Industry Trends Brief

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Korean Government's Low Carbon Steel Production Strategy: Key Challenges and Improvements

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- **The global steel sector is facing significant challenges to decarbonize, amidst the emerging new trade order of international competitiveness in low-carbon products.**
- **To achieve carbon neutrality while protecting the domestic steel industry, it is essential to secure competitiveness in low-carbon technologies. More active financial and policy support is needed for the commercialization of HyREX, South Korea's unique hydrogen reduction steel technology.**
- **In particular, domestic renewable energy production capacity and price competitiveness are critical prerequisites to adopting low-carbon steel technological innovations.**

° International Trends Toward a Low-carbon Economy[1]

Major economies are introducing policies such as the EU **Carbon Border Adjustment Mechanism (CBAM)** and the US **Inflation Reduction Act (IRA)** to accelerate **national energy transitions** and the **development of low-carbon technologies**.

- The recent COVID-19 pandemic and Russia's prolonged invasion of Ukraine have intensified the **uncertainty over dependence on fossil fuel-based energy imports**.
- **EU CBAM** is a carbon levy designed to accelerate the decarbonization of carbon-intensive products, including iron and steel, cement, aluminum, fertilizer, electricity, and hydrogen.
    - A provisional agreement was reached in the EU in December 2022. Starting in 2026, importers will be required to purchase **CBAM certificates** (carbon price payable under the EU Emission Trading System, ETS) at the EU import clearance.
    - According to the Korea Energy Economics Institute, the cost of CBAM certificates is estimated to be **KRW 258.3 billion (USD 196 million)**, or **8.1%** of South Korea's total exports of CBAM steel products.[2]
- The US **IRA** legislation which was passed in 2022 amends the tax code and utilizes public funds to address climate change and promote clean energy by allocating the federal budget funding to suitable projects on a project basis.

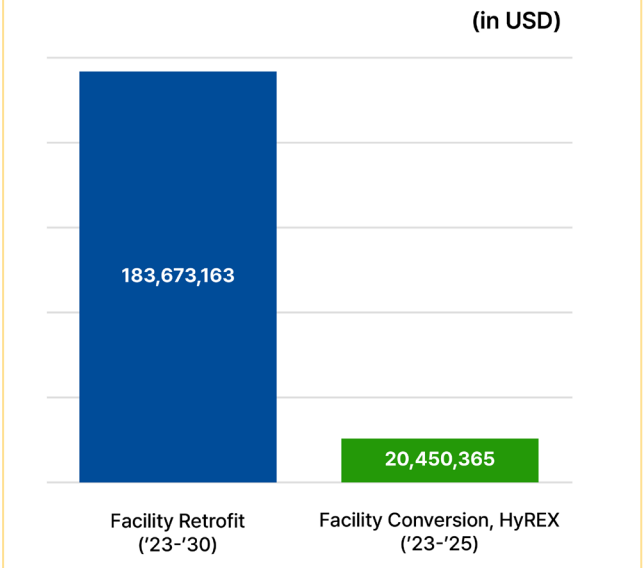
- Publicly announced on March 8, 2023, the Industrial Demonstrations Program received **USD 6.3 billion to support the advancement of transformational technologies** necessary to decarbonize the heavy industry sector including iron and steel.

° Korean Government's Strategy for Steel Industry Decarbonization

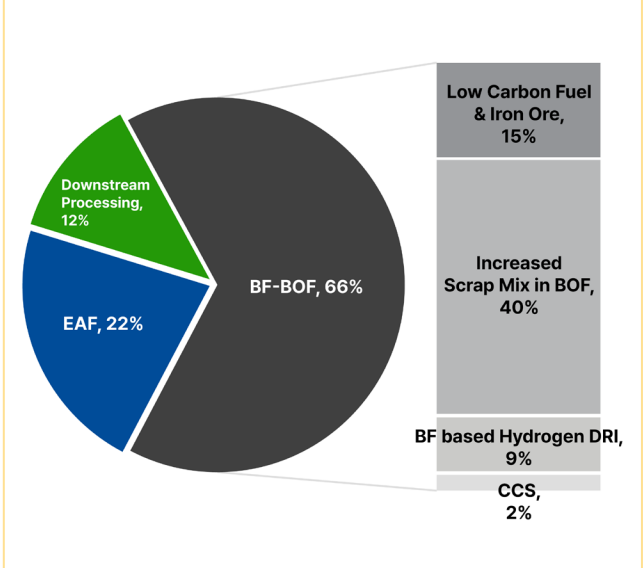
On February 16, 2023, the Ministry of Trade, Industry and Energy (MOTIE) released the **Steel Industry Development Strategy for Transition to Low-Carbon Steel Production** (hereinafter the 'strategy'),[3] but the institutional and financial commitments appear to be insufficient to maintain competitiveness in a low carbon economy.

