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Louisiana Department of Environmental Quality

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Comments on Hyundai Steel Louisiana, LLC Title V Permit and PSD Permit Application, Agency Interest No. 248885

Please accept this third set of comments on Hyundai's permit application from Sierra Club and its Delta Chapter. Expert analysis shows Hyundai's proposed steel facility fails to consider available clean technologies, which violates the Clean Air Act, the Louisiana Public Trust Doctrine, and the company's own environmental commitments. Dr. Elizabeth Boatman's[1] report demonstrates that electrifying components could reduce the facility's total annual greenhouse gas emissions by 39.5%—over 764,000 tons annually, nitrogen oxides by 33.8%, and volatile organic compounds by 25.2%, while potentially saving $2.7 million per month in operating costs. Her report also explains why Hyundai's claim that green hydrogen is infeasible is factually incorrect. Using green hydrogen would also significantly reduce the facility's total annual greenhouse gases and combustion emissions. LDEQ must mandate that Hyundai evaluate electrification and green hydrogen as feasible alternatives to mitigate or eliminate emissions, particularly given the existing disproportionate pollution burden on the surrounding community.

Summary of Attached Expert Comments of Dr. Elizabeth Boatman

Despite Hyundai's stated commitments to "environmental excellence" and building an "ultra-low carbon steel production steel mill,"[2] the attached expert comments and accompanying exhibits demonstrate how Hyundai failed to consider many electrified component alternatives for the plant that are cleaner, cheaper, and safer than Hyundai's proposed fossil fuel-fired components. Not only will electrified technologies eliminate greenhouse gas emissions and all combustion

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[1] *See* Boatman, Elizabeth, PhD, PE, May 2026, Resume, 5 Lakes Energy (attached as Exhibit 35).

[2] Hyundai Steel Louisiana, LLC, Initial Title V Permit and PSD Permit Application, AI No. 248885, (Dec. 23, 2025), at 4-7 (pdf 116), 4-1 (pdf 110), [hereinafter "Application"], *available at* https://edms.deq.louisiana.gov/app/doc/view?doc=15036873.

emissions from the fossil-fired components they replace, substantially reducing public health impacts, they also offer many advantages for Hyundai and plant workers. Electrified alternatives are more efficient and flexible, safer, often smaller, quieter, reduce indoor fugitive pollution that harms workers, produce better quality and uniform output, require less maintenance and infrastructure, have longer lifetimes, and cost less to install. Many electrified alternatives have existed in the marketplace for decades, are in use at other steel plants, and some components, like utility boilers, are “drop-in” technologies that do not require custom engineering.

A key advantage of electrification includes the potential for a significant reduction in operating costs, due to efficiency gains. Based on Dr. Boatman’s conservative estimates, Hyundai could save over $2.7 million dollars a month in operating expenses by switching from gas to electricity. The actual operating cost savings could be even greater. In the most impressive single example, by using electric induction for steel slab reheating in the steel melting plant instead of a walking beam furnace, Dr. Boatman calculates that Hyundai could save over $1.1 million a month. Her estimates are consistent with manufacturer estimates that energy consumption can be cut in half.[3] In another example, according to Kanthal (a global, industry-leading electric heating company founded in 1931), electric ladle preheaters in place of natural gas-fired preheaters can cut a facility’s energy use for ladle preheating operations by up to 70%.[4]

Dr. Boatman’s comments also explain how Hyundai wrongfully dismissed green hydrogen as an infeasible control measure for the iron-making direct reduction process (DRP), and identify flaws in Hyundai’s analysis of greenhouse gas (GHG) calculations and pollution reduction plans related to the DRP. Specifically, she explains how the application improperly accounts for the DRP’s potential GHG emissions and fails to describe any carbon sequestration plans. She challenges Hyundai’s dismissal of hydrogen by highlighting three key points: 1) on-site hydrogen production is already proven at greenfield steel facilities; 2) no technical barriers prevent Hyundai from producing its own green hydrogen; and 3) Hyundai could adopt an incremental "blending" approach to overcome local supply gaps.

Hyundai’s failure to consider the cleanest technologies to reduce harmful pollution violates its obligations under both the Clean Air Act and the Louisiana Public Trust doctrine, as well as its own corporate commitments to environmental excellence. As detailed in the legal section below, Hyundai plainly did not consider all the available control technologies at step one of the 5-step BACT evaluation.

Under the Louisiana Public Trust, Hyundai must consider these technologies to avoid the “potential and real adverse environmental effects” of the proposed facility… “to the maximum

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[3] SELIT Induction Heating Systems, “Induction furnaces for hot rolling mills,” (accessed April 2026), *available at* https://www.selit-induction.com/induction-furnace-for-induction-furnaces-for-hot-rolling-mills/, (attached as Exhibit 10).

[4] Kanthal, “Ladle Preheating,” (accessed April 2026), *available at* https://www.kanthal.com/en/industries/steel/ladle-preheating/, (attached as Exhibit 27).

extent possible."[5] While Hyundai claims it "holds itself to environmental excellence" and has avoided the environmental effects to the maximum extent possible, Dr. Boatman's analysis shows that is clearly not the case. ***With electrified technologies, Hyundai could avoid over 764 thousand tons per year of GHG emissions, which is a potential reduction of 39.5% of Hyundai's proposed GHG limit of 1.9 million tons per year.*** Importantly, electrification could also eliminate all combustion emissions at these components, reducing 447.22 tons per year (tpy) of nitrogen oxide (NOx), 34.86 tpy of volatile organic compounds (VOCs), 175.12 tpy of carbon monoxide (CO), 4.25 tpy of sulfur dioxide (SO2), 3.38 tpy of particulate matter (PM), and corresponding public health impacts. The facility's total annual emissions of NOx could be reduced by 33.8% and total VOCs could be reduced by 25.2%. Using green hydrogen for the DRP could reduce the facility's GHG and combustion emissions even more. Reducing impacts as much as possible is critical since Hyundai is proposing to locate in a community that is already overburdened with pollution, and required by law.

Dr. Boatman's report provides numerous references and resources demonstrating commercially available components and examples of facilities utilizing them, which are attached as exhibits to these comments. Sierra Club would be pleased to connect experts in clean steel technologies, including Dr. Boatman and others, with LDEQ and Hyundai to share information about these technologies and answer questions.

