Defining Low-Carbon Steel in Korea

Technology Pathways under the K-Steel Act

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SUMMARY

- *The Act on Strengthening the Competitiveness of the Steel Industry and Supporting Its Carbon Neutral Transition* (the "K-Steel Act"), passed by the National Assembly on November 27, marks Korea's first formal commitment to steering its steel industry toward a low-carbon transition through institutional government support. With concrete implementation tools such as a Prime Minister-led Special Committee and the designation of low-carbon steel industrial zones, the Act makes the definition of low-carbon steel products and low-carbon steel technologies a decisive factor for the industry's future competitiveness.

- Although the low-carbon steel market is still emerging, its direction is clear. Major demand-side initiatives such as the First Movers Coalition and SteelZero have committed to sourcing a significant share of their steel as low-carbon steel by 2030, while European producers including Stegra and SSAB plan to commercialize hydrogen-based steel production by the late 2020s. In practice, EU CBAM, the First Movers Coalition, and SteelZero already function as de facto global benchmarks, benchmarks that Korea's dominant BF-BOF production route does not meet.

- By 2030, three production pathways are realistically viable in Korea and could be recognized as low-carbon steel technologies: the blast furnace–electric arc furnace (BF-EAF) hybrid route, POSCO's hydrogen-based HyREX technology, and DRI-based electric arc furnace production (DRI-EAF). The BF-EAF hybrid route benefits from existing asset utilization but carries the risk of failing to meet international cleanliness thresholds. HyREX offers the strongest performance in terms of carbon intensity and technological sovereignty, but entails the highest costs among mitigation technologies and requires a substantial and sustained supply of clean hydrogen. The DRI-EAF route is more cost-competitive than HyREX and meets the carbon-intensity requirements of most international demand initiatives, but faces challenges related to the establishment of a DRI supply chain.

- Current transition discussions within Korea's steel industry tend to focus heavily on HyREX. However, a single-technology strategy is ill-suited to the pace of change in global markets. Multiple technology options, including DRI-EAF, should be formally recognized as low-carbon steel technologies in order to build a strategic portfolio. In particular, DRI-EAF can leverage already-commercialized gas-based DRI supply chains, enabling rapid scale-up and accelerating Korean steelmakers' entry into low-carbon steel markets. The K-Steel Act should clearly articulate such multiple technology pathways and play an institutional role in enabling timely transition investments. It should also be designed in alignment with the government's forthcoming K-Green Transformation (K-GX) comprehensive plan, ensuring consistency with national industrial transition roadmaps for power grids, hydrogen infrastructure, and related systems.

Terminology

Technology	Description
BF-EAF Hybrid Stage 1	A route where molten steel produced in an EAF is then charged into a BOF to remove impurities and fine-tune alloy composition before making final products.
BF-EAF Hybrid Stage 2	A route where hot metal produced in a blast furnace is charged into an EAF for melting and refining.
BF-BOF	The conventional integrated route: ore and coal are pre-treated (sintering and coking), then ironmaking in a blast furnace (BF) produces hot metal, and steelmaking in a basic oxygen furnace (BOF) lowers carbon and impurities (phosphorus, sulfur, etc.).
Scrap-EAF	Steelmaking in an EAF using scrap as the primary feedstock. Because scrap quality can be inconsistent, it has limits for high-grade steel and is mainly used for general structural steels (for example, long products and standard plate/sheet).
HyREX	A hydrogen-based reduction route that produces DRI using hydrogen as the reductant, then melts it in an electric melting furnace together with scrap. This brief assumes 20% scrap input.
DRI-EAF	An EAF route that melts a blend of DRI and scrap. This brief assumes 70% gas-based DRI and 30% scrap.

1. Low-Carbon Steel Technology Transition under the K-Steel Act

- *The Act on Strengthening the Competitiveness of the Steel Industry and Supporting Its Carbon Neutral Transition* (the K-Steel Act), jointly proposed by the ruling and opposition parties, was passed by the National Assembly on November 27, 2025. The Act is significant in that it marks a shift away from relying solely on corporate discretion or voluntary commitments and toward a framework in which the state formally sets direction and provides support for the transition of Korea's steel industry.
- For the first time in 50 years since the government-led establishment of POSCO in the 1970s, the Korean government has once again explicitly recognized steel as a strategic industry and legislated policy instruments to support both industrial upgrading and decarbonization.
- The K-Steel Act stipulates that the government shall designate low-carbon steel technologies and promote projects to advance research and development, commercialization, deployment, and the installation of related facilities in order to facilitate the steel industry's transition to carbon neutrality. The Act assigns the authority to designate low-carbon steel technologies to the Minister of Trade, Industry and Resources (MOTIR), with detailed criteria and procedures to be specified by Presidential Decree. In addition, a new low-carbon steel certification scheme will be introduced to nationally manage product-level carbon intensity standards and stimulate market demand through preferential public procurement.
- In effect, the scope of technologies recognized as low-carbon steel technologies and the certification thresholds for low-carbon steel products will become the decisive criteria determining access to government support and market opportunities. These definitions will therefore shape the technological and investment trajectory of Korea's steel industry.
- Given that approximately 40 percent of Korea's steel production is exported, the designation of low-carbon steel technologies must simultaneously satisfy two critical constraints: credibility in the eyes of global demand-side buyers, and technical and economic feasibility within Korea. If standards are set too low, there is a risk that public funds will be spent supporting production facilities that fail to gain recognition in international markets. Conversely, if standards are set excessively high without due consideration of Korea's technological capabilities and cost structures, domestic steelmakers may be unable to pursue the transition at all. Determining an appropriate, context-specific threshold is therefore of paramount importance.

