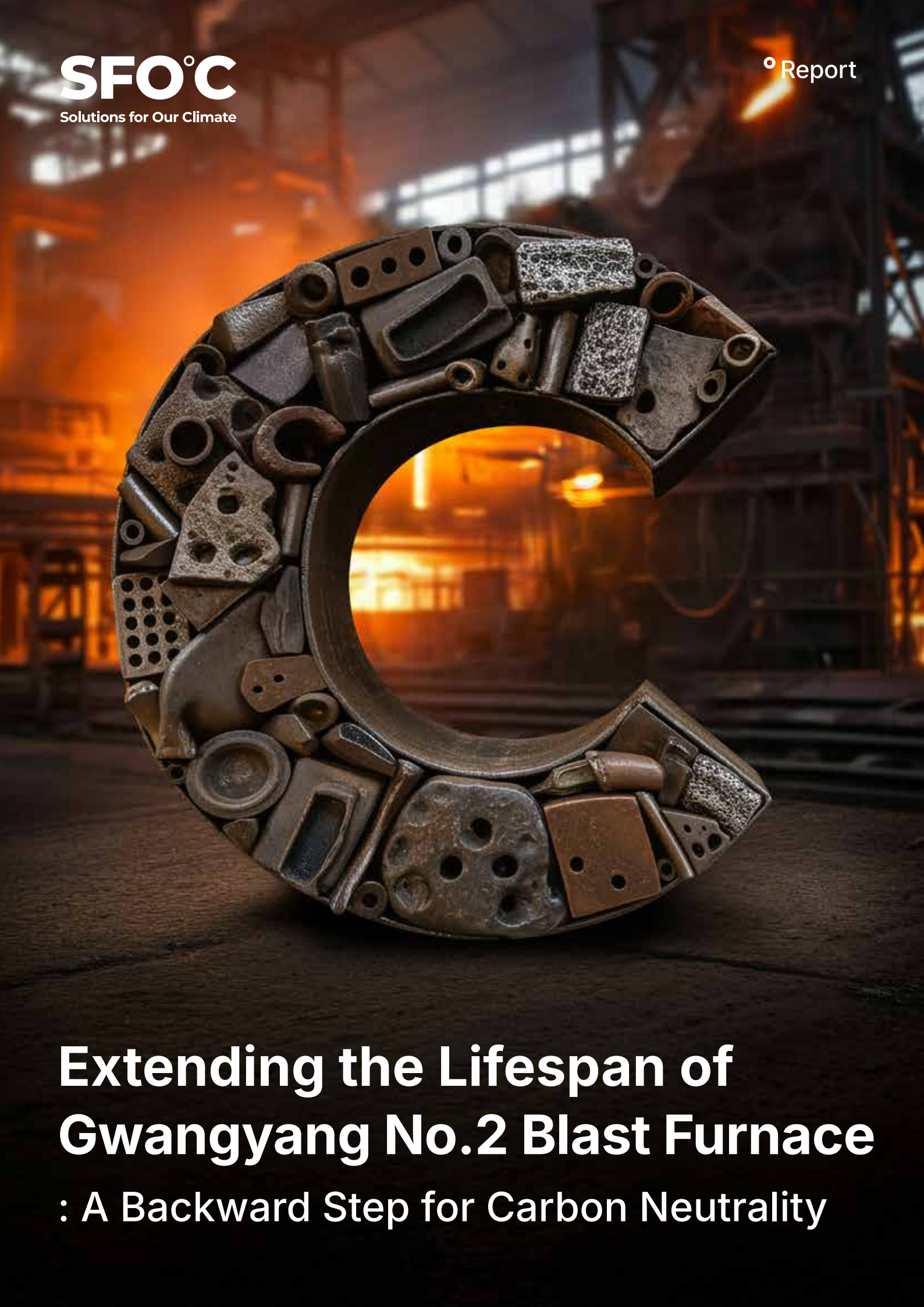
SFO°C
Solutions for Our Climate

° Report



Extending the Lifespan of Gwangyang No.2 Blast Furnace

: A Backward Step for Carbon Neutrality

SFO°C

Extending the Lifespan of Gwangyang No.2 Blast Furnace:

A Backward Step for Carbon Neutrality

Publication Date	**October 2024**
Writers	**Haebin Gahng** | Solutions for Our Climate **Yeongmin Kweon** | Solutions for Our Climate
Modeling Advisor	**Sanghyun Hong** | PLANiT
Design	**sometype**

Solutions for Our Climate (SFOC) is an independent nonprofit organization that works to accelerate global greenhouse gas emissions reduction and energy transition. SFOC leverages research, litigation, community organizing, and strategic communications to deliver practical climate solutions and build movements for change.

Extending the Lifespan of Gwangyang No.2 Blast Furnace: A Backward Step for Carbon Neutrality

TABLE OF CONTENTS

Executive Summary

- POSCO has pledged to reduce carbon emissions by 10% from its baseline by 2030. However, the extension of the lifespan and the suspected expansion of the Gwangyang No. 2 blast furnace, which began this year, could increase the required reductions to as much as 12.505 million tonnes.

- According to scenarios examining the remaining carbon budget (allowable carbon emissions) for the Korean steel industry to meet the 1.5°C target, four coal-based blast furnaces need to be shut down by 2030. The Korean steel industry will risk depleting its carbon budget very soon if it fails to begin phasing out these facilities immediately.

- The relining of the Gwangyang No. 2 blast furnace signals an intention to continue emitting huge volumes of carbon for at least another 15 years. This will clearly undermine not only Korea's national emissions reduction goals and its commitment to the internationally agreed-upon 1.5°C target, but also POSCO's own carbon-neutral roadmap. In addition, the decision to reline the blast furnace risks exacerbating the global surplus of steel and hindering the efforts to meet the rising global demand for green steel.

- Instead of investing in maintaining coal-based steelmaking, POSCO should prioritize transitioning to green steel. The company should also implement the following measures to demonstrate its commitment to decarbonization:

    - Transparently disclose reduction alternatives and quantitative reduction plans for the period leading up to the commercialization of hydrogen-based direct reduction ironmaking (H_2-DRI).

    - Stop the ongoing relining of the Gwangyang No. 2 blast furnace, as it does not align with achieving the global 1.5°C target and carbon neutrality, and declare its immediate shutdown.

    - Incorporate a clear plan for the phased shutdown of all blast furnaces within the carbon neutrality roadmap.

01 Reline of No. 2 Blast Furnace at POSCO's Gwangyang Steelworks

1.1 Background and current status

☑ POSCO's continuous relining that proudly extends the lifespan of coal-based blast furnaces

Despite concerns raised domestically and internationally[1] about relining coal-based blast furnaces, POSCO decided to reline the No. 4 blast furnace at its Pohang steelworks. Upon completing the relining in June 2024, POSCO celebrated the recommissioning of the mega-sized coal-based steelmaking facility, which will emit massive volumes of carbon for the next 15 years. The relined furnace, which had accumulated at least 315 million tons of emissions, was promoted with the implementation of a smart furnace system designed to enhance durability and stability, increase efficiency, and reduce costs.[2] However, POSCO has not mentioned any measures or systems to reduce carbon emissions. The company, believing that coal-based blast furnaces will secure its future and enable it to thrive for the next few decades, has instead initiated yet another relining.