- In 2019, the global steel industry accounted for 7% of total global greenhouse gas emissions and 25% of the global industrial sector emissions, while the Korean steel industry accounted for 16.7% of total domestic greenhouse gas emissions and 30% of the domestic industry emissions.[4]
- The strategy was announced through the 'Steel Industry Development Roundtable', a public-private council involving the MOTIE, seven steel companies (POSCO, Hyundai Steel, Dongkuk Steel, SeAH Steel, KG Steel, Korea Steel, and Aju Steel), the Korea Iron & Steel Association, and the Korea Steel Scrap Industry Association.
- While including both facility retrofit and facility conversion allocations, the current strategy provides significantly less support for facility conversion and lacks the specificity of a plan to meet the goal of closing all 11 blast furnaces and replacing them with 14 HyREX facilities during 2040-2050 (see Figure 1).

° [Figure 1] Funding in Low Carbon Steelmaking R&D



° [Figure 2] Facility Retrofit R&D Funding Breakdown



Source: SFOC graph from the 'Low-Carbon Steel Production Strategy'[3] data

° Environmental Implications of the Current National Strategy

[Facility Retrofit] The Blast Furnace-Basic Oxygen Furnace (BF-BOF) retrofit technologies shown in Figure 2 (66% of total Facility Retrofit funding) **maintain the use of coke (coal) as the primary source of production**, where coking coke is **the major source of carbon emissions**.

- Investments in electric arc furnaces (EAFs) and downstream processes are meaningful as instruments for GHG reduction **only under the premise of decarbonizing the Korean electricity market**.
    - While EAFs have relatively low carbon emissions compared to blast furnaces, EAF expansion must be coupled with renewable energy procurement to achieve meaningful emissions reductions to gain a competitive advantage in the global steel decarbonization race.
        - **Indirect emissions from electricity** used during the EAF process account for about **58.3%** of the total EAF emissions.[5]
        - Currently, about **65%** of South Korea's electricity energy is **fossil fuel-based**.[6]

[Facility Conversion] Refers to the **introduction of hydrogen DRI (HyREX)** facilities. To achieve carbon neutrality and maintain economic competitiveness, the use of green hydrogen (i.e., hydrogen produced by electrolyzing water with electricity from renewable sources)[7] is required.

- Hydrogen DRI technology replaces coal with hydrogen where coal is used as both fuel and raw material for BF-BOF facilities. With hydrogen DRI, **water is produced instead of carbon dioxide**.
- Transitioning from coal-based to green hydrogen-based steel production would require **3.7 million tons** of hydrogen per year for an annual production capacity of 38 million tons of steel. This makes up about **70%** of the hydrogen production target set out in the Korean government's 2040 National Hydrogen Roadmap.[8]

° Key Challenges in Hydrogen DRI Technology Innovation

Globally, the development of hydrogen DRI technology is at the commercialization stage where **the first movers are likely to acquire a competitive advantage** in the international low-carbon steel market.

- As shown in Table 1, plans for hydrogen DRI steelmaking and clean energy procurement in some of the major economies indicate **carbon emission reduction levels from steel production** which are absent in the Korean strategy. For the abovementioned economies, **both the production scale and government funding are greater than Korea's** (up to four times higher for the annual funding).