Sierra Club intends to submit additional expert reports to LDEQ soon that will provide more analysis on the feasibility of using green hydrogen and renewable power at the proposed Hyundai steel plant. The reports will include a detailed assessment of meeting Hyundai's existing power demands, as well as additional hydrogen production and component electrification demands with renewable energy. Sierra Club also plans to submit additional expert analysis of the flaws in Hyundai's BACT analyses.

The Clean Air Act and the Louisiana Public Trust Doctrine Require Hyundai To Evaluate Electrified Components and Green Hydrogen

Hyundai must provide a robust analysis evaluating electrified technologies at its proposed plant, including for the DRP, pickling line, acid regeneration plant, continuous galvanizing lines of the cold mill, reheating of steel slabs in the hot mill, furnaces employed in the continuous galvanizing lines, and cold rolling mill operations. Hyundai must also conduct a thorough analysis evaluating green hydrogen, including incremental blending-in, address its accounting errors in the DRP GHG analysis, and clarify its carbon capture plans.

The Clean Air Act requires the proposed Hyundai plant implement the Best Available Control Technology (BACT) to reduce or eliminate the air quality impacts of its emissions.[6] BACT is a

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[5] *Save Ourselves v. La. Env't Control Comm'n*, 452 So.2d 1152, 1157 (La. 1984); *see* Application at 4-7 (pdf 116).

[6] Application at 3-5 (pdf 35).

broad concept, defined as “an emission limitation based on the maximum degree of reduction of each pollutant,” including “production processes and available methods, systems, and techniques.”[7] BACT was specifically designed to encourage “technology forcing,” driving new facilities to use progressively cleaner processes and “state-of-the-art” control technologies.[8] A BACT analysis must consider an expansive scope of potential control technologies, including add-on technologies, lower emitting practices and designs, or combinations of both.[9]

Adopting electrified heating technologies in industrial applications is a highly effective strategy for reducing emissions (air pollutants and greenhouse gases). By replacing combustion-based heat with electric sources, these technologies eliminate pollution at the source rather than relying on downstream controls. A diverse range of electric alternatives—including induction furnaces, utility boilers, and resistance heaters—are commercially available and already proven in high-temperature sectors like glass, cement, and in iron and steel production. Many technologies, including utility-boilers, induction furnaces and electric resistance hot water heaters, have existed in the marketplace for decades. While some advanced electric solutions are newer, they are often developed by the same R&D and business development units that designed their fossil-fuel predecessors. These manufacturers possess a sophisticated understanding of technical constraints and process objectives, ensuring that electrified 'business-as-usual' alternatives are both reliable and market-ready.

Dr. Boatman’s attached comments detail the specific electrified control technologies relevant to Hyundai’s BACT analyses, provide commercial examples of those technologies, and outline potential benefits and impacts. Hyundai must evaluate these technologies and green hydrogen in its BACT analysis and select them as the most effective emission control absent “adequate explanation” for not doing so.[10] Any cost-effectiveness evaluation must consider both capital and holistic operating costs (utilities, maintenance labor and parts, lifetime) of the electrified alternative technology.

Hyundai’s application violates Clean Air Act requirements by failing to consider these commercially available electrification technologies in its BACT analysis. A control technology can only be excluded from initial BACT consideration if it would “call into question the facility’s existence” and result in a “fundamentally different” facility.[11] Essentially, a control technology redefines the source only if it prevents an applicant from achieving the basic purpose of a proposed facility.[12]

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[7] 42 U.S.C. § 7479(3).

[8] *In re Tenn. Valley Auth*., 9 E.A.D. 357, 391 (EAB 2000).

[9] *In re Ariz. Pub. Serv. Co. Ocotillo Power*, 17 E.A.D. 323, 327-28 (EAB 2016).

[10] *E.g., In re General Motors, Inc.*, 10 E.A.D. 360 (EAB 2002).

[11] *Ariz. Pub. Serv. Co*., 17 E.A.D. at 335; *In re N. Mich. Univ. Ripley Heating Plant*, 14 E.A.D. 283, 302 (EAB 2009).

[12] *In re Desert Rock Energy Co*., 14 E.A.D. 484, 530 (EAB 2009); *Ariz. Pub. Serv. Co*., 17 E.A.D. at 336.

Here, electrified components or using green hydrogen would not alter the mill's basic purpose to produce "ultra-low carbon" high-quality primary steel, and would not impact the plant's primary DRP and EAF components. On the contrary, lower-carbon and lower-polluting alternatives better align with the Hyundai's stated mission to build a "ultra-low carbon steel production steel mill,"[13] "produc[e] an environmental sustainable, efficient, and reliable steel", "minimize and avoid adverse environmental impacts…to the maximum extent possible,"[14] as well as "advance sustainable energy solutions,"[15] and "hold[] itself to environmental excellence."[16] Regarding green hydrogen, Hyundai's application explains that the DRP has "the flexibility to use up to 90% pure H2,"[17] includes green H2 as a possible control technology,[18] and states its intention to utilize it in the future.[19]

Hyundai's application also violates the Louisiana Public Trust Doctrine by failing to consider these technologies. The Public Trust Doctrine requires Hyundai avoid the "potential and real adverse environmental effects" of the proposed facility… "to the maximum extent possible."[20] The Louisiana Supreme Court has mandated that under the Public Trust, "environmental costs and benefits must be given <u>full and careful consideration</u> along with economic, social[,] and other factors."[21] Hyundai and LDEQ cannot lawfully ignore alternatives that eliminate combustion emissions and have numerous other benefits.

Please do not hesitate to contact us with any questions.

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[13] Application at 4-1 (pdf 110).
[14] Application at 4-7 (pdf 116).
[15] Application at 4-1 (pdf. 110).
[16] Application at 4-7 (pdf 116).
[17] Application at 1-2 (pdf 14).
[18] Application at Table 3-79 (pdf 101).
[19] Application at 3.11.1.2 (pdf 107).
[20] *Save Ourselves*, 452 So.2d at 1157 (requiring agencies to determine "before granting approval of proposed action affecting the environment, [] that adverse environmental impacts have been minimized or avoided as much as possible consistently with the public welfare"); Application at 4-7 (pdf 116).
[21] *Save Ourselves*, 452 So.2d at 1157 (emphasis added).

