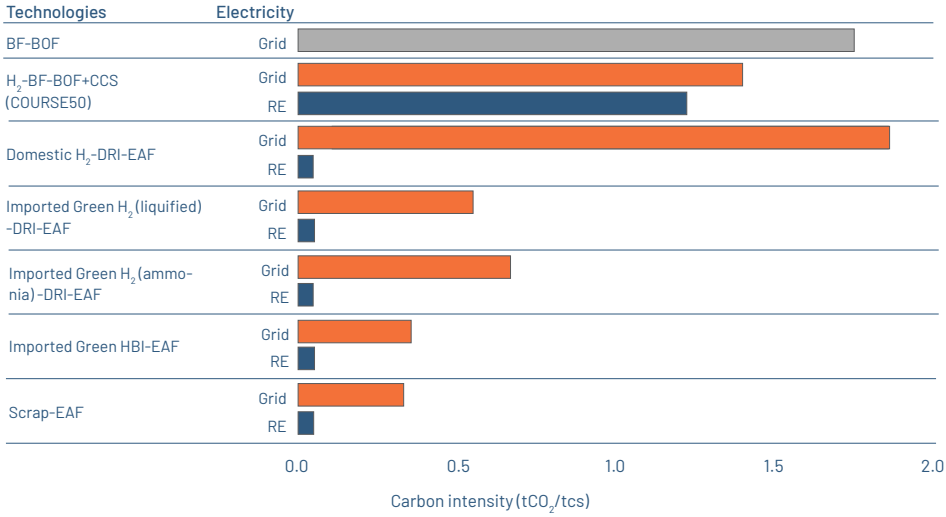
Source: TA analysis

IMPACTS OF ELECTRICITY SOURCE AND TECHNOLOGY CHOICES

Given the lack of decarbonisation the 6th SEP delivered for the steel industry, the 7th iteration needs to specify which steelmaking technologies should take precedence within Japan. Depending on whether grid electricity or RE is used, the technologies we have analysed can have highly variable emission intensities. Importing hydrogen or HBI, or reusing scrap steel offers the highest decarbonisation potentials. When utilising RE, these methods can achieve decarbonisation rates of up to 95% compared to BF-basic oxygen furnace (BF-BOF) steelmaking.

Highlighting the importance of using RE instead of unabated grid electricity, our analysis for the domestic H_2-DRI-EAF production, suggests an increase in emissions per tonne of steel, exceeding the emissions of BF-BOF by 7% when utilising grid electricity at today's emission intensity. Independent of the electricity used, COURSE50 technology using coal and BF technology has a limited emission reduction potential of approximately 20% to 30% compared to conventional BF-BOF.

Figure 2. Decarbonisation potentials compared to BF-BOF using grid or RE electricity



Source: TA analysis

Shifting to imported green HBI-EAF production represents the most viable pathway for Japan to produce high quality primary steel

Our analysis also suggests that secondary steel production through 100% scrap-EAF is the most efficient way to decarbonise, achieving 2.15 to 2.59 tonnes of CO_2 reduction for every MWh of RE. This is closely followed by the imported green HBI-EAF process which can also reach the CO_2 abatement level of 2 tCO_2/MWh. Where some Japanese steel companies and downstream steel purchasers have doubts about the quality of obsolete scrap, importing green HBI to be charged into EAFs presents the most viable pathway for Japan to produce high-quality primary steel. This approach minimises strain on the domestic power grid while achieving the highest decarbonisation rates. Hence, these are the two processes where the 7th SEP should prioritise support.

Japan has established EAF steel mills in operation with companies like Tokyo Steel, Japan Steel Works and Yamato Steel producing EAF steel, albeit with a limited supply of RE. These steelmakers currently account for a minority of Japan's steel products, as BF-BOF steel accounts for 75% of Japanese steel production.[2] Yet the future of decarbonised steelmaking is through electrification. In the US, the steel market is dominated by EAFs, accounting for over 70% of steel production, with American steelmakers providing high-grade steel for automotive and industrial customers.[3] Even as large-scale electrified iron and steel infrastructure is being developed in the EU, some policymakers are publicly calling for ironmaking to be outsourced to other countries, allowing the continent to focus further on steel production via EAFs. Japanese steel production needs to be electrified to keep pace.

2 https://www.meti.go.jp/shingikai/sankoshin/green_innovation/energy_structure/pdf/018_04_00.pdf
3 https://www.steel.org/steel-technology/steel-production/

PPAS CAN HELP TO ACHIEVE CORPORATE GOALS WHILST THE WIDER ENERGY SYSTEM TRANSITIONS

Japan's iron and steel industry is localised on the coast near highly urbanised areas. Because of this, captive RE generation is not a viable option to provide the iron and steel industry with the electrical requirements to power EAFs. Therefore, on-grid solutions must take precedence to achieve a decarbonised iron and steel sector in Japan.

Currently, corporations seeking to decarbonise their electrical supply in Japan can utilise a number of market-based solutions such as J-Credits, green electricity certificates and non-fossil certificates. Energy attribute certificates (EACs) such as these leave the industry exposed to market electricity tariffs and their role in facilitating the addition of RE capacity is questionable. Noting the preference to have stability in prices and reliability in decarbonised electrical supply, and contribute meaningfully to new RE projects; corporate power purchase agreements (CPPAs) represent a strong and viable mechanism in which the steel companies can meet and deliver these items. CPPAs are beneficial in providing stabilised, hedged electricity prices for both the generator and offtaker. However, PPAs are not as common as in other regions such as North America or Europe, due in part to the market risks both offtakers and developers must price into contracts. This must be tackled by policy makers to accelerate corporate demand for RE.