1.2 Is the relining of the Gwangyang No. 2 blast furnace a prelude to expanding coal-based steelmaking?

☑ The relining restarted two years after an indefinite postponement

The relining of the No. 2 blast furnace at POSCO's Gwangyang Steelworks was first mentioned in its 2019 Annual Report disclosed on the Data Analysis, Retrieval, and Transfer System (DART) system of the Financial Supervisory Service (FSS) in March 2020. The first contract was concluded

1 Hansbrough, M., et al. (2023). SteelWatch, Hovenier, J. (2023). BankTrack

2 150 million tonnes of cumulative molten iron production of Pohang No. 4 blast furnace x 2.1 CO_2e per metric ton of POSCO's carbon intensity from Cho, E. (2024, June 27). Pohang No. 4 Furnace Recommissioned as a Smart Blast Furnace. *Financial News*.

approximately two and a half years prior to the Pohang No. 4 blast furnace (the first contract started in October 2021 and ended in July 2022 and totaled USD 162.96 million KRW 220 billion). However, the contract period was changed three times, and the project was indefinitely postponed according to the 2021 Q3 Report published in November 2021; both the contract start and end dates were left to be determined.

☑ The relining of the Gwangyang No. 2 blast furnace, with initial work already underway, is expected to be completed in the first half of next year

The 2023 Annual Report, released in March 2024, specified the contract period for the Gwangyang No. 2 blast furnace (January 2024 to August 2025), which had been pending for over two years. It also disclosed details of a supply contract worth USD 22.22 million KRW 30 billion for the refractories required for the furnace reline. In the 2024 Semi-Annual Report, the contract amount was revised to USD 187.41 million KRW 253 billion, with USD 22.22 million KRW 30 billion for the refractory order, bringing the total relining budget to USD 209.63 million KRW 283 billion. Initial relining has already begun, at a cost of USD 2.54 million KRW 3.425 billion, or 1.2% of the total budget. Although no spending has been reported on the refractory manufacturing budget yet, a full-scale relining of the No. 2 blast furnace in Gwangyang is expected to start four months ahead of its scheduled completion in August 2025, given the contract and relining timeline of the recently relined No. 4 blast furnace in Pohang.

High refractory replacement costs with suspected expansion of the blast furnace

The Gwangyang No. 2 blast furnace has an annual production capacity of 4.35 million tonnes, approximately 78% of the 5.6-million-tonne-capacity of the Pohang No. 4 blast furnace. However, its refractory replacement cost is set at USD 22.22 million KRW 30 billion, nearly equivalent to the USD 24 million KRW 32.4 billion required for the Pohang No. 4 blast furnace. This suggests that the relining of the Gwangyang No. 2 blast furnace may involve an expansion to the scale of the ultra-large No. 4 blast furnace at Pohang steelworks.[3]

The budget for the third reline of the Pohang No. 4 blast furnace was gradually increased from the initial contract amount of USD 148.15 million KRW 200 billion disclosed in 2022. The total investment was reported to be USD 392.59 million KRW 530 billion after 16 months of relining work.[4] Given that a total budget of USD 209.63 million KRW 283 billion has been allocated for the Gwangyang No. 2 blast furnace, which has a lower annual production capacity than the Pohang No. 4 furnace—which has a lower annual production capacity than the Pohang No. 4 furnace—it likely involves an expansion and incorporates technologies to improve efficiency and other factors. If this is the case, the total budget may exceed USD 392.59 million KRW 530 billion.

3 Seo, D (2020, May 21). *Maeil Business Newspaper.*

4 Cho, Y. (2024, June 27). *Maeil Business Newspaper.*

02 Why Should the Gwangyang Blast Furnace Relining Be Stopped?

2.1 Emission caps of the Korean steel industry to achieve the global target of 1.5°C

Carbon Budget

What is a carbon budget?

A carbon budget is the quantified limit of carbon dioxide emissions that the world can produce to keep the increase in average global temperature within a certain threshold, compared to pre-industrial levels. The United Nations Intergovernmental Panel on Climate Change (IPCC) calculates carbon budgets based on various scenarios, taking into account cumulative emissions, projected future emissions, and other human activities. These budgets serve as guidelines for setting fair and effective reduction targets for greenhouse gas emissions.

Carbon budgets are typically presented as 'remaining carbon budgets', which indicate the maximum amount of carbon dioxide that can be emitted from a specific point in time onward. When calculating the remaining carbon budget, emissions already released up to that point are considered. The budget varies depending on the target temperature and the likelihood of achieving it. For instance, if there is a high probability of limiting the temperature rise to 1.5°C or lower, the remaining carbon budget decreases. To the contrary, if the target is set to 2°C, the permissible emissions increase, causing the remaining carbon budget to rise.

Key to achieving the 1.5°C target: Reasonable management and allocation of the carbon budget

The international community has committed to limiting the rise in global average temperature by no more than 1.5°C compared to pre-industrial levels for the sustainable future of humanity. This target was formalized in the 2015 Paris Climate Agreement as a commitment by countries to prevent severe damage caused by climate change. Research indicates that exceeding this threshold increases the probability of irreversible catastrophic consequences, such as sea level rise, extreme climate events, and ecosystem collapse. Therefore, the 1.5°C target is not just a declaration but an international commitment that must be carried out, with Korea also taking responsibility for achieving it.

If the remaining carbon budget to curb the increase in global average temperature to 1.5°C or lower is fully depleted, the likelihood of failing to meet the target will increase, and extreme climate events will worsen. It is essential to allocate the limited resource of the remaining carbon budget across countries based on reasonable criteria, and then allocate it by sector within each country to effectively control emissions. This will ensure that the carbon budget is not exceeded, which is crucial for achieving the 1.5°C target.

Fairness concerns could arise if the steel industry exceeds its carbon budget

When carbon budgets are allocated by sector according to certain standards, exceeding the allotment from one sector encroaches on the carbon budget available for other industries, raising fairness concerns. In this study, the carbon budget was allocated by sector on sector-specific greenhouse gas emissions and energy consumption. This led to a greater percentage of the carbon budget being allocated to the steel industry, the largest greenhouse gas emitter in Korea. If the steel industry exceeds its carbon budget, it will not only make achieving the global 1.5°C target more difficult but also require other industries to make greater emissions

reductions. This could result in imbalance across the overall economy and raise fairness issues across industries.