Hyundai Steel – Air Permit Application
Electrified Alternatives and GHG BACT Analysis

Elizabeth Boatman, 5 Lakes Energy

May 2026

Hyundai Steel – Air Permit Application
Electrified Alternatives and GHG BACT Analysis
Elizabeth Boatman, 5 Lakes Energy
May 2026

1. Overview

This report contains my analysis and recommendations related to Hyundai Steel's air permit application.[1] Many of the processes covered by the applicant's BACT analysis focus heavily on post-process controls, with less emphasis on control technologies that can prevent the relevant pollutant from developing in the first place (e.g., "Low-NOx Burner," which reshapes the combustion process to avoid zones likely to form NOx, or "Good Process Operation"). The use of electrified heat-supplying technologies in industrial applications is a highly effective strategy for reducing emissions (air pollutants and greenhouse gases) because it eliminates the combustion source and thus prevents the pollution from ever developing.

In the process-specific comments that follow, I demonstrate where and which electrified control technologies are relevant to the BACT analyses presented by the applicant, present examples of those technologies, and outline potential benefits and impacts.[2]

To demonstrate that these technologies are cost-effective, I have estimated the monthly energy costs for electricity and gas to supply the electric alternatives versus the incumbent natural gas-fired technologies proposed by the applicant. However, energy costs are only a part of the story with utility bills. In the case of electricity supplied by Entergy Louisiana LLC, assuming the Hyundai Steel plant would qualify for the "Large load, high load factor power service rate schedule,"[3] I further estimate that the monthly demand charge to supply an incremental 288.2 MW of load would be on the order of $2.19M, bringing the total electric utility bill (if all electrified alternatives presented in **Sections 2.1-2.6** of these comments were adopted) to an estimated $2.86M per month. In contrast, using an estimated average natural gas spot price market (from Henry Hub) of $4.24/MMBtu (based on an average of historical data from the U.S. Energy Information Administration (EIA)), I would estimate the total cost of gas purchases per month at $4.93M, with either an additional transportation fee that would be established by the local distribution company or the cost to maintain and operate a facility-side lateral pipeline incorporated into an interstate pipeline gas service contract. While these should be regarded as conservative estimates (additional notes in **Appendix A to these comments**, below), nonetheless in this case, it appears that the large efficiency gains that could be made by switching to electric alternative technologies may also offer the applicant monthly utility savings. All supporting work papers are included in **Appendix A**, below.

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[1] Hyundai Steel Louisiana, LLC, Initial Title V Permit and PSD Permit Application, AI No. 248885, (Dec. 23, 2025) [hereinafter "Application"], *available at* https://edms.deq.louisiana.gov/app/doc/view?doc=15036873.

[2] Note that the conversion factor of 1 million BTU/hr to 293.07 kW was used in all calculations for scaling the electrically powered alternative technologies proposed as control technology alternatives.

[3] Entergy Louisiana, LLC, Large Load, High Load Factor Power Service Rate Schedule, Aug. 30, 2024 (accessed April 2026), *available at* https://www.entergylouisiana.com/wp-content/uploads/ell_elec_llhlfps-l.pdf, (attached as Exhibit 1).

Additionally, from reviewing the applicant's GHG BACT analysis, I find the full picture of the greenhouse gas emissions from the facility's direct reduction process (DRP) to be unclear. Across multiple instances, it appears that CO2 scrubbing built into the spent reducing gas recycling process (a core feature of the Energiron Zero Reformer direct reduction system that Hyundai has proposed) is identified as a GHG reduction control, even though to the best of my review, I cannot identify an associated carbon sequestration or utilization project. Without such a project, the CO2 amine scrubber cannot be identified as a true GHG reduction control, because the process of regenerating the scrubber will release and vent the captured CO2. By my estimate, Hyundai Steel may have underestimated the facility's potential to emit for CO2e by 729,000 to 1,220,439 tons of CO2 per year. If Hyundai Steel has instead contracted for carbon sequestration, then that information should be incorporated into the air permit application with greater clarity.

2. Detailed analysis

2.1. Package/utility boilers in the DRP and pickling line

Hyundai Steel proposes to install three boilers: two package/utility boilers (DRP.3, CRM.FSL)[4] associated with the direct reduction plant and the pickling line, and an acid regeneration boiler in the acid regeneration plant. The BACT analyses, e.g., 3.5.11 NOx BACT Analysis for Boilers,[5] alternatively state that "the proposed facility will include boilers as part of the DRP, pickling line, and acid regeneration plant," and considers all three boilers together in one analysis, despite their distinctions in functionality. Additional descriptions of these boilers are given as follows: 1.1 Project Description[6] identifies "boilers" under "Miscellaneous Operation", while section 1.2.1.2 Reduction Furnace[7] identifies boiler DRP.3 as a "package boiler" used to generate steam in association with the direct reduction process.

Note that section 1.2.5.3 Boilers[8] alternatively states "three areas of the proposed mill will require one utility boiler each – the DRP, pickling line, and acid regeneration plant." However, upon closer study of the air permit application, the boiler associated with the acid regeneration plant appears not to be a package boiler, but a specialty acid regeneration boiler. Therefore, the following comments pertain to the package boiler in the direct reduction process (DRP.3) and the utility boiler in the pickling line (CRM.FSL).

Section 2.1.1.2 40 CFR 60 Subpart Dc identifies boilers DRP.3 and CRM.FSL units as subject to NSPS Dc,[9] while section 2.1.2.6 40 CFR Part 63 Subpart JJJJJJ[10] further identifies both units as

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[4] *See* Application at Table 3-1. Sources Requiring a BACT Analysis, at 3-5 (pdf 35).
[5] Application at 3-21 (pdf 51).
[6] *Id.* at 1-1 (pdf 13).
[7] *Id.* at 1-2 (pdf 14).
[8] *Id.* at 1-5 (pdf 17).
[9] *Id.* at 2-2 (pdf 24).
[10] *Id.* at 2-5 (pdf 27).

meeting the definition of a boiler under this definition, but being exempt because they are gas-fired.