2. The Materializing Low-Carbon Steel Market

- Global demand for low-carbon steel has already moved beyond the stage of abstract ambition. Demand-side commitments are firm, and once production is realized, an initial market will be effectively open.
- For example, steel-consuming companies participating in the First Movers Coalition (FMC), a corporate alliance led by the World Economic Forum, have pledged to procure 10 percent of their total steel demand as near-zero steel by 2030. Even when considering only the annual demand of the top three steel-consuming FMC members, their combined steel procurement amounts to approximately 16.5 million tonnes. If 10 percent of this volume is sourced as near-zero steel, this translates into minimum demand of at least 1.65 million tonnes.
- Similarly, members of another low-carbon steel procurement initiative, SteelZero, have declared that by 2030 they will source 50 percent of their total steel purchases as low-carbon steel. The combined steel demand of SteelZero members is estimated at approximately 10 million tonnes[1], implying potential low-carbon steel demand of around 5 million tonnes. These members are primarily Europe- and North America–based manufacturers in sectors such as automotive and renewable energy equipment, including Ørsted, Volvo, Ford, and Siemens Gamesa, companies that exercise substantial purchasing power in global steel markets.
- SteelZero currently comprises around 40 member companies, while the First Movers Coalition includes approximately 96 members. Even when considering only the explicitly committed volumes under these two initiatives, conservative estimates suggest that total demand will comfortably exceed 6–7 million tonnes. Moreover, these procurement shares are expected to increase toward 2040 and 2050, indicating that the low-carbon steel market will continue to expand over time.
- At present, only two producers have announced plans to commercialize low-carbon steel before 2030: the Swedish steelmakers Stegra and SSAB. Stegra is constructing production facilities with the goal of commencing commercial operations in 2026, while SSAB has announced its intention to transition to fossil-free steel production by 2028. Each company plans annual production volumes of approximately 2.5 million tonnes, resulting in combined potential supply of around 5 million tonnes.
- Offtake agreements have already begun to emerge. Volvo has been sourcing low-carbon steel from SSAB since 2022 under a bilateral agreement. Mercedes-Benz signed a letter of intent in 2023 with Stegra for the

[1] Sameen (2025.11.18)

purchase of 50,000 tonnes of low-carbon steel[2]. Other companies, including Microsoft[3], IKEA, and Porsche[4], have also entered into long-term offtake arrangements, with most physical deliveries expected to commence between 2026 and 2028.

- The commercialization of hydrogen-based steel production, particularly Stegra's planned operations beginning in 2026, is expected to trigger a fundamental shift in steel markets. Once low-carbon steel becomes available as a physical product, today's procurement pledges will be converted into tangible demand. The low-carbon steel market is therefore not a mirage, but a market that will materialize in the near future.
- This market is of particular importance to Korea's steel industry because the companies driving demand are core buyers of Korean steel exports. Automotive manufacturers, energy equipment producers, shipping companies, and construction firms in North America and Europe are already planning to progressively tighten their procurement criteria for low-carbon and near-zero steel. Failure to meet these requirements would not merely result in reduced transaction volumes, but could lead to the structural exclusion of Korea's key steel products from major export markets. Going forward, the ability to comply with low-carbon steel standards will become a necessary condition for market access, on par with price competitiveness.

[2] Stegra (2023)

[3] Gallucci (2025)

[4] European Commission (2023)

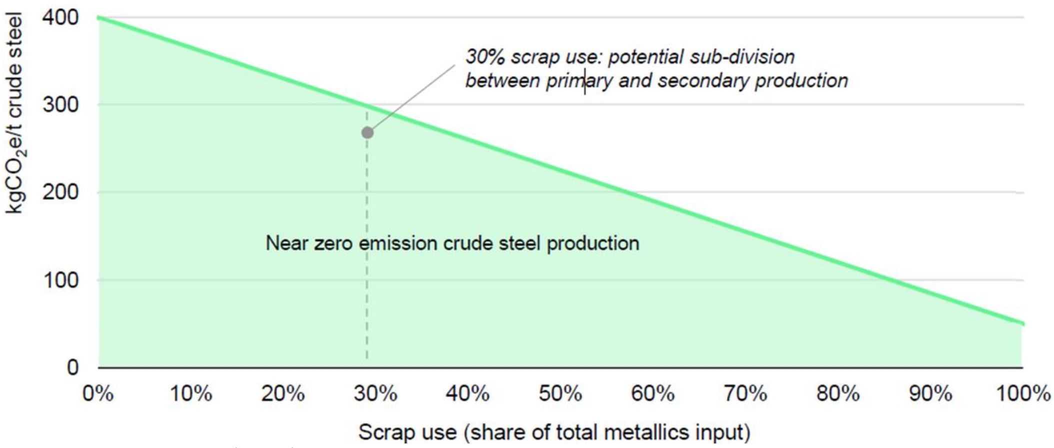
3. International Trends in Low-Carbon Steel Standards

- There is currently no single, globally unified definition of low-carbon steel. However, a wide range of actors—including national governments, international organizations, industry associations, private standard-setting bodies, and demand-side initiatives—have each proposed criteria for assessing the environmental performance of steel products according to their respective objectives. In practice, the carbon-intensity benchmarks that are actively shaping market behavior are being formed by the European Union, SteelZero, and the First Movers Coalition.