☑ The remaining carbon budget for the Korean steel industry to achieve the 1.5°C target: 550 $MtCO_2e$

The IPCC estimates the remaining global carbon budget to meet the 1.5°C target with a probability of 50%, at approximately 500 billion tonnes of carbon dioxide (500 $GtCO_2$) as of January 2020.[5] Exceeding this limit would make it difficult to keep the rise in global temperature within 1.5°C.

To estimate the carbon budget for the Korean steel industry in 2024, the global carbon budget for that year was first calculated using global emissions data from 2020 through 2023. Then, the carbon budget that can be allocated to Korea was determined by considering the emissions and population of each country. Finally, industry-specific carbon emissions and energy consumption data were used to calculate the budget allotment for the Korean steel industry. As a result, the **estimated remaining carbon budget allocated to Korean steelmakers for 2024 is 550 $MtCO_2e$.**[6]

☑ Modeling outcomes for blast furnace shutdown based on the carbon budget

Scenarios for shutting down steel production facilities in Korea were analyzed based on the estimated carbon budget allocated for the Korean steel industry. First, all possible combinations for shutting down the facilities were generated based on data on the production capacity, the dates of previous relining, and other relevant factors for the 11 blast furnaces owned by POSCO and Hyundai Steel, as well as two FINEX plants operated by POSCO.[7] The cumulative emissions for each combination were then calculated and compared to the target carbon budget, and the combination with cumulative emissions closest to, but not exceeding, the carbon budget was selected. In this process, uncertain factors, such as changes in Korea's future steel production and the timing of adopting low-

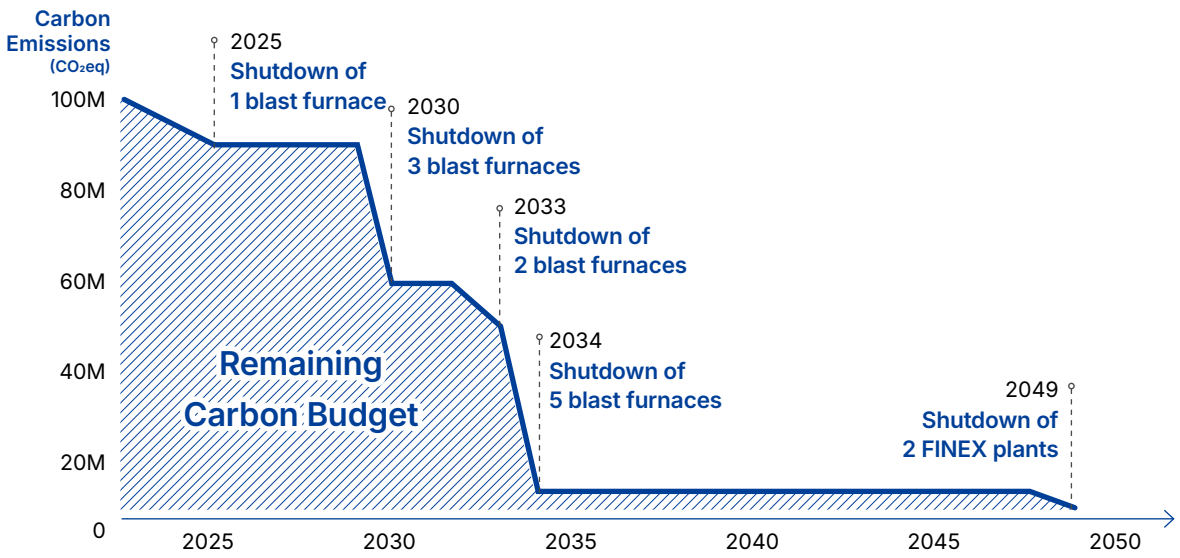
5 IPCC (2021)

6 Refer to [Appendix] at the end of this report for a detailed research methodology.

7 The potential closure date for facilities was set to the year of the latest relining (or the year of operation commencement for facilities without a reline). The final year of operation for each facility was set at 20 years after the last relining. Given that FINEX facilities could reduce carbon emissions to nearly half of those produced by blast furnaces, carbon intensity was included as a variable. For further details, see the Appendix.

carbon steel production technologies, including hydrogen-based direct reduction ironmaking (H_2-DRI), were excluded. The scenarios were based solely on current carbon emissions data from the steelmaking facilities.

Figure1 Path of the Korean Steel Industry Depleting the Carbon Budget

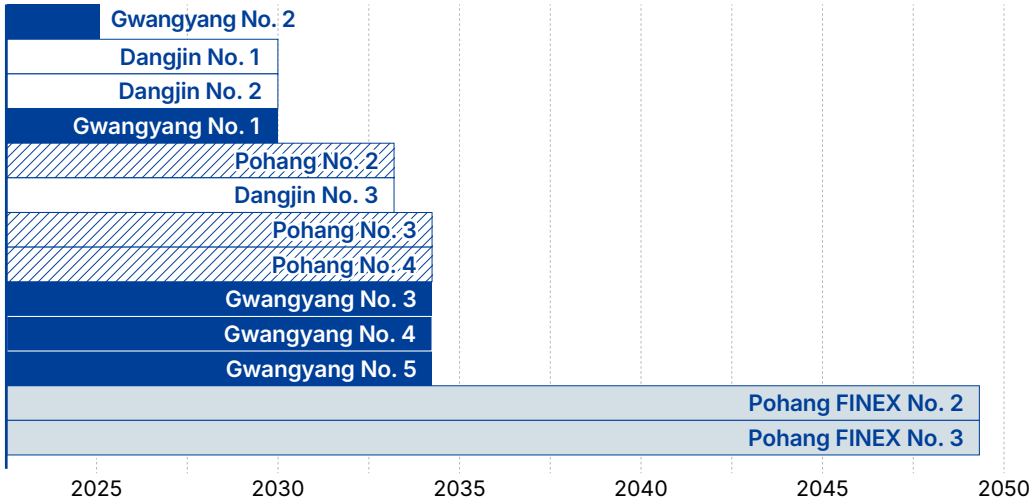


Source: Solutions for Our Climate (SFOC)

Among the various scenarios considered, only one achieves the 1.5°C target with a 50% probability. The graph in [Figure 1] illustrates annual carbon emissions, with the area beneath the graph representing the remaining carbon budget. At each point where the values change, carbon emissions must be reduced by decommissioning outdated furnace facilities. After 2034, carbon emissions from current facilities—in other words, steel production using existing coal-based facilities—will reach nearly zero.

The decommissioning timeline for each blast furnace based on these results is shown in [Figure 2].

Figure 2 The Sequence of Shutdown and Duration of Each Facilities according to the Scenario



Source: SFOC

According to the scenario, the shutdown process should begin with the Gwangyang No. 2 blast furnace in 2025, marking 20 years since its last relining. By 2030, Hyundai Steel's No. 1 and No. 2 blast furnaces, as well as POSCO's Gwangyang No. 1 blast furnace, should be closed. The decommissioning of Hyundai Steel's No.3 and POSCO's Pohang No. 2 blast furnaces should be followed in 2033, with all remaining five blast furnaces shut down in 2034, except for the two FINEX plants. This pathway is essential for adhering to the carbon budget and achieving the 1.5°C target. In other words, **all blast furnace facilities currently in operation should be phased out by 2035. Failure to implement these closures will inevitably lead to an early depletion of the Korean steel industry's carbon budget**.