Summary of BACT analyses:

- NOx: The applicant finds only the use of "Low-NOx Burners" and "Good Combustion Practices" to be both technically feasible and cost-effective.
- CO: The applicant finds that only "Good Process Operation" is technically feasible.
- SO2: The applicant finds only "Good Process Operation" and the "Use of Pipeline Quality Natural Gas" to be technically feasible.
- PM/PM10/PM2.5: The applicant finds only "Good Process Operation" to be technically feasible.
- VOC: The applicant finds only "Good Process Operation" to be technically feasible.

A package/utility boiler, by definition, is a 'drop-in' industrial-scale boiler. While these types of boilers have, historically, been combustion-based (usually burning commercial natural gas), electrified counterparts have existed in the marketplace for decades. Today, electrified boiler technologies are the leading choice in terms of energy efficiency: they can achieve efficiencies of 98-99.5%, in contrast to efficiencies of just 80-95% for modern, combustion-based package/utility boiler models.[11]

1.1.1. Recommendation

Hyundai Steel should alternatively consider the use of electrode and electric resistance boilers for the package/utility boilers identified as DRP.3 and CRM.FSL, and these technologies should be included in the BACT analyses for NOx,[12] CO,[13] SO2,[14] PM,[15] and VOCs,[16] as well as for the GHG BACT analysis for the DRP and pickling line.[17]

2.1.2. Product examples

There are two major classes of steam-supplying electric boilers: electrode and electric resistance. For large-quantity, high-pressure applications, electrode boilers are typically preferred. Examples:

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[11] All combustion-based heat-supplying units, including boilers, suffer an inherent *inefficiency* due to the loss of high-value heat as it escapes in the combustion exhaust gases. Electric boilers bypass this issue and deliver efficiencies of 99% because nearly all generated heat is transferred directly into the working fluid.

[12] Application at 3-21 (pdf 51).

[13] *Id.* at 3-31 (pdf 61).

[14] *Id.* at 3-40 (pdf 70).

[15] *Id.* at 3-55 (pdf 85).

[16] *Id.* at 3-67 (pdf 97).

[17] *Id.* at 3-70 (pdf 100).

- CleaverBrooks Model HSB Electric Boiler[18] – Up to 3,375 kW (3.375 MW) power rating (11.5 MMBtu/hr) and 11,813 lb/hr of steam at a max of 250 psi
- Precision Boilers Model HVJ Jet Type Electrode Boiler[19] – Up to 50,000 kW (50 MW) power rating (170.6 MMBtu/hr) and 167,000 lbr/hr of steam at a max of 500 psi
- AEP Thermal CEJWS Immersed Electrode Steam Boiler[20] – Up to 32,000 kw (32 MW) power rating (109.2 MMBtu/hr) and 107,000 lb/hr of steam at a max of 175 psi
- AEP Thermal CEJS Jet-Type Electrode Steam Boiler[21] – Up to 53,000 kW (53 MW) power rating (180.8 MMBtu/hr) and 180,200 lb/hr of steam at a max of 125 psi

2.1.3. Relevant system attributes

- Combustion-free, zero fuel

2.1.4. Estimated impact on utility costs/OPEX

- DRP.3 – Package boiler in DRP – 23.37 MMBtu/hr → 6,539 kW
    - Estimated energy charge for 1 month of operation (electric model) - $15,180
    - Estimated gas charge for 1 month of operation (gas model) - $72,335
- CRM.FSL – Cold-rolling PL of PLTCM – Boiler – 40.00 MMBtu/hr → 11,193 kW
    - Estimated energy charge for 1 month of operation (electric model) - $25,983
    - Estimated gas charge for 1 month of operation (gas model) - $123,808

2.1.5. Environmental benefits

- Because electric steam boilers are an emissions-free technology (scope 1), they are the most environmentally friendly alternative to traditional fossil fuel-powered steam boilers.
- Because electric steam boilers essentially eliminate the point source emissions from the boiler operation, they reduce a facility's emissions footprint (GHGs and air toxics).

2.1.6. Other relevant considerations

- Because electric steam boilers require less on-site infrastructure (e.g., gas lines, fuel storage, exhaust systems, pollution control), they generally offer a more economical

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[18] CleaverBrooks, Model HSB Electric Boiler, (accessed April 2026), *available at* https://cleaverbrooks.com/product/model-hsb, (attached as Exhibit 2).
[19] Thermon, HVJ Jet Type Electrode Boiler, accessed April 2026), *available at* https://thermon.com/products/jet-type-electrode-boiler/, (attached as Exhibit 3).
[20] AEP Thermal Inc., Immersed Electrode High Voltage Steam Boiler 4.16 KV to 25 KV, (accessed April 2026), *available at* https://www.aepthermal.com/wp-content/uploads/2025/07/Bulletin-CEJWS-Rev.2023-01-EN.pdf, (attached as Exhibit 4).
[21] AEP Thermal, Inc., High Voltage Jet Type Electrode Steam Boilers 4.16 KV to 25 KV, (accessed April 2026), *available at* https://www.aepthermal.com/wp-content/uploads/2025/07/Bulletin-CEJS-Rev.-2022-11-EN.pdf, (attached as Exhibit 5).

installation than fossil fuel-powered steam boilers. For example, Precision Boilers estimates that electric boilers can cost up to 75% less to install.

- Because most electrode steam boiler models offer a vertical configuration, they are more compact than traditional fossil fuel-powered steam boilers which means they require less floor space.
- Because electric steam boilers have no exhaust requirements, they offer more flexibility in facility design, require less on-site infrastructure, and typically cost less to install than traditional fossil fuel-powered steam boilers.
- Because electric steam boilers typically have lower maintenance needs, simpler control systems, and lower insurance requirements (lower safety risk) compared to traditional fossil fuel-powered steam boilers, they can reduce a facility's overall operating costs
- Because electric steam boilers are more power-intensive than fossil fuel-powered hot water boilers, they require additional planning for power infrastructure, on the sides of both the utility and the facility. However, these incremental additions are small in comparison to, for example, the electric arc furnaces (estimated to be at least 100 MW based on anticipated production level of 2.7 million metric tons of steel per year)[22] that Hyundai Steel has proposed to use in its steelmaking process.