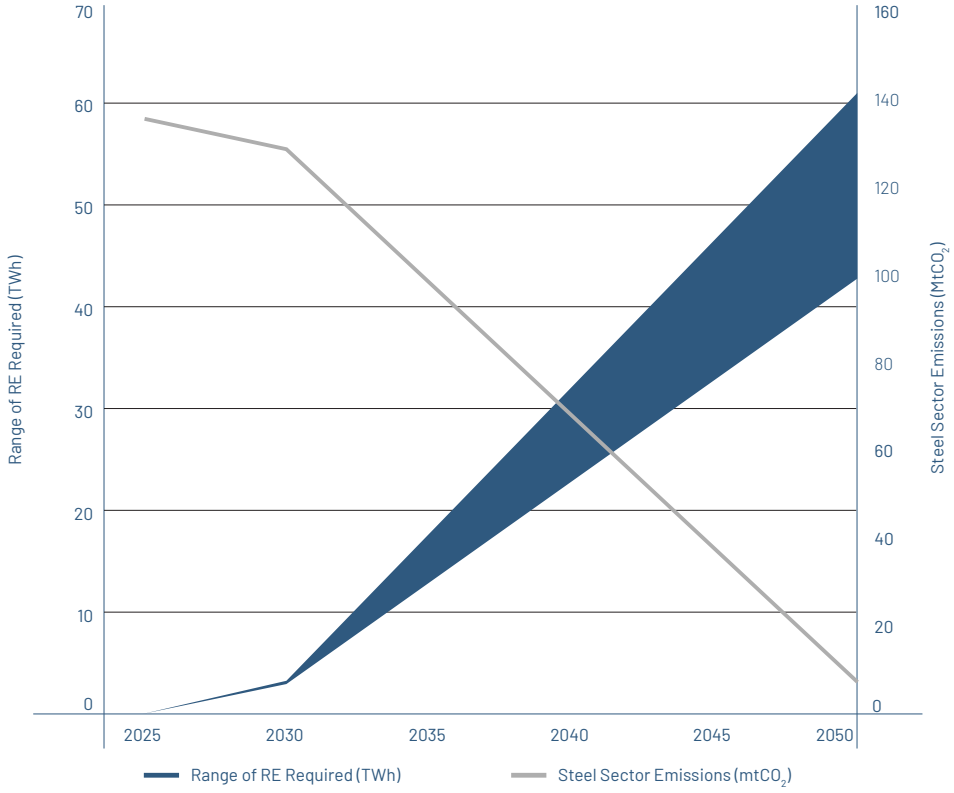
Japanese solar and wind electricity often costs more than the market tariff. To encourage the decarbonisation of the steel industry through the use of RE, the 7th SEP needs to prioritise policies that can incentivise steel companies to sign agreements with new RE projects, while ensuring the contractual bases for the RE projects themselves are stable and bankable.

RENEWABLE ELECTRICITY ADDITIONS ARE MANAGEABLE AND IMPACTFUL

Should steelmakers sign CPPAs for scrap-EAF and green HBI-EAF processes, they will drive the decarbonisation of their steel operations and Japan's power sector at the same time. If the Japanese steel industry were to adopt these two processes to reach a 30% reduction in emissions by 2030, a total of 590-600 tonnes of EAF capacity would have to replace existing BF-BOF production, replacing 4.5 mtpa of BF-BOF steel. Approximately 3 TWh of RE would be required for this transition, less than 0.5% of the current electricity generation in Japan.[4]

4 https://www.iea.org/countries/japan/energy-mix

Figure 3: RE requirements for steel sector decarbonisation



Source: TA analysis

By 2050, total RE requirements amount to 43-61 TWh, or 5-7% of Japan's current electricity production. Grid electricity emissions would also drop 5-7% from today's levels to 409-418 tCO_2/GWh for this infrastructure alone. Consequently, steel sector emissions would reduce 95% from 2013 levels. In reaching this target, the total EAF production capacity in Japan would have to reach 64 to 86 mtpa, representing a substantial EAF capacity albeit comparable with the US steel sector today.

RECOMMENDATIONS

The 7th SEP must prioritise the most electricity efficient and high carbon abatement potential steelmaking processes for the future of Japan's steel industry. Within 2030, a manageable target of 590-600 tonnes of EAF capacity should be connected to greenfield RE infrastructure. This would replace 4.5 mtpa of BF-BOF steel. Toward 2050, these targets must be increased so that by 2050, between 8,600 and 11,500 tonnes of EAF capacity provide steel production of between 64 and 86 mtpa.[5]

To fully realise the abatement potential of EAF-based steel production, RE must be the power source. The 7th SEP should incorporate targets for RE capacity specifically allocated for new EAFs. Within 2030, 3 TWh of new RE should be allocated to EAFs. This equates to a modest sum of approximately 2.5 GW of solar PV capacity. Toward 2050,

5 Upper and lower ranges for Japan's long term steel output

these targets must be increased to between 43 and 61 TWh RE supply for EAFs.

Lastly, steel companies aiming to decarbonise should not incur higher electricity costs than standard grid tariffs. The 7th SEP needs to advocate for the support of financing solutions to help Japanese industry realise these targets.

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