Decision to reline the Gwangyang No. 2 blast furnace implies a lack of commitment to the 1.5°C target

These findings indicate that continuing steel production with the current level of carbon emissions maintained will lead to a sharp decrease in the amount of steel that can be produced over time, given the carbon budget allocated to the Korean steel industry. This highlights the need to accelerate the introduction of low-carbon steel production technologies to replace the existing high-carbon emission facilities through technology development, commercialization, and the transition to new facilities. Moreover, achieving the 1.5°C target requires not only shutting down blast furnaces nearing the end of their lifespans but also decommissioning certain facilities before they reach 20 years of operation. Thus, the decision to invest in extending the life of the Gwangyang No.2 blast furnace, rather than shutting it down, clearly demonstrates the steel industry's lack of commitment to achieving the 1.5°C target. Such a decision increases the likelihood of violating international carbon reduction commitments and suggests that the Korean steel industry may be underestimating the urgency of addressing climate change.

2.2 Impact on national and industrial reduction targets

Relaxed industry targets and conservative emissions reduction projection of the steel industry

In Korea's 2030 Nationally Determined Contribution (NDC), announced in 2021, the emissions target for the industrial sector was set at 222.6 million tonnes, reflecting a 14.5% reduction from the 2018 baseline. However, the National Master Plan for Carbon Neutrality and Green Growth announced in March 2023 adjusted this reduction target to 11.4%, resulting in a higher emissions target of 230.7 million tonnes. This adjustment allowed an additional 8.1 million tonnes of emissions for the industrial sector, which accounts for about 40% of national total emissions, indicating the government's intention to ease the reduction burden on this sector.

The emissions target for the steel industry in the government's 2023 announcement was set at 96.5 million tonnes, which appears more stringent than the 98.9 million tonnes announced in 2021 [Table 1]. However, this change is primarily due to a downward adjustment in projected steel production, which is used to calculate emissions targets. As a result, projected emissions decreased from 108.8 million tonnes to 101.9 million tonnes. Consequently, the total reduction from all mitigation measures was 5.4 million tonnes, significantly lower than 9.9 million tonnes planned in 2021. The steel industry now accounts for about 15% of Korea's total emissions, but if the current plan is implemented as it is, its share is expected to rise to 22.1% of the projected national total emissions of 436.6 million tonnes in 2030, making the steel industry an even greater emitter.

Table 1 **Comparison of Steel Industry's Reduction Targets for 2030 (2021 NDC vs 2023 Carbon Neutrality Master Plan)**

Unit: 1 million tonnes of CO_2e

		2021 Proposed Upward Adjustment of National Greenhouse Gas Emissions Target	2023 National Master Plan for Carbon Neutrality and Green Growth (Current)	Note (Reasons for Change)
Projected Emissions		108.8	101.9	Lowered emissions projection due to the downward adjustment of production forecasts
Target Emissions		98.9	96.5	Projected emissions – total reduction = target emissions
Reduction Amount	Transition of Fuels and Raw Materials	5.4	2.6	Excluding measures for conversion to an electric arc furnace, and adjusting the classification of reduction measures
	Improving Energy Efficiency	4.5	2.5	Measures remain the same, but some of their classifications are adjusted.
	Emissions Reduction from Steelmaking Processes	-	0.2	-
	Others	-	0.1	Adjustment in the classification of reduction measures
	Total	**9.9**	**5.4**	Adjustment in the classification of reduction measures

Source: Korea Institute for Industrial Economics & Trade (KIET), Research on Implementing NDC in Industrial Sector

☑ Key to reduction strategy: cutting emissions from processes;[8] breaking dependence on current reduction measures that have limited effectiveness

Reducing process emissions is essential to strengthening Korea's NDC, which is currently viewed as inadequate, allowing for a potential global temperature rise of 3 to 4°C.[9] It is also necessary to establish higher targets for the industrial sector. Relying on the transition of fuels and raw materials or improving energy efficiency merely to maintain coal-based blast furnaces will only yield limited effects. Therefore, reducing process emissions by introducing H_2-DRI and phasing out blast furnaces must be the primary strategy for emission reduction. Consequently, the ongoing extension of blast furnace lifespans—that is, delaying their shutdown—must be stooped be stopped.

2.3 Alignment with POSCO's Own Carbon Neutrality Roadmap

☑ 10% of base year emissions, with up to 12.505 million tonnes of reduction, may be required

POSCO, in line with its carbon neutrality roadmap, should reduce CO_2e emissions by 7.88 million tonnes, representing 10% of its baseline year emissions.[10] This is a significant amount, comparable to the annual emissions from a medium-to-large blast furnace or approximately three months of Denmark's total national greenhouse gas emissions in 2022. When accounting for additional emissions from a new electric arc furnace with a production capacity of 2.5 million tonnes, set to begin operation in 2026, the reduction target will increase **to approximately 9.88 million tonnes of CO_2e**[11]—comparable to Korean oil refining company S-Oil's 2022 emissions of 9.39 million tonnes. If POSCO proceeds with relining and expansion of the Gwangyang No. 2 blast furnace to an ultra-large scale, the total emissions reduction requirement by 2030 could rise to **up to 12.505 million tonnes**.[12]

8 Strategy of reducing direct emissions from production processes by means of implementing new technologies. Other reduction strategies include transitioning to low-carbon fuels and raw materials and raising energy efficiency.