Converting to hydrogen DRI facilities with an annual production capacity of 38 million tons of steel will increase the steel plant's electricity demand to 3,700 MWh per year. With this technological shift, the **steel plants will need to purchase the entirety of their electricity demand** in the existing grid system whereas Korean BF-BOF plants are self-supplying approximately **80%** of the electricity demand.[8]

- To offset additional costs of low-carbon steel production, it is essential to **increase the domestic renewable energy supply and ensure price affordability**.
    - As of 2020, the theoretical power generation potential of renewable energy in Korea was 340,678 GWh per year, but only about 12.7% (43,096 GWh) of this was generated by renewable energy in 2021.[9]
    - In 2021, the **LCOE (levelized cost of electricity) of solar power** was about USD 0.10/kWh,[10] around **2 times higher** than the global average of USD 0.048/kWh,[11] and the **LCOE of onshore wind power** was about USD 0.12/kWh, around **3.7 times higher** than the global average of USD 0.033/kWh.

◦ [Table 1] Global Trends in Hydrogen DRI R&D and Production Plans

	Facility Conversion Plans	Funding Scale
Germany[12]	Completion of a hydrogen-only DRI manufacturing facility with 100,000 tons annual capacity by 2026 with government funding and private investment. Annual production of 1 million tons of carbon-free steel at Arcelor Mittal's Hamburgplant by 2030.	German Government ▪ EUR 55 million (USD 60 million) ◦ 50% of the construction costs of the Hamburg plant
Sweden[13]	Annual production of 1.35 million tons of carbon-free steel in Sweden through the HYBRIT-project by2030.	European Union (Under the Innovation Fund) ▪ EUR 143 million (USD 157 million)
Japan[14]	① Demonstration of a technology that reduces carbon emissions by 'at least 50% compared to existing levels' with low-carbon raw materials and offsite hydrogen in a 500m^3 medium-scale experimental blast furnace by2030 (no production target). ② Demonstration of a hydrogen DRI technology with carbon emissions reduction goal of 50% or more compared to the current blast furnace method by 2030 (no production target).	Japanese Government ▪ JPY 155.9billion ['21~'30] (USD 1.18 billion) (¥155.9 billion = ①¥121.4 billion + ②¥34.5 billion) ◦ 42.8% of the total cost of technology demonstration
S. Korea	**Annual production of 1 million tons of steel with HyREX technology by2030** (**no carbon emission reduction levels from steel production**).	South Korean Government ▪ KRW 26.9 billion ['23~'25] (USD20.4 million)

° Recommendations for South Korea's Low-carbon Steel Strategy

- **To reduce carbon emissions throughout the steelmaking process, legislation should be strengthened to allow for rapid expansion of renewable energy distribution at the national level.**

    - It is important to ensure that renewable energy capacity is available to meet the increase in electricity purchases, and to this end, **relaxing regulations and easing licensing requirements for renewable energy** will need to be considered.[15]

    - With the introduction of hydrogen DRI facilities, **the amount of electricity purchased by steel plants will increase**, due to electricity use for **green hydrogen production** (to be used as a reducing agent), heat sources for melting H-DRI in electric arc furnaces, and heat sources for downstream processes.

    - **Domestic renewable energy production and distribution capacity are central to the steel industry's competitiveness, both for DRI and EAF-based steel production.**

- **With a range of hydrogen reduction steel technologies competing globally, stable and long-term policy and monetary support is essential for the commercialization of HyREX technology to gain a competitive edge.**

    - Achieving technological innovation with **POSCO's HyREX technology** (fluidized bed reduction reactor) is **a way to secure domestic low-carbon steel production technology and facilities** which will also **protect the domestic job market** for steel production and related industries.

        - Falling behind in technology commercialization **can compromise industrial competitiveness** by relying on imports for the upstream part of the low carbon steel-making process where **the most of value-added opportunities are found**.

        - HyREX technology offers **easier access to raw materials, lower production costs, and more effective carbon emission reductions** than other steelmakers' hydrogen reduction technologies using shaft furnaces.[16]

- **Increased transparency of emissions reduction targets and methodologies for low-carbon steel production support plans.**

- The current national low-carbon steel strategy **does not specify steel production emission reduction targets for the low-carbon technologies R&D support** unlike other major economies (see Table 1).
    - This could **create uncertainty** among the public, key industry and policy stakeholders, and investors about the realization of carbon neutrality in the Korean steel industry.
- **Greater transparency around the methodology** being used to allocate technology development grants would allow for more efficient and effective policy recommendations.

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Solutions for Our Climate (SFOC) is an independent policy research and advocacy group that aims to make emissions trajectories across Asia compatible with the Paris Agreement 1.5°C warming target.
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