1) International Organizations and Private Standards

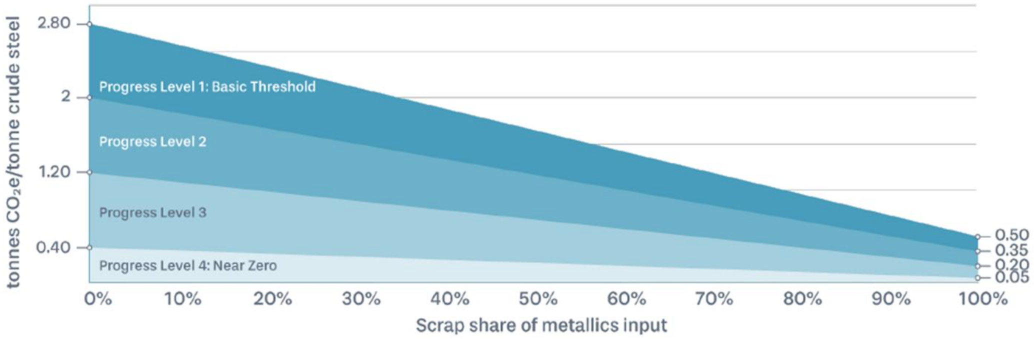
- International organizations such as the International Energy Agency (IEA) and private non-profit standard-setting bodies such as ResponsibleSteel propose carbon-intensity thresholds that are defined as linear functions of the scrap input ratio used in crude steel production. Under these approaches, higher scrap input shares correspond to more stringent allowable emissions thresholds. In both cases, carbon intensity is defined at the crude steel level.
- These standards generally include direct emissions (Scope 1) and indirect emissions from electricity and steam use (Scope 2) as a baseline, while also incorporating certain upstream emissions associated with raw material production and transport (a portion of Scope 3).
- The IEA provides reference benchmarks for near-zero steel, defining carbon-intensity thresholds ranging from 0.05 to 0.4 tCO_2 per tonne of crude steel, depending on the scrap input ratio. ResponsibleSteel largely follows the IEA framework but further subdivides lower-emissions performance into additional decarbonization levels.

Figure 1. IEA Carbon-intensity Benchmarks for Near-zero Steel



Source: IEA(2022)

Figure 2. ResponsibleSteel Decarbonization Levels



Source: ResponsibleSteel(2024)

- Private demand-side initiatives such as SteelZero and the First Movers Coalition set their procurement targets based on these standards. SteelZero has committed to sourcing 50 percent of its total steel purchases by 2030 from producers that meet ResponsibleSteel's Level 2 decarbonization criteria. The First Movers Coalition has pledged to source 10 percent of its steel demand by 2030 from producers that meet the IEA's near-zero steel benchmarks.

2) Government Policies and Regulatory Standards

- Carbon-intensity benchmarks are also increasingly reflected in government policy frameworks. In contrast to demand-side initiatives, government standards often rely on methodologies developed independently at the national or regional level rather than directly adopting international benchmarks.
- The European Union's Carbon Border Adjustment Mechanism (CBAM) applies benchmarks derived from the EU Emissions Trading System (EU ETS), imposing carbon costs on emissions that exceed benchmark levels. In the United States, California's Buy Clean California public procurement policy establishes product-specific carbon-intensity thresholds based on average emissions levels in the domestic steel industry and uses these thresholds as eligibility criteria for public construction projects.
- A summary of carbon-intensity benchmarks that are currently applied, or expected to be applied, to steel procurement and imports across major jurisdictions and initiatives is presented in Table 1.

Table 1. Examples of Carbon-intensity Benchmarks Applied to Steel Procurement and Imports

	Gv't/ Org'	Scheme	Estimated annual procurement volume	Carbon intensity benchmarks (tCO_2/t)	Emissions Scope	Year in Effect	Remarks
Gov't	EU	CBAM	3-4 million t[1)]	BF-BOF hot metal : 1.662[2)] EAF carbon steel: 0.215 EAF alloy steel : 0.268	Scope 1+2	2025	• Carbon border levy applies if benchmark exceeded
	CA (U.S.)	Buy Clean California	Not disclosed	Sections : 1.83 Plates : 1.59 Hot rolled coils : 1.08	Scope 1+2	2025	• Non-compliance disqualifies bidders
Private	SteelZero		6-7 million t[3)]	Crude steel : 0.35~2.0 (ResponsibleSteel Level 2, inverse to scrap share)	Scope 1+2 +upstream 3	2030	• 50% of total procurement
	FMC			Crude steel : 0.05~0.4 (IEA near-zero benchmarks, inverse to scrap share)	Scope 1+2 +upstream 3	2030	• 10% of total procurement

1) Average annual steel exports to the EU over the past three years

2) Sum of benchmarks for coke production (0.217), sintering (0.157), and hot metal production (1.288)

3) Conservative estimate based only on the top three FMC steel-consuming members

- The First Movers Coalition applies the most stringent carbon-intensity thresholds, but only to 10 percent of total steel procurement. This approach is intended to create a strong signaling effect that accelerates early market formation for near-zero steel. SteelZero, by contrast, applies less stringent thresholds than FMC but commits to applying them to a much larger share—50 percent—of total steel procurement, reflecting an emphasis on large-scale, system-wide transition.
- Government benchmarks tend to reflect prevailing technological conditions more closely than private demand initiatives. The EU's benchmarks are effectively set at the performance level of the top 10 percent of producers, while California's Buy Clean thresholds are based on domestic industry averages. These approaches are designed to encourage competition among producers while remaining grounded in existing industrial capabilities.