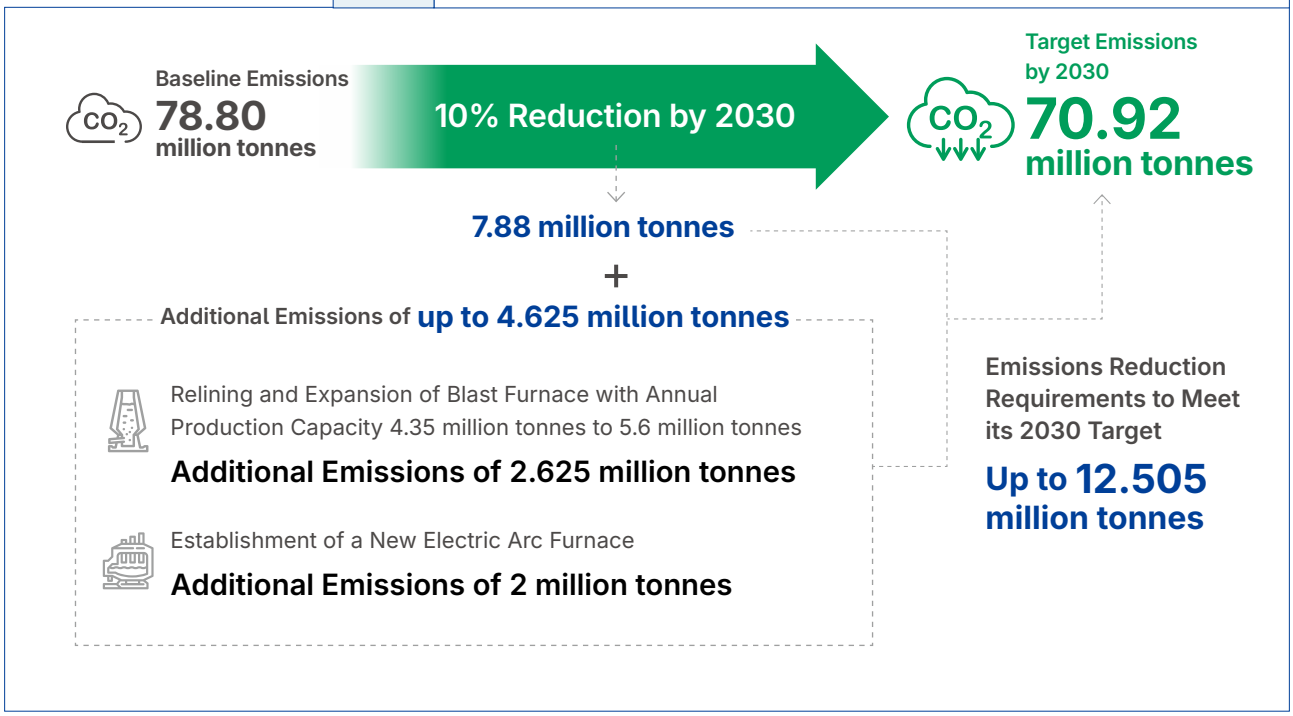
9 Climate Action Tracker, South Korea

10 POSCO's average CO_2e emissions from 2017 through 2019 totaled 78.8 million tonnes. To achieve net zero by 2050, POSCO should reduce the emissions 10% by 2030, 30% by 2035, and 50% by 2040.as a variable. For further details, see the Appendix.

11 (10% of 78.8 million tonnes of CO_2e of the baseline year) + (2.5 million tonnes x carbon intensity of an electric arc furnace of 0.8 CO_2e per metric ton) = 7.88 million tonnes + 2 million tonnes = 9.88 million tonnes of CO_2e.

12 Added 1.25 million tonnes of production (the additional production when the Gwangyang No. 2 blast furnace with annual production capacity of 4.35 million tonnes is relined and expanded to the scale of the Gwangyang No. 1 blast furnace with annual production capacity of 5.6 million tonnes) x 2.1 CO_2e per ton (blast furnace carbon intensity) = 262.5 CO_2e.

Figure 3 POSCO's Emissions Reduction Requirement to Meet the 2030 Target in its Carbon Neutrality Roadmap



Source: SFOC

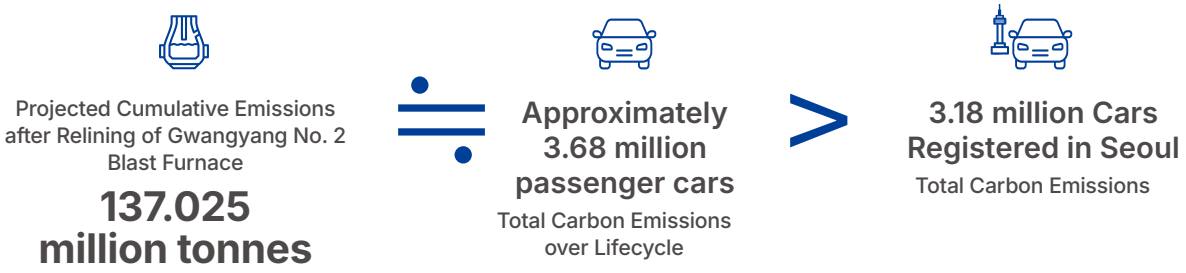
☑ Achieving the targets outlined in POSCO's carbon neutrality roadmap becomes less obtainable as the operational lifespan of the blast furnace is extended

Beyond 2030, the roadmap's target requires even greater reductions, aiming for 30% by 2035, 50% by 2040, and complete carbon neutrality by 2050. Yet, POSCO has not announced any specific details about projected reductions through the application of emissions reduction technologies to its existing facilities or plans to shut down its coal-based steelmaking operations. Extending the lifespan of the Gwangyang No. 2 blast furnace through relining is tantamount to building a new facility that would emit a cumulative 137.025 million tonnes of carbon over the next 15 years,[13] even without considering its expansion. It is approximately equivalent to the emissions generated by about 3.68 million passenger vehicles over their lifecycles, which exceeds the number of registered cars in Seoul.[14] This is a move that is contrary to the effort of reducing carbon emissions, making it challenging to adhere to the carbon neutrality roadmap, which requires a gradual reduction over the long term, and raises doubt about its feasibility.

13 4.35 million tonnes of annual production x 2.1 per metric ton of blast furnace carbon intensity x 15 years = 137.025 million CO_2e

14 Kang, et al., (2023). Greenpeace. Average emissions of an internal combustion engine passenger car over its lifecycle of 200,000 km is 37.2 tonnes, and there are 3.18 million registered in Seoul (as of August 2024).

Figure 4 Projected Cumulative Emissions after Relining of Gwangyang No. 2 Blast Furnace



Source: SFOC

A decision that is far from restoring steel competitiveness: The first of POSCO's Seven Future Innovation Challenges

In April 2024, POSCO Holdings unveiled its Seven Future Innovation Challenges at its Board of Directors' strategy session, with the primary goal of restoring steel competitiveness through a transition to low-carbon production to capture first-mover advantage.[15] This objective appears to be in response to increasing pressure from green trade barriers, notably the European Union's European Union's Carbon Border Adjustment Mechanism (CBAM), and the forecast increase in green steel demand.

As of September 2024, POSCO is requesting strong government support for the completion of a 300,000-tonne-scale HyREX (Hydrogen Reduction) pilot facility by 2027 and the commercialization of the technology by 2030.[16] However, the USD 592.59 million KRW 800 billion cost, which POSCO claims is "too much for a private company to undertake alone," is actually less than the investment required for the relining of two blast furnaces. While seeking government assistance for the pilot H_2-DRI facility, POSCO has allocated a budget for the relining of Pohang No. 4 and Gwangyang No. 2 blast furnaces, which exceeds the government support it has requested. This underscores its intention to maintain existing coal-based blast furnaces to maximize profits in the short term, while effectively demanding that the government bear a substantial part of the costs of developing green steel technology, which would enhance the company's long-term value and competitiveness.