2.2. Cleaning water heaters used in the continuous galvanizing lines of the cold mill

Hyundai Steel proposes to install three "Cleaning water heaters" (CRM.CWH1, CRM.CWH2, CRM.CWH3) to support the continuous galvanizing lines of the plant's cold mill. In comparison to package/utility boilers, the typical purpose of a cleaning water heater is to supply hot water, not steam. While Hyundai Steel makes a distinction here, in the technology market these hot water heaters would just as commonly be called hot water boilers (as opposed to steam boilers).

Therefore, the rest of this section considers alternatives to natural gas-fired hot water heaters, not steam boilers, which were covered in **Section 2.1** of these comments, above.

Electric resistance hot water heaters have been available in the market at commercial scale for roughly a century, with industrial models dating back a half-century. In particular, higher-efficiency models have been available for several decades. As in the case of electric alternatives to combustion-powered steam boilers, modern electric hot water heaters (also commonly known as hot water boilers) are more energy efficient than their gas-powered counterparts and offer other co-benefits like emissions-free operation that underscore the importance of considering them as alternative control technologies. Electric resistance hot water heaters typically offer efficiencies on the order of 98-99.5%, whereas combustion-powered hot water heaters typically offer lower efficiencies, ranging from just 80-95%.

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[22] This estimate assumes a specific electricity need of 350 kWh per ton of steel, with steel production carried out across all 8,760 hours of the year.

2.2.1. Recommendation

Hyundai Steel should alternatively consider the use of electric resistance hot water heaters, and these technologies should be included in the BACT analyses for NOx, CO, SO2, PM, and VOCs, as well as for the GHG BACT analysis for the continuous galvanizing lines of the cold mill.

2.2.2. Product examples

Electric resistance hot water heaters (hot water boilers) constitute a developed technology capable of supplying the hot cleaning water needed in many industry applications. Examples:

- CleaverBrooks Model WB Electric Boiler[23] – Up to 3,360 kW (3.36 MW) power rating (11.5 MMBtu/hr)
- Precision Boilers HW Electric Water Boiler[24] – Up to 4,212 kW (4.21 MW) power rating (14.37 MMBtu/hr)
- AEP Thermal Immersed Electrode Hot Water Boiler[25] – Up to 68,000 kW (68 MW) power rating (232 MMBtu/hr) and max temp of 180°C (360°F)

2.2.3. Relevant system attributes

- Combustion-free, zero fuel

2.2.4. Estimated impact on utilities/OPEX

- CRM.CWH1 and CRM.CWH2 – Continuous galvanizing lines 1 and 2 (CGL1 and CGL2) – two at 12.00 MMBtu/hr <u>each</u> → 3.36 MW <u>each</u>
    - Estimated energy charge for 1 month of operation (electric model) - $7,795 <u>each</u>
    - Estimated gas charge for 1 month of operation (gas model) - $37,142 <u>each</u>
- CRM.CWH3 – Continuous vertical galvanizing line (CVGL) – 16.20 MMBtu/hr → 4.53 MW
    - Estimated energy charge for 1 month of operation (electric model) - $10,523
    - Estimated gas charge for 1 month of operation (gas model) - $50,142

2.2.5. Environmental benefits

- Because electric hot water boilers are an emissions-free technology (scope 1), they are the most environmentally friendly alternative to traditional fossil fuel-powered hot water boilers.

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[23] CleaverBrooks, Model WB Electric Boiler, (accessed April 2026), *available at* https://cleaverbrooks.com/product/model-wb, (attached as Exhibit 6).

[24] Thermon, HW Series II, Electric Hot Water Boiler From The Precision Boiler Family, (accessed April 2026), *available at* https://precisionboilers.com/wp-content/uploads/2022/01/PB_US_BR_HWSeriesIIMarketingBrochure_01062026v1.pdf, (attached as Exhibit 7).

[25] AEP Thermal, Inc., Immersed Electrode High Voltage Hot Water Boiler, (accessed April 2026), *available at* https://www.aepthermal.com/wp-content/uploads/2025/07/Bulletin-CEJW-EN-.pdf, (attached as Exhibit 8).

- Because electric hot water boilers essentially eliminate the point source emissions from the boiler operation, they reduce a facility's emissions footprint (GHGs and air toxics).

2.2.6. Other relevant considerations

- Because electric hot water boilers require less on-site infrastructure (e.g., gas lines, fuel storage, exhaust systems, pollution control), they generally offer a more economical installation than fossil fuel-powered hot water boilers. For example, Precision Boilers estimates that electric boilers can cost up to 75% less to install.
- Because many electrode steam boiler models offer a vertical configuration, they can be more compact than traditional fossil fuel-powered steam boilers which means they can require less floor space.
- Because electric hot water boilers have no exhaust requirements, they offer more flexibility in facility design, require less on-site infrastructure, and typically cost less to install than traditional fossil fuel-powered hot water boilers.
- Because electric hot water boilers typically have lower maintenance needs, simpler control systems, and lower insurance requirements (lower safety risk) compared to traditional fossil fuel-powered hot water boilers, they can reduce a facility's overall operating costs
- Because electric hot water boilers are more power-intensive than fossil fuel-powered hot water boilers, they require additional planning for power infrastructure, on the sides of both the utility and the facility. However, these incremental additions are small in comparison to, for example, the electric arc furnaces (estimated to be at least 100 MW based on anticipated production level of 2.7 million metric tons of steel per year)[26] that Hyundai Steel has proposed to use in its steelmaking process.

2.3. Walking beam furnaces (steel slab reheating) in the hot mill

Hyundai Steel proposes to use two walking beam furnaces[27] (HRM.1 and HRM.2) for the reheating of steel slabs in the hot mill prior to rolling. These furnaces typically exhaust by using fans to produce negative pressure to pull their combustion products through the furnace and into an exhaust stack.

As a combustion-free alternative, electric induction reheat furnaces for use in steel production have been available in the market since at least the 1960s. For example, in 1967, McLouth Steel installed six lines of induction slab reheaters at its Trenton mill in Michigan, a facility designed around two blast furnaces capable of producing roughly 1 million tons of iron per year.[28]

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[26] This estimate assumes a specific electricity need of 350 kWh per ton of steel, with steel production carried out across all 8,760 hours of the year.