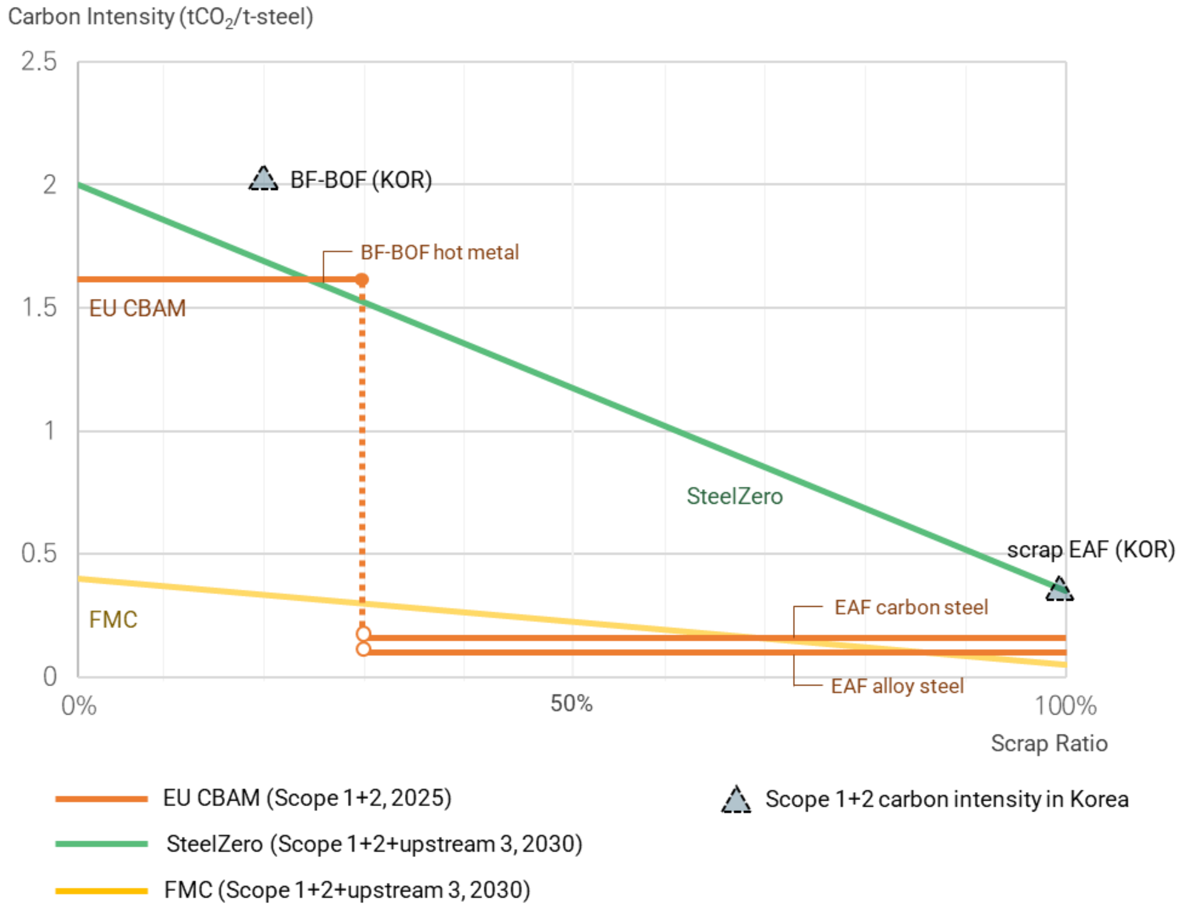
4. Suggested Range of Low-Carbon Steel Technologies for Korea's Steel Industry

1) The Gap between Global Demand-Side Standards and Domestic Production Routes

- From the perspective of steel producers, the most immediate low-carbon steel markets to target are those in which major demand-side buyers and global procurement initiatives have explicitly articulated carbon-intensity requirements. Korea's definition of low-carbon steel must therefore meet at least these minimum thresholds. Otherwise, the K-Steel Act risks remaining a declaratory framework that fails to deliver meaningful industrial transition outcomes.
- Figure 3 compares the carbon-intensity benchmarks required by key low-carbon steel demand-side initiatives with the carbon intensity of steel currently produced through domestic production routes. [5]

[5] California's public procurement market is not included in this analysis, as its overall scale and the scope of policy application have limited direct implications for Korean steelmakers.

Figure 3. Comparison of Carbon-intensity Benchmarks set by Low-carbon Steel Demand-side Initiatives and Domestic Production Routes



Note 1. For domestic BF-BOF production, the scrap input ratio is indicated at 20 percent, reflecting the typical range of 15–20 percent.
Note 2. Following the IEA classification, crude steel with a scrap input ratio of up to 30 percent is categorized as primary steel, while steel with a higher scrap share is categorized as secondary (scrap-based) steel. Accordingly, EU CBAM benchmarks for BF-BOF hot metal are shown only for scrap shares below 30 percent, and EAF benchmarks only for scrap shares above 30 percent.
Note 3. Under EU CBAM, EAF steel is differentiated between carbon steel and alloy steel, and is presented accordingly in the chart.

- The average carbon intensity of crude steel produced via the BF-BOF route in Korea is approximately 2.1 tCO_2 per tonne of steel (Scope 1+2) [6], which falls well short of the thresholds required by low-carbon steel demand-side initiatives. In contrast, scrap-based EAF production achieves carbon intensities of

[6] POSCO (2024)

approximately 0.3 tCO_2 per tonne of steel (Scope 1+2) [7]. However, because upstream Scope 3 emissions have not been fully verified, it cannot be conclusively determined whether such production would meet SteelZero's 2030 procurement criteria (indicated by the green line in Figure 3).