15 Ed. (2024, April 26). *The Hankook Ilbo*

16 Jeong, Y. (2024, September 26). *Sisajournal-e*

To justify the government's funding support and achieve its self-proclaimed future innovation challenge goal of restoring steel competitiveness, POSCO must stop investing in the relining of the Gwangyang No. 2 blast furnace and instead redirect its efforts toward the commercialization of H_2-DRI technology.

2.4 Responsibility for air pollution and health issues

☑ Steelworks top the list of the largest air pollutant emitters, and their emissions are steadily rising despite substantial investment

The steel industry is not only a major contributor to carbon emissions but also the largest emitter of airborne pollutants[17] in Korea. POSCO has allocated approximately USD 2.6 billion KRW 3.51 trillion for improving its environmental performance from 2018 to 2026. This investment is intended to reduce harmful emissions into the environment surrounding its steelworks. Although approximately USD 1.42 billion KRW 1.92 trillion of the earmarked investment had already been spent by 2023[18], the air pollutant emissions from POSCO's steelworks have continued to rise steadily. According to the report on annual airborne pollutant emissions from businesses released by the Ministry of Environment in 2023, emissions from the Gwangyang steelworks increased by 7,443 tonnes from the previous year to 28,257 tonnes, while Pohang steelworks' emissions increased by 5,802 tonnes to 20,080 tonnes. These increases make them the first and second-largest industrial emitters out of 943 businesses monitored across the country.

17 EDust, sulfur oxides (SOx), nitrogen oxides (NOx), hydrogen chloride (HCL), carbon monoxide (CO), hydrogen fluoride (HF), and ammonia

18 POSCO Holdings. (2024. March 22). [Corrected] *Annual Report.*

Table 2 POSCO's Annual Air Pollutant Emissions between 2021 and 2023

Unit: kg/year

	2021	2022		2023	
	Emissions	Compared to the Previous Year	Emissions	Compared to the Previous Year	Emissions
POSCO Gwangyang Steelworks	16,120,891	▲4,703,095	20,823,986	▲7,442,469	28,266,455
POSCO Pohang Steelworks	10,306,135	▲3,971,715	14,277,850	▲5,802,480	20,080,330

Source: CleanSys (Environment Ministry's stack monitoring system)

POSCO attributes these increases in air pollutant emissions to the expanded installation and operation of stack monitoring systems or tele-monitoring systems (TMS) at the steelworks, following the 2020 revision of the enforcement rules of the Clean Air Conservation Act. The national average emissions per stack decreased by 9.7% from the previous year,[19] but POSCO's emissions declined by a lesser percentage, and it has remained the largest emitter for several years.

From 2021 to 2023, POSCO consistently violated environmental laws and regulations. Both steelworks were caught almost every year in violation of laws and regulations, including the Clean Air Conservation Act and the Act on the Integrated Control of Pollutant-Discharging Facilities. However, they have received only minor corrective orders or fines, often no more than a few hundred dollars per violation, raising questions over the effectiveness of the regulatory system.

☑ Facility shutdown, a fundamental solution to improving health problems in the region surrounding the steelworks, is not considered

The substantial volume of air pollutants emitted by the coal-based blast furnaces in operation significantly impacts air quality nationwide and poses serious health risks to nearby communities. Research on air pollution and the health impacts of the use of blast furnaces[20] estimates

19 Shin, H. (2024, June 27). *The Hankookilbo*

20 Kim, G., et al. (2022)

that there were 506 premature deaths due to air pollution from three domestic steelworks in Gwangyang, Pohang, and Dangjin in 2021 alone. The research also points out that emissions from domestic blast furnace plants could account for 8 to 12% of the country's acceptable level of annual pollution, given the World Health Organization's recommended safe level of annual average air pollution.

Residents and the media have long raised concerns about severe pollutant emissions and associated health risks. In response, POSCO has filed lawsuits against civic organizations and media outlets that highlighted these issues.[21] The company also strongly opposed operational suspensions imposed by local governments for violations of the Clean Air Conservation Act.[22] It has clearly prioritized corporate interests over the severity of environmental problems. The ongoing air pollution and its health impact reveal the limitations of its reduction measures to date. POSCO's statement that emissions are inevitable does not consider the most effective and fundamental solution; shutting down the coal-based facilities. Extending the lifespan of coal-based production facilities only prolongs the emission of these pollutants.

2.5 Adaptability to global steel oversupply, recession in downstream industries, and increasing demand for green steel

☑ Targeting green steel market: a key strategy for improve the competitiveness of the steel industry

The Korean steel industry continues to face stagnant demand and recession because of the prolonged downturn in its downstream industries and intensified competition from the imported products. Moreover, global oversupply pressures remain elevated as coal-based production capacity in China, India, the member countries of the Association of Southeast Asian Nations (ASEAN), and other countries expands. Cost-

21 Park, C. (2021, January 20). *Pressian*

22 Koo, D. (2019, May 27). *The Hankyoreh.*

competitive Chinese steelmakers, supported by the Chinese government, are aggressively capturing a larger share of the global steel market. As a result, major trade partner countries like the United States and the European Union have tightened import restrictions and introduced trade remedies to address this oversupply, which may, in turn, have repercussions on the Korean steel industry.[23]

Under this pressure from low-cost steel imports, the Korean steel industry can enhance its competitiveness by swiftly transitioning to low-carbon steel and seizing first-mover advantage in the green steel market. Green trade barriers, particularly the EU CBAM, are increasingly impacting industries worldwide, driving the shift towards low-carbon production. A report[24] forecasts that the green steel market, valued at USD 2.4 billion in 2023, will grow to USD 320.67 billion by 2030. In response, global steelmakers are announcing plans to shut down blast furnaces and replace them with electric arc furnaces (EAFs) that process scrap. A notable example is the Port Talbot steelworks in the U.K. After facing challenges from low-cost steel imports, it ceased operations of its blast furnaces at the end of September 2024 and plans to transition to EAF by 2027 to reduce carbon emissions.[25]

However, the Korean government's current strategy, which considers the phase-out of blast furnaces only after the commercialization of H_2-DRI technology, does not adequately address the risks involved prior to its commercialization. By progressing slowly toward the 2050 carbon neutrality goal while continuing to expand existing blast furnaces and adding new facilities without a plan to retire outdated ones, the Korean steel industry risks losing the low-carbon steel market to other steel-producing countries that have robust renewable energy infrastructure and a strong commitment to facility transitions.

23 Lee, J., et al. (2024). Korea International Trade Association. P.35-37

24 Stellar Market Research (2024, July 29) PR Newswire "Tata steel, British Steel, JFE Steel in Japan, and Kobe Steel"

25 Bang, J. (2024, October 8). *Iron & Metal News*.

03 Stopping the Relining of the Gwangyang No. 2 Blast Furnace: The First Step toward Phasing Out Coal-Based Facilities

Relining blast furnaces is equivalent to continued investment in coal-based steelmaking, which accelerates climate change and delays the industry's transition to green steel. The Korean steel industry must take accountability for its severe impact on climate change and the accumulated damage it has caused. A meaningful step would be demonstrating a firm commitment to discontinuing coal-based production practices and redirecting all resources toward the commercialization of hydrogen-based steel production.