[27] Application at 3-5; *see* Table 3-1 Sources Requiring a BACT Analysis (pdf 35).

[28] GPW Law, "McLouth Steel, Trenton Plant," (accessed April 2026), *available at* https://gpwlaw.com/mclouth-steel-trenton-plant/, (attached as Exhibit 9).

Manufacturer SELIT has produced modern versions of these heating systems since the early 2000s, and estimates that one installation at a customer site yielded an energy savings of 50% by modernizing its induction reheat furnaces (rated at 36 MW, 10 kHz) for use in a hot rolling mill,[29] similar to the application for which Hyundai Steel proposes to use natural gas-fired walking beam furnaces. Similarly, manufacturer Inductotherm Group reports that one of its largest installations supports a 900,000 metric ton/year melt shop using four 22-MW power supplies, which is on the order of the capacity required by Hyundai Steel's plant.[30]

According to the U.S. Department of Energy, electrified induction heating is a "highly energy efficient heating method that minimizes energy losses and enables precise control over temperatures,"[31] and in fact, greater control over temperatures than the incumbent natural gas-fired walking beam furnaces proposed by the applicant. This is one reason that U.S. DOE's Industrial Demonstrations Program awarded steelmaker Cleveland-Cliffs $19 million to remove the gas-fired reheat furnaces from its Butler Works facility, to instead install induction furnaces for reheating.[32] Notably, in this U.S. DOE-sponsored project, the agency states that the Butler Works project benefits include "improving air quality for nearby communities by reducing criteria and hazardous air pollutants."[33] Unfortunately, this project has not yet come to fruition, due to federal cuts to the associated funding program.

Additionally, because induction furnaces transfer nearly all produced energy directly into the working metal, they are more energy efficient than natural gas-fired furnaces, which lose significant fractions of heat energy to hot exhaust gases. For example, Inductotherm Group states that their induction heating systems are the "most efficient" technology on the market, in part because their design addresses steel slab reheating needs "at the point in the thermal curve where gas-fired furnaces rapidly lose efficiency."[34]

First introduced into the metals industry in the early 1900s, induction heating systems today are commonly used for melting and/or heat-treating a range of conductive metals, especially iron and

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[29] SELIT Induction Heating Systems, "Induction furnaces for hot rolling mills," (accessed April 2026), *available at* https://www.selit-induction.com/induction-furnace-for-induction-furnaces-for-hot-rolling-mills/, (attached as Exhibit 10).

[30] Foundry Management & Technology, "Efficient, Reliable Large-Scale Induction Melting," August 11, 2016, (accessed April 2026), *available at* https://www.foundrymag.com/melt-pour/article/21928862/efficient-reliable-large-scale-induction-melting, (attached as Exhibit 11).

[31] U.S. DOE's Office of Clean Energy Demonstrations, "Steel Slab Electrified Induction Reheat Furnace Upgrade," Aug. 2024, (accessed April 2026), *available at* https://www.energy.gov/sites/default/files/2024-08/IDP%20Little%20Cliffs%20CBC%20Summary%20V5.pdf, (attached as Exhibit 12).

[32] Cleveland-Cliffs, "U.S. Energy Dept.: Butler Works Project,"(accessed April 2026), *available at* https://www.clevelandcliffs.com/sustainability/steel-as-a-sustainable-material/dept-of-energy-butler-works-project, (attached as Exhibit 13).

[33] *Supra* note 31.

[34] Inductotherm Group, "Slab Heating and Reheating Systems," (accessed April 2026), *available at* https://inductothermgroup.com/products/slab-heating-and-reheating-systems/, (attached as Exhibit 14).

steel.[35] According to experts from the steel industry, induction reheat furnaces offer improved product quality and yield by eliminating the development of scale on the slab surfaces and by applying heat more evenly, which also produces products with superior properties.[36] This is one reason why Nippon Steel's Yawata Works in Japan first adopted induction heating decades ago and continues to use it today.[37]

Additional electric reheat alternatives also exist. For example, Kanthal custom designs electrically heated walking beam furnaces, with scalability. Kanthal estimates that electric heating furnaces that use electric heating elements to replace natural gas-fired walking beam furnaces can offer thermal efficiencies in excess of 90%, in comparison to 30-60% for conventional natural gas-fired models.[38]

2.3.1. Recommendation

Electric reheat furnaces should be included in the BACT analyses for NOx,[39] CO,[40] SO2,[41] PM,[42] and VOCs,[43] as well as for the GHG BACT analysis for the reheating of steel slabs in the hot mill. The analysis should separately consider the feasibility of electric induction reheat furnaces on the slabs that come directly from the continuous caster and slabs that are reheated from cold. For those slabs coming from the continuous caster, they would require only minimal surface heating which will change the BACT analysis potential for technical and economic feasibility. When evaluating the top-down BACT, the regulatory authority must choose the best technically and economically feasible option for each application.

2.3.2. Product example

Electric reheat furnace technologies are well developed, although large-scale projects may require custom engineering. Examples:

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[35] Kintek Furnace, "Which Industries Commonly Use Induction Melting Technology? Unlock Precision and Efficiency in Metal Processing," (accessed April 2026), *available at* https://kintekfurnace.com/faqs/which-industries-commonly-use-induction-melting-technology (attached as Exhibit 15).

[36] Inductotherm Group, "Induction heating for the steel industry," (accessed April 2026) *available at* https://inductothermgroup.com/induction-heating-for-the-steel-industry/, (attached as Exhibit 16).

[37] Moravec, Rudolf. Association for Iron and Steel Technology, 2017 Japan Caster Tour Recap, (accessed April 2026), *available at* https://www.aist.org/AIST/aist/AIST/Technology_Committees/Contin_Casting/Agenda_RSVP/18_apr_Caster-Japan_Study_tour_recap.pdf, (attached as Exhibit 17).

[38] Kanthal, "Walking Beam Furnaces for Billet Preheating,"(accessed April 2026), *available at* https://www.kanthal.com/en/industries/steel/walking-beam-furnaces-for-billet-preheating/, (attached as Exhibit 18).

[39] Application at 3-17 (pdf 47).

[40] *Id.* at 3-28 (pdf 58).

[41] *Id.* at 3-38 (pdf 68).

[42] *Id.* at 3-49 (pdf 79).