- These comparisons indicate that Korea's core product portfolio, which is largely based on BF-BOF production of high-grade steel, is currently unable to access low-carbon steel markets. At a minimum, Korean steelmakers must meet SteelZero's procurement thresholds by 2030 in order to retain market access.

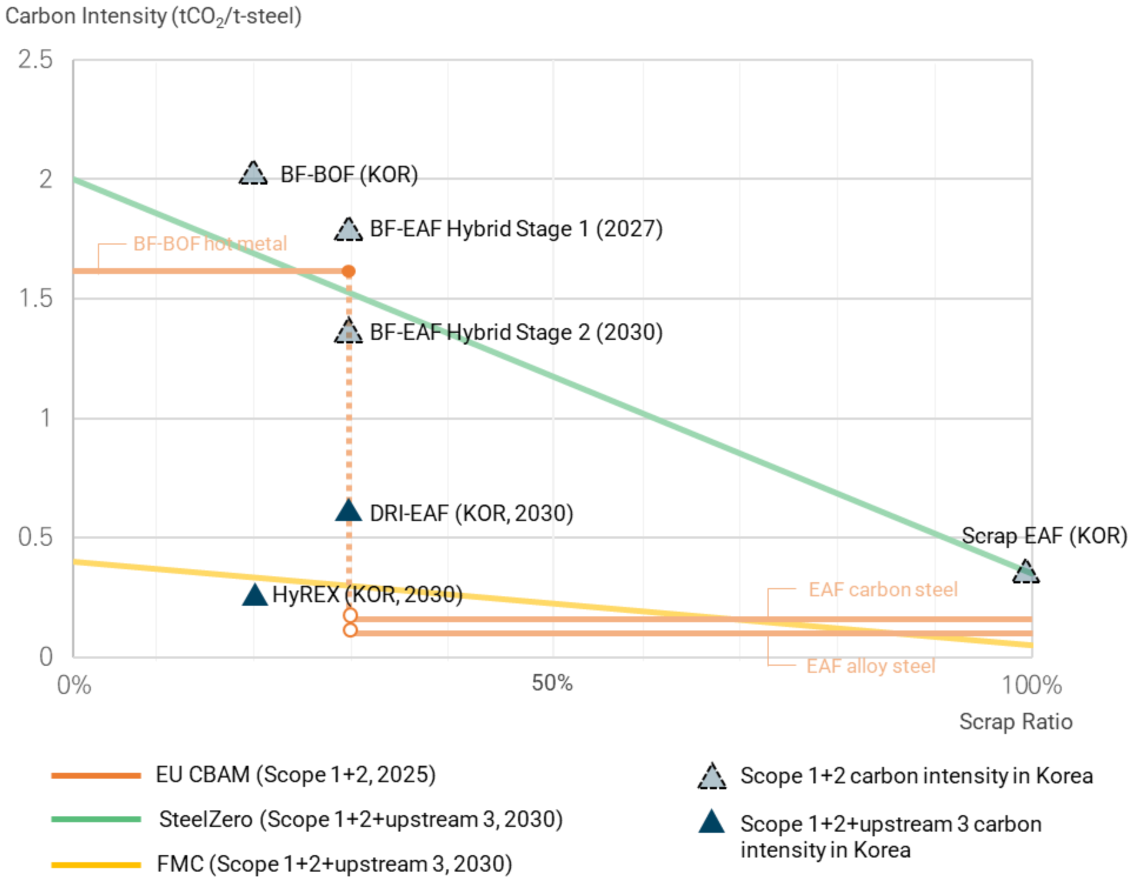
2) Carbon-Intensity Analysis of Decarbonization Technologies Applicable in Korea by 2030

- The major decarbonization technologies that are either currently under consideration in Korea or have a high likelihood of being commercially deployable by 2030 are the blast furnace–electric arc furnace (BF-EAF) hybrid route, POSCO's hydrogen-based HyREX process, and the DRI-based electric arc furnace (DRI-EAF) route[8]. Each technology exhibits a different level of emissions-reduction potential, and a comparison with international benchmarks is presented in Figure 4.

[7] Dongkuk Steel (2023)

[8] The DRI–EAF route is assessed on the basis of gas–based DRI that is already commercially traded. Hydrogen–based DRI produced using green hydrogen is excluded due to its very low likelihood of commercial availability by 2030. The scrap–EAF route is also excluded, as it faces technical limitations in producing high–grade steel for applications such as automotive and shipbuilding.

Figure 4. Carbon Intensity of Decarbonization Technologies Applicable in Korea Compared with International Benchmarks



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Note 3. Under EU CBAM, EAF steel is differentiated between carbon steel and alloy steel, and is presented accordingly.