If POSCO can achieve the goals outlined in its carbon neutrality roadmap without introducing H_2-DRI while maintaining and even expanding its coal-based facilities, it must clearly specify what innovative reduction alternatives it has, along with timelines and measurable emissions reductions. However, this information has not been transparently disclosed. To take responsibility as a corporate citizen—and contribute to the global 1.5°C target—POSCO must take the following steps:

- Transparently disclose reduction alternatives and quantitative reduction plans for the period leading up to the commercialization of hydrogen-based direct reduction ironmaking (H_2-DRI).
- Stop the ongoing relining of the Gwangyang No. 2 blast furnace, as it does not align with achieving the global 1.5°C target and carbon neutrality, and declare its immediate shutdown.
- Incorporate a clear plan for the phased shutdown of all blast furnaces within the carbon neutrality roadmap.

Appendix

Modeling of Blast Furnace Shutdown Based on the Carbon budget

Methodology and Data

Korean steel industry's carbon budget

According to the IPCC, the remaining carbon budget for the world as of January 2020 is estimated at approximately 500 gigatonnes of CO_2 ($GtCO_2$), assuming a 50% probability of keeping global temperature rise within 1.5°C. This means that if total future carbon dioxide emissions are kept within 500 billion tonnes from 2020, there is a 50% chance that the global temperature rise can be maintained at or below 1.5°C. The remaining carbon budget, which represents the limit of CO_2 emissions that the world is allowed to emit, is gradually being depleted every year by emissions from all country.

Table 3 Estimated Remaining Global Carbon Budget

Unit: $GtCO_2$

Temperature Increase Compared to Pre-Industrial Levels	Remaining Carbon Budget (as of January 2020)				
	17%	33%	50%	67%	83%
1.3	400	250	150	100	50
1.5	900	650	500	400	300
1.8	1750	1250	1000	850	650
2.0	2300	1700	1350	1150	900

Source: IPCC 6th Assessment Report

This study calculates the remaining carbon budget for 2024 by subtracting global emissions from 2020 through 2023 from the global carbon budget baseline released by the IPCC in 2020. The emissions for the 2020-2023 period are calculated with reference to the Carbon Budget 2023 and national emissions data.

Table 4 Estimated Global Carbon Budget

Unit: $GtCO_2$

Year	Global Carbon Budget	Global Emissions
2020	500	35.008
2021	464.992	36.817
2022	428.175	37.150
2023	391.025	37.400
2024	353.625	-

Source: Global Carbon Budget 2023

Subsequently, Korea's remaining carbon budget needs to be calculated based on the global carbon budget. There are various methods of allocating the global carbon budget across countries, incorporating factors such as each country's responsibilities and capabilities. One of the most commonly used methods is "grandfathering," which allocates future emissions in proportion to current emissions. It allows countries with high historical emissions to retain a larger share of future emissions, incorporating the difficulty of their rapid reductions. This method is widely used to allocate carbon emission permits in emissions trading system (ETS). Another approach is a population-based allocation, which assigns an equal carbon budget in proportion to a country's population. While this may be considered fair, it could result in varied advantages and disadvantages for each country. Other approaches include allocations based on cumulative emissions incorporating historical responsibility and allocations based on countries' reduction capabilities, taking feasibility into account.

This study adopts a hybrid approach, combining grandfathering and population-based allocations in a 50/50 ratio to estimate Korea's carbon budget. To minimize uncertainty in future scenarios, the analysis was conducted using the 2023 population[26] and emissions data.[27] Because the global carbon budget is represented in CO_2 emissions rather than total greenhouse gases, a factor of 0.91, the average ratio of CO_2 emissions to total greenhouse gas emissions in Korea from 2021 to 2023, was applied to

26 WorldBank (2022)

27 Friedlingstein et al. (2023)

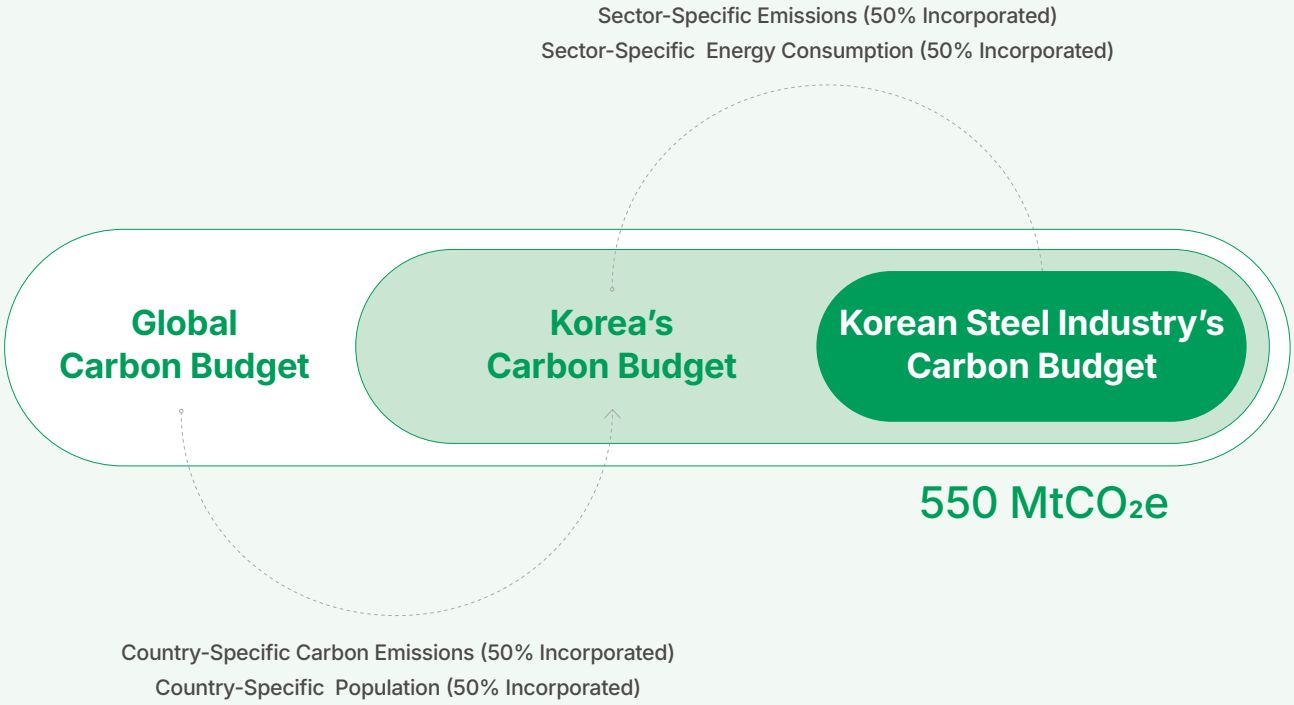
calculate the remaining carbon budget based on total emissions.