[43] *Id.* at 3-65 (pdf 95).

- Inductotherm Group Inductotherm IMZ System[44]
- Kanthal Globar SiC Heating Elements[45]

2.3.3. Relevant system attributes

- Combustion-free, zero fuel

2.3.4. Estimated impact on utilities/OPEX

- HRM.1 and HRM.2 – Hot rolling mill – Two at 432.00 MMBtu/hr <u>each</u> → 84.4 MW
  - Estimated energy charge for 1 month of operation (electric model) - $195,936 <u>each</u>
  - Estimated gas charge for 1 month of operation (gas model) - $1,337,126 <u>each</u>

2.3.5. Environmental benefits

- Because electric induction furnaces are an emissions-free technology (scope 1), they are the most environmentally friendly alternative to traditional natural gas-powered walking beam furnaces.
- Because electric induction furnaces essentially eliminate the point source emissions from the furnace reheat operation, they reduce a facility's emissions footprint (GHGs and air toxics).
- Because of differences in system design elements, electric induction furnaces require about 10% as much floor space as same-size natural gas-fired furnaces. This allows for more economical facility size construction (i.e., less land, reduced building HVAC needs for the hot strip mill).
- Because of differences in system operating parameters, electric induction furnaces broadly offer better-quality products. For example, electric induction furnaces can heat steel slabs more rapidly and more evenly than natural gas-fired furnaces, which significantly reduces the formation of oxide scale on the slab's surface that would otherwise need to be removed. In turn, this helps reduce the development of particulate matter from the hot strip mill activities, because less mechanical descaling is needed to produce a slab with a quality surface finish.
- Because electric induction furnaces have no burners, they reduce the amount of noise produced by the slab reheat operation.

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[44] Inductotherm Group, "Slab Heating and Reheating Systems,"(accessed April 2026), *available at* https://inductothermgroup.com/products/slab-heating-and-reheating-systems/, (attached as Exhibit 14).
[45] Kanthal, "Walking Beam Furnaces for Billet Preheating,", (accessed April 2026), *available at* https://www.kanthal.com/en/industries/steel/walking-beam-furnaces-for-billet-preheating/, (attached as Exhibit 18).

2.3.6. Other relevant considerations

- Because electric induction furnaces require less on-site infrastructure (e.g., gas lines, exhaust systems, pollution control), they generally offer a more economical installation than natural gas-fired walking beam furnaces.
- Because electric induction furnaces have no exhaust requirements, they offer more flexibility in facility design, require less on-site infrastructure, and typically cost less to install than traditional natural gas-fired walking beam furnaces.

2.4. Galvanizing line furnaces

Hyundai Steel proposes to use three furnaces in the facility's galvanizing lines: CRM.FUR1 and CRM.FUR2 in the continuous galvanizing line (CGL) and CRM.FUR3 in the continuous vertical galvanizing line (CVGL).[46] Galvanizing of steel coils requires treating the metal in a hot zinc bath in a manner that promotes good adhesion of the zinc coating. This is a high-temperature process that requires the use of furnaces to maintain the molten zinc baths. Electric alternatives have existed in the market since at least the early 2000s and are seen as increasingly attractive because of their ability to deliver superior products through better temperature control (i.e., stratified temperature control in the zinc bath).[47] Electric galvanizing furnaces also offer improved energy efficiency over their natural gas-fired counterparts (up to 98% for electric versus roughly 75% for traditional natural gas-fired tubes[48]), and are emissions-free at the point of operation.

2.4.1. Recommendation

Electric galvanizing furnaces should be included in the BACT analyses for NOx,[49] CO,[50] SO2,[51] PM,[52] and VOCs[53], as well as for the GHG BACT analysis for the furnaces employed in the continuous galvanizing lines.

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[46] Application at 1-8; *see* Table 1-1. Proposed Air Emission Sources (pdf 20).
[47] Gimeco, "Furnaces," (accessed April 2026), *available at* https://gimeco.com/furnaces/, (attached as Exhibit 19).
[48] Kretschmer, Matthias, Kilders, Inga, SMS Group, "Emission-free heating, more production galvanizing," Mar. 2, 2026, (accessed April 2026), *available at* https://www.sms-group.com/insights/all-insights/emission-free-heating-more-productive-galvanizing#:~:text=Practical%20applications%20show%20that%20three,as%20the%20need%20for%20maintenance, (attached as Exhibit 20).
[49] Application at 3-18 (pdf 48).
[50] *Id.* at 3-30 (pdf 60).
[51] *Id.* at 3-39 (pdf 69).
[52] *Id.* at 3-52 (pdf 82).
[53] *Id.* at 3-66 (pdf 96).

2.4.2. Product example

Electric galvanizing furnace technologies are well developed, although large-scale projects may require custom engineering. Example:

- Kanthal Tubothal heating elements[54] with Kanthal APM radiant tubes[55]
- Gimeco Electric Panel[56] for use in galvanizing baths

2.4.3. Relevant system attributes

- Combustion-free, zero fuel

2.4.4. Estimated impact on utilities/OPEX

- CRM.FUR1, CRM.FUR2 – CVL – Two at 88.30 MMBtu/hr each → 19.80 MW
    - Estimated energy charge for 1 month of operation - $45,975 each
    - Estimated gas charge for 1 month of operation (gas model) – $273,306
- CRM.FUR3 – CVGL – 126.25 MMBtu/hr each → 28.32 MW
    - Estimated energy charge for 1 month of operation - $65,734
    - Estimated gas charge for 1 month of operation (gas model) - $390,769

2.4.5. Environmental benefits

- Because electric furnace heating elements are an emissions-free technology (scope 1), they are the most environmentally friendly alternative to traditional natural gas-fired furnace technologies.
- Because electric furnace heating elements essentially eliminate the point source emissions from the galvanizing furnace heating operations, they reduce a facility's emissions footprint (GHGs and air toxics).
- Because electric furnace heating elements have no burners, they reduce the amount of noise produced by the galvanizing operation.
- Because electric furnace heating elements are burner-free, they induce less oxidation and cause no combustion byproduct buildup on other furnace elements, which prevents contamination and particulate matter generation from spalling, and in general requires less maintenance.