Sources: Domestic BF-EAF hybrid routes (Stages 1 and 2) – Cho (2024); Domestic DRI-EAF and HyREX – Ko (2024)

Table 2. Comparison of Carbon Intensity of Decarbonization Technologies Applicable in Korea with International Benchmarks

	BF-EAF hybrid (Stage 1)	BF-EAF hybrid (Stage 2)	HyREX	DRI-EAF
EU CBAM	X	△	O	O
SteelZero	X	△	O	O
FMC	X	X	O	X

O: Meets benchmark; △: Uncertain; X: Does not meet benchmark

- The BF-EAF hybrid route (Stage 1), which involves charging molten steel produced in an electric arc furnace into a basic oxygen furnace, can reduce carbon intensity to approximately 1.8 tCO_2 per tonne of steel (Scope 1+2) [9]. While this represents an improvement relative to conventional BF-BOF production, it does not meet the carbon-intensity thresholds required by low-carbon steel demand-side initiatives. Under EU CBAM, steel produced via this route would still be subject to carbon border adjustment costs. Hyundai Steel plans to commence commercial production using this route at a scale of approximately 4 million tonnes per year beginning next year.

- The BF-EAF hybrid route (Stage 2), which is targeted for commercialization by 2030, involves charging hot metal produced in a blast furnace into an electric arc furnace. This route can reduce carbon intensity to approximately 1.4 tCO_2 per tonne of steel (Scope 1+2) [10]. While this approaches the thresholds required by SteelZero, compliance remains uncertain depending on upstream Scope 3 emissions [11]. In addition, benchmark tightening under the EU ETS Phase IV is likely, meaning that CBAM-related cost exposure may persist. Although this route offers significant infrastructure cost advantages by utilizing existing blast furnaces and EAFs, the risk of falling short of international low-carbon steel benchmarks remains.

- POSCO's HyREX process, assuming first production in 2030 and hydrogen supplied via nuclear-powered alkaline electrolysis, could achieve a carbon intensity of approximately 0.26 tCO_2 per tonne of steel (Scope 1+2 plus upstream Scope 3, assuming a 20 percent scrap input) [12]. This level meets even the near-zero steel benchmarks pursued by the First Movers Coalition. In this scenario, all electricity consumed domestically is assumed to be sourced from renewable energy through power purchase agreements. HyREX offers advantages in terms of technological sovereignty and raw material flexibility, as it can utilize lower-grade iron ore. However, it requires a sustained supply of large volumes of clean hydrogen[13], and its cost competitiveness is significantly weaker than that of alternative technologies.

- Under the DRI-EAF route, crude steel is produced by melting a mix of 70 percent gas-based DRI and 30 percent scrap in an electric arc furnace. In this case, Scope 1 and 2 emissions are estimated at approximately 0.16 tCO_2 per tonne of steel, while total emissions including upstream Scope 3 are projected at around 0.64 tCO_2 per tonne of steel[14]. As with HyREX, domestic electricity consumption is assumed to be fully supplied through renewable energy PPAs. While this route does not meet the First Movers

[9] Cho, S. (2024)

[10] Cho, S. (2024)

[11] No publicly available data currently provide a reliable estimate of upstream Scope 3 emissions for Korean steel producers.

[12] Estimated by NEXT group

[13] Supporting 46 million tonnes of BF–BOF steel production in 2024 would require approximately 2.2 million tonnes of hydrogen (at 48 kg H_2 per tonne of steel), a volume comparable to Korea's total annual hydrogen production of 2.48 million tonnes.

[14] Ko, E. (2024)

Coalition's near-zero steel benchmarks, it can reliably satisfy most low-carbon steel procurement standards, making it advantageous for maintaining export competitiveness. Nevertheless, successful deployment will require the establishment of a DRI import supply chain and further advancement of EAF refining technologies.

3) The Need for a Portfolio Approach to Low-Carbon Steel Technologies

- The key policy question, then, is how the government should define and combine low-carbon steel technologies going forward. As discussed above, the BF-EAF hybrid route (Stage 2), HyREX, and DRI-EAF are the major technologies that are realistically deployable in Korea by 2030, each with distinct emissions-reduction potential and cost structures. Given the technological and economic uncertainties associated with each pathway, relying on a single technology route would entail significant risk. A portfolio-based approach that considers multiple technology pathways based on their respective characteristics and feasibility is therefore required.
- The BF-EAF hybrid route offers relatively high cost efficiency among low-carbon steel options due to its ability to leverage existing infrastructure. However, its emissions-reduction potential is limited, and there remains a risk that it will fail to meet the carbon-intensity thresholds required by demand-side buyers.
- HyREX, by contrast, is capable of producing steel with very low carbon intensity, but its levelized cost of steel production (LCOS) [15] is more than 50 percent higher than that of the DRI-EAF route (see Table 3 and Figure 5). In addition, HyREX requires a continuous supply of large volumes of clean hydrogen. Nevertheless, it is the only hydrogen-based direct reduction process in the world capable of using low-grade iron ore, giving Korea a unique opportunity to secure technological sovereignty.