The carbon budget that can be allocated to the steel industry was calculated using this estimated carbon budget for Korea. For sectoral allocations, various metrics—such as revenue, value added, and current emissions—can be used. However, this study used an average of sector-specific greenhouse gas emissions and energy consumption at a 50/50 ratio. For energy use, primary energy supply was used to avoid overlap from secondary energy consumption, and the supply of byproduct gas was excluded from the calculation, given that it is generated from the use of fuels and raw materials like coal. Variables with high uncertainty, such as future changes in steel production and the timeline for adopting low-carbon steel technologies were excluded.

As a result, the estimated remaining carbon budget for Korean steel industry's emission from 2024 is 550 $MtCO_2e$.

Figure 5 Estimation of the Carbon Budget for the Korean Steel Industry

Source: SFOC



Steelmaking Facilities Data Used for Modeling Scenarios

There are 11 blast furnaces: eight owned by POSCO, three by Hyundai Steel, and two FINEX facilities owned by POSCO. Their carbon emissions vary depending on their production capacity, and the potential shutdown dates differ based on the latest reline year of each. The input data on the facilities in operation at POSCO and Hyundai Steel used for scenario modeling of greenhouse gas emissions and blast furnace shutdown is as follows:

Table 5 Steelmaking Facilities in Operation

Blast Furnace	Operation Start Year	Recent Reline Year	Average Production (from 2021 to 2023, 10,000 tonnes)	Carbon Intensity Coefficient
Pohang No.2 Blast Furnace	1976	2015	191.4	1
Pohang No.3 Blast Furnace	1978	2017	412.8	1
Pohang No.4 Blast Furnace	1981	2024	380.4	1
Gwangyang No.1 Blast Furnace	1987	2013	472.2	1
Gwangyang No.2 Blast Furnace	1988	2005	323.9	1
Gwangyang No.3 Blast Furnace	1990	2020	412.7	1
Gwangyang No.4 Blast Furnace	1992	2022	362.4	1
Gwangyang No.5 Blast Furnace	1999	2016	423.7	1
Pohang FINEX No. 2	2007	2018	128.0	0.5
Pohang FINEX No. 3	2014	-	168.3	0.5
Dangjin No. 1 Blast Furnace	2010	-	400.0	1
Dangjin No. 2 Blast Furnace	2010	-	400.0	1
Dangjin No. 3 Blast Furnace	2013	-	400.0	1

Source: SFOC reprocessed data released by the National Assembly

The average annual production from 2021 to 2023 was used for the steel production of each blast furnace, and 2025 was designated as the first year of facility shutdowns. Each facility is to be shut down 20 years after its most recent relining. Given that FINEX facilities emit nearly half as much as blast furnaces, a carbon intensity coefficient was applied, and longer operating periods were compared to those for blast furnaces.

Based on the steelmaking facilities data, all possible facility shutdown combinations were considered, and cumulative emissions of each combination were calculated. Each scenario was identified by comparing it to the target carbon budget and finding the combinations with the closest value without exceeding the cumulative emissions. The results are illustrated in [Figure 1].

References

- Bang, J. (2024, October 8). UK's largest steel mill ceases production after 100 years. *Iron & Metal News*.
- Chairman Jang In-hwa: "Advancing as a world-class company through seven future innovations. (2024, April 26). *The Hankook Ilbo*.
- Cho, S., & Lee, M. (2023). POSCO Profile No.1 POSCO: *Where is the commitment to carbon neutrality?* Solutions for Our Climate
- Cho, Y. (2024, June 27). POSCO's fourth blast furnace enters its 'fourth life'... KRW 530 billion invested for the third reline. *Maeil Business Newspaper*.
- Cho, E. (2024, June 27). Pohang No. 4 blast furnace reborn as a 'smart furnace.' *Financial News*.
- Climate Action Tracker, South Korea (Last accessed: October 3, 2024).
- Friedlingstein, P. et al. (2023). Global Carbon Budget 2023. *Earth System Science Data*, 15, 5301–5369
- Hansbrough, M., Ashley, C., & Lee, M. (2023). *Redline not reline: 4 leading steel companies in OECD set to lock in almost half a billion tonnes of CO_2*. SteelWatch.
- Hovenier, J., (2023, December 18). POSCO is relining coal-based steel furnaces to prolong their lifetimes. This jeopardises its financiers' climate commitments. BankTrack.
- Intergovernmental Panel on Climate Change (IPCC). (2023). *Climate Change 2021 – The Physical Science Basis: Working Group I Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press.
- Jung, Y. (2024, September 26). Government's 'green steel' support of KRW 900 billion budget nears approval... National Assembly will persuade the Ministry of Economy and Finance for budget expansion. *Sisajournal-e*.
- Kang, D., Woo, J., Choi, H., Hong, H., & Choi, E. (2023). Large automobiles, larger crisis. Greenpeace.
- Kim, G., Suarez, I., & Ecal, D. (2022). The hidden truth of steelworks - Air pollution impacts and health damages from integrated steelworks in South Korea. Solutions for Our Climate & CREA.
- Koo, D. (2019, May 27). Gyeongbuk Province notifies POSCO Pohang Steelworks of a 10-day 'suspension of operations' because of air pollutant emissions. *The Hankyoreh*.
- Korea Institute for Industrial Economics & Trade. (2023). Study on NDC implementation in the industrial sector.

- Lee, J., Kang, K., & Oh, J. (2024). Major countries' responses to China's oversupply and implications. *KITA Trade Report 2024* VOL.08.
- Ministry of Land, Infrastructure, and Transport. (2022). Pohang National Industrial Complex Plan (Revised): Environmental impact assessment for the POSCO hydrogen reduction steelmaking site development project.
- Park, C. (2021, January 20). POSCO faces backlash from civil organizations over "lawsuit against a Pohang MBC journalist." *Pressian*.
- POSCO Holdings. (2024). [Corrected] *Annuals Report*.
- POSCO Holdings. (2024). 2024 *Quarterly Report*.
- POSCO Holdings. (2024). 2024 *Semi-Annual Report*.
- Seo, D. (2020, May 21). [Exclusive] POSCO Gwangyang Steelworks transformed into a 'super-large blast furnace.' *Maeil Business Newspaper*.
- Shin, H. (2024, June 27). Major industrial facilities emitted 220,000 tonnes of air pollutants last year... Emissions per stack decreased by 10%. The Hankook Ilbo.
- Stellar Market Research. (2024, July 29). *Green Steel Market to reach 320.67 Bn at a CAGR of 101.23 percent by 2030 – Says Stellar Market Research*. PR Newswire
- WorldBank. (2022). Population, total | Data (Last accessed: Month Date, 2024).