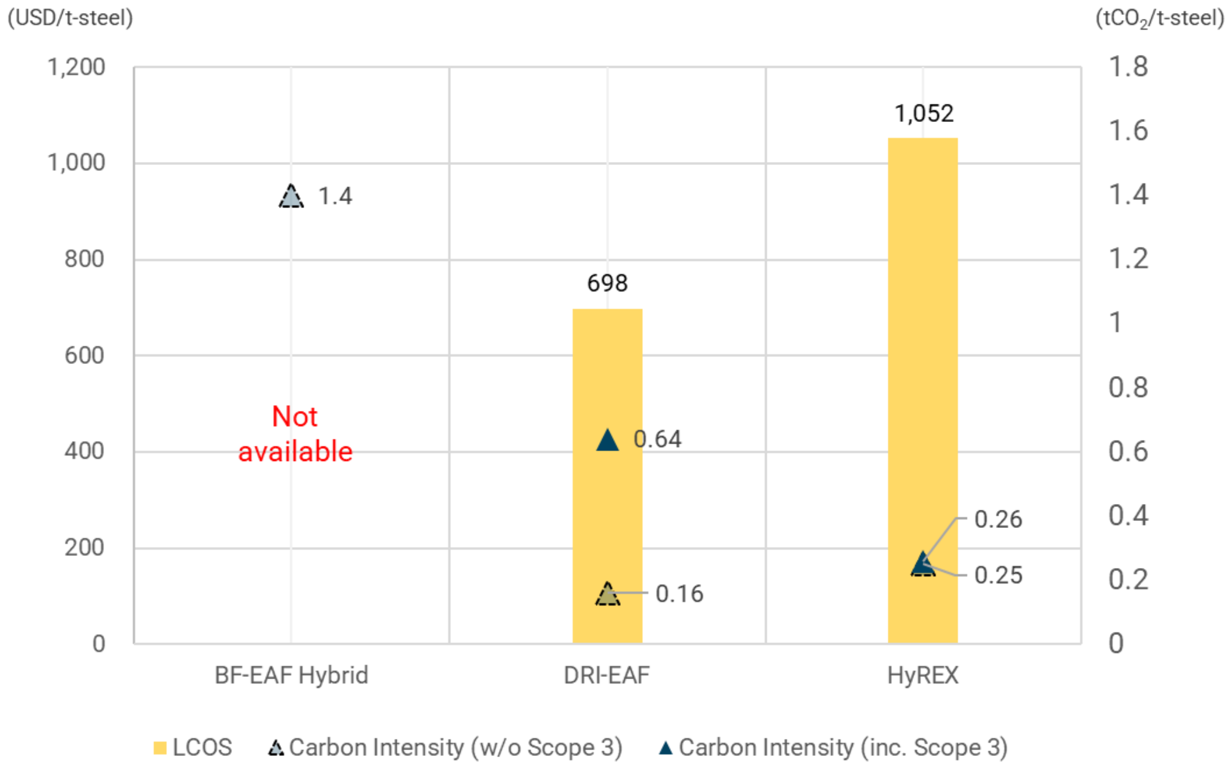
[15] This refers to the average unit cost of steel production, calculated by dividing the total costs incurred over the full lifetime of steel production facilities—including capital expenditures, fuel costs, operating expenses, and maintenance costs—by the total volume of steel produced over the same period.

Table 3. Comparison of Candidate Low-Carbon Steel Technologies

Technology	Carbon Intensity[3] (w/o Scope3) (tCO_2/t-steel)	Carbon Intensity[3] (inc. Scope3) (tCO_2/t-steel)	LCOS[2] (USD/t-steel)
BF-EAF Hybrid [1]	1.80(Stage 1) 1.40(Stage 2)	Not available	Not disclosed
DRI-EAF	0.16	0.64	698
HyREX	0.25	0.26	1,052

[1] Hyundai Steel
[2] Estimated by NEXT group. Key assumptions are provided in the Annex.
[3] Carbon intensity values are based on 2030 assumptions.

Figure 5. Comparison of LCOS (left axis) and Carbon Intensity of Candidate Low-Carbon Steel Technologies (right axis)



- This omission is notable because gas-based DRI is already commercially traded on international markets, allowing for rapid scale-up once sufficient EAF capacity is available domestically. As such, DRI-EAF offers a practical means of accelerating entry into low-carbon steel markets. Incorporating DRI-EAF into Korea's low-carbon steel technology portfolio would not only reduce dependence on a single technology pathway centered on HyREX, but also help offset HyREX's cost disadvantages in the near to medium term. Given its balance of cost efficiency and feasibility, DRI-EAF should be positioned as a core pillar of Korea's medium-term transition strategy, complementing a HyREX-centered long-term vision.

5. The Role of the K-Steel Act in Enabling Market Entry for Low-Carbon Steel

- The central role of the K-Steel Act is to provide clear and credible technological direction that enables Korean steelmakers to enter low-carbon steel markets at an early stage. In a market that has yet to be dominated by first movers, Korea possesses the technological capability, capital base, and policy capacity to secure a leading position.
- Skepticism remains as to whether the low-carbon steel market will materialize rapidly. However, given the escalating impacts of climate change—including increasingly frequent extreme weather events, rising sea temperatures, and disruption of agricultural and fisheries ecosystems—it is highly unlikely that the direction of industrial activity toward emissions reduction will be reversed. Even if market uptake proceeds gradually, the transition toward low-carbon steel is irreversible.
- The K-Steel Act must therefore function as an institutional framework that removes compliance uncertainty on the production side, clarifies investment direction, and encourages timely transition. Without clear definitions and standards, firms risk investing in capital-intensive facilities with uncertain emissions-reduction outcomes and demand prospects, potentially resulting in stranded assets. Establishing a clear definition of what constitutes low-carbon steel is the starting point for a viable new industrial strategy.
- In addition, the K-Steel Act should form a core pillar of the government's forthcoming K-Green Transformation (K-GX) comprehensive plan. The government has announced its intention to develop the K-GX framework by the first half of next year as a central strategy for achieving the 2035 Nationally Determined Contribution (NDC) target and positioning carbon neutrality as a driver of industrial growth[16]. The plan is expected to focus on scaling up key green industries, including solar and wind power, power grids, energy storage systems, electric vehicles, and batteries.
- Low-carbon steel must be designed as an integral component of this broader framework. By ensuring alignment with national investment strategies for power grids, hydrogen infrastructure, and related systems, the K-Steel Act can maximize synergies with other industrial sectors and establish low-carbon steel as a foundational element of Korea's green industrial transition.

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[16] Ministry of Climate, Energy, and Environment (2025.11)

Appendix. Key Assumptions for the Levelized Cost of Steel Production (LCOS) Analysis of Low-Carbon Steel Technologies

- Assumption 1: For the DRI–EAF route, gas-based DRI produced in Saudi Arabia is imported and melted in domestic electric arc furnaces.
- Assumption 2: For the HyREX route, hydrogen is produced via alkaline electrolysis powered by nuclear electricity.

Table 4. Key Assumptions Used in the LCOS Analysis

Category	Item	Unit	Value	Notes and Sources
CAPEX	DRI-EAF	USD/t-steel	46	Based on Scrap-EAF CAPEX values. IEA (2020a)
	HyREX (excluding electrolysis)	USD/t-steel	281	Based on Hüttel & Lehner (2024), assuming a greenfield project; infrastructure CAPEX increased by a factor of ~2.3 (POSCO interviews, 2025)
	AEC electrolyzer	USD/t-steel	73	US DOE (2022), assuming greenfield deployment; infrastructure CAPEX increased by a factor of ~2.3 (POSCO interviews, 2025)
	Efficiency	kWh/kgH_2	51	US DOE(2022)
	Utilization rate	%	90	US DOE(2022)
	DRI input	tDRI/t-steel	1.2	Assumes 100% DRI charging rate. IEA (2020a)
	H_2 input	kgH_2/tDRI	48	IEA(2020b)
Fixed OPEX	DRI-EAF	USD/t-steel	43	Based on Scrap-EAF OPEX values. IEA (2020a)
	HyREX (excluding electrolysis)	USD/t-steel	60	Nurdiawati et al.(2025)
	AEC electrolyzer	USD/t-steel	7	Assumes stack replacement every 60,000 operating hours
	Stack lifetime	hours	60,000	
	Replacement cost	% of CAPEX	11	US DOE(2024)
Feedstocks	Iron ore fines (62% Fe)	USD/t	120	CFR main China port, 62% Fe
	Iron ore fines (68% Fe)	USD/t	161	CFR 62% Fe price + 2% Fe premium
	BF pellets (65% Fe)	USD/t	175	CFR 62% Fe price + BF pellet premium
	DR pellets (68% Fe)	USD/t	194	CFR 62% Fe price + DR pellet premium
	Scrap	USD/t	328	Weighted average: domestic scrap (78%) + imported scrap (22%)

	Gas DRI	USD/t	421	Assumes imports from Saudi Arabia in 2025
	Nuclear-based H^2	KRW/kWh	4,075	Based on nuclear settlement price of 79.9 KRW/kWh (Jan–Apr 2025) and electrolyzer efficiency of 51 kWh/kgH_2
Fuel	Electricity price	KRW/kWh	195.3	Estimated PPA price for domestic solar power (NEXT group estimate)
	Natural gas price	USD/MJ	0.012	Average LNG import price, 2019–2023
Exchange rate		KRW/USD	1,256	Average exchange rate, 2020–2024

References

Korean Literature

Ahn, J., & Kim, G. (2024). *A Study on Expanding the Domestic Clean Hydrogen Production Base.* Korea Energy Economics Institute.

Cho, S. (2024). *Hyundai Steel's Insufficient Decarbonization Roadmap and the Risk of Delaying Hyundai Motor's Carbon Neutrality.* Solutions for Our Climate.

Ko, E. (2024). *Net-Zero Roadmap and Strategy for Korea's Steel Industry II: Five-Year Strategy for Achieving a 1.5°C Pathway.* NEXT group.

International Literature

European Commission. (2023). STEGRA: welcoming a new era of green steel production. European Commission. Accessed at https://cinea.ec.europa.eu/featured-projects/stegra-welcoming-new-era-green-steel-production_en

Gallucci. (2025). Sweden's Stegra to supply green steel for Microsoft's data centers. Canary Media. Accessed at https://www.canarymedia.com/articles/green-steel/stegra-microsoft-data-center-deal

GSCC. (2024). The Steel Climate Standard.

Huttel and Lehner. (2024). Revisiting Investment Costs for Green Steel: Capital Expenditures, Firm Level Impacts, and Policy. German Institute for Economic Research.

IEA. (2020a). Iron and Steel Technology Roadmap.

IEA. (2020b). IEA G20 Hydrogen report: Assumptions.

IEA. (2022). Achieving Net Zero Heavy Industry Sector in G7 Members.

Nurdiawati et al. (2025). Prospective environmental and economic assessment of green steel production in the Middle East.

ReponsibleSteel. (2024). ResponsibleSteel International Production Standard. Version 2.1.1.

Sameen (2025.11.18). Empowering demand-side leadership. Climate Group. Decarbonizing the Steel Industry Global Approaches and Japan's Challenges [seminar].

Stegra. (2023). Mercedes-Benz and H2 Green Steel announce agreements in both Europe and North America. Stegra. Accessed at https://stegra.com/news-and-stories/mercedes-benz-and-h2-green-steel-announce-agreements-in-both-europe-and-north-america

Theuringer et al. (2025). Rulebook for the classification system of the Low Emission Steel Standard (LESS).

US DOE. (2022). Technical Targets for Liquid Alkaline Electrolysis. Accessed at https://www.energy.gov/eere/fuelcells/technical-targets-liquid-alkaline-electrolysis

Volvo Cars. (2024). Volvo Cars position on sustainable steel.