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[54] Kanthal, Tubothal Heating Elements, (accessed April 2026), *available at* https://www.kanthal.com/en/products/furnace-products/electric-heating-elements/tubothal-and-industrial-cartridge-heaters/tubothal-heating-element/, (attached as Exhibit 21).

[55] Kanthal, Kanthal APM and Kanthal APMT Fecral Alloys, (accessed April 2026), *available at* https://www.kanthal.com/en/products/furnace-products/furnace-tubes/kanthal-apm-and-apmt/, (attached as Exhibit 22).

[56] Gimeco, "Furnaces," (accessed April 2026), *available at* https://gimeco.com/furnaces/#3, (attached as Exhibit 19).

2.4.6. Other relevant considerations

- Because the use of electric furnace heating elements requires less on-site infrastructure (e.g., gas lines, exhaust systems, pollution control), they generally offer a more economical installation than natural gas-fired furnace technologies.
- Because electric furnace heating elements have no exhaust requirements, they offer more flexibility in facility design, require less on-site infrastructure, and typically cost less to install than traditional natural gas-fired furnace technologies.
- Because the use of electric furnace heating elements in galvanizing lines offers better temperature control than traditional natural gas-fired galvanizing line furnaces, they offer greater operational control to furnace operators.

2.5. Air heaters and strip dryers

Hyundai Steel proposes to install three air heaters (CRM.AAH1, CRM.AAH2, CRM.AAH3), three cleaning strip dryers (CRM.CSD1, CRM.CSD2, CRM.CSD3), and three tension lever (TL) strip dryers (CRM.CTSD1, CRM.CTSD2, CRM.CTSD3) in association with the cold rolling mill operations.[57] These air heaters and dryers are used for a combination of strip/coil cleaning, heating, and drying activities in a cold roll mill, with some employed before galvanizing treatment (e.g., CRM.CSD1) and others employed after (e.g., CRM.AAH1) to enable controlled cooling.[58] Some electric alternatives that are available on the market use electric resistance heating elements instead of natural gas-fired burners, while others employ electric induction technology. In all cases, the electric alternatives offer increased energy efficiency (e.g., the efficiency of an electric heating process is nearly 99%, whereas that for a natural gas-fired process is typically about 85%,[59] making electric induction-based continuous strip heaters 70-90% more efficient than natural gas-fired continuous strip heaters[60]) and are emissions-free at the point of operation.

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[57] Application at 3-18; *see* Table 3-14. Galvanizing Line Natural Gas Combustion Units (pdf 48).

[58] *Id.*

[59] ASTEC, "Is an Electric Process Heater the Right Choice,"(accessed April 2026), *available at* https://astecindustries.com/case-study/is-an-electric-process-heater-the-right-choice/, (attached as Exhibit 23).

[60] HLQ Induction Equipment Co., Ltd., "Induction Preheating and Post Welding," (accessed April 2026), *available at* https://dw-inductionheater.com/product/continuous-induction-steel-strip-annealing-machines, (attached as Exhibit 24).

2.5.1. Recommendation

Electric air heaters and strip dryers should be included in the BACT analyses for NOx,[61] CO,[62] SO2,[63] PM,[64] and VOCs,[65] as well as for the GHG BACT analysis for the cold rolling mill operations.

2.5.2. Product example

Electric air heaters and strip dyer technologies are well developed, although large-scale projects may require custom engineering. Example:

- Electrotherm E&T Induction Strip Heater/Dryer[66]
- Kanthal Flow Heaters[67]

2.5.3. Relevant system attributes

- Combustion-free, zero fuel

2.5.4. Estimated impact on utilities/OPEX

- CRM.AAH1, CRM.AAH2, CRM.AAH3 – CGL and CVGL – Three at 2.75 MMBtu/hr each → 0.69 MW
  - Estimated energy charge for 1 month of operation (electric model) - $1,606 each
  - Estimated gas charge for 1 month of operation (gas model) – $8,512 each
- CRM.CSD1, CRM.CSD2, CRM.CSD3 – CGL and CVGL – Three at 1.00 MMBtu/hr each → 0.25 MW
  - Estimated energy charge for 1 month of operation (electric model) - $584 each
  - Estimated gas charge for 1 month of operation (gas model) - $3,095 each
- CRM.CTSD1, CRM.CTSD2, CRM.CTSD3 – CGL and CVGL – Three at 1.00 MMBtu/hr each → 0.25 MW
  - Estimated energy charge for 1 month of operation (electric model) - $584 each
  - Estimated gas charge for 1 month of operation (gas model) - $3,095 each

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[61] Application at 3-18 (pdf 48).
[62] *Id.* at 3-30 (pdf 60).
[63] *Id.* at 3-39 (pdf 69).
[64] *Id.* at 3-52 (pdf 82).
[65] *Id.* at 3-66 (pdf 96).
[66] Electrotherm Engineering & Technology Division, Induction Strip Heater (Induction Dryer), (accessed April 2026), *available at* https://www.electrotherment.com/induction-heating-hardening-equipment/induction-heating/induction-strip-heater-induction-dryer#product_Technical_Specifications, (attached as Exhibit 25).
[67] Kanthal, Flow Heaters, (accessed April 2026), *available at* https://www.kanthal.com/en/products/air-heaters/flow-heaters/, (attached as Exhibit 26).

2.4.5. Environmental benefits

- Because electric air heating and continuous strip drying/heating elements are emissions-free technologies (scope 1), they are the most environmentally friendly alternative to traditional natural gas-fired air heating and continuous strip drying/heating technologies.
- Because electric air heating and continuous strip drying/heating elements essentially eliminate the point source emissions from the associated set of cold roll mill operations, they reduce a facility's emissions footprint (GHGs and air toxics).
- Because electric air heating and continuous strip drying/heating elements have no burners, they reduce the amount of noise produced by the cold roll mill's operation.
- Because electric air heating and continuous strip drying/heating elements are burner-free, they induce less oxidation and cause no combustion byproduct buildup on other furnace elements, which prevents contamination and particulate matter generation from spalling, and in general require less maintenance.

2.4.6. Other relevant considerations

- Because electric air heating and continuous strip drying/heating elements direct nearly all energy consumed into air/strip heating activities, they can be 70-90% more energy efficient than natural gas-fired counterparts.
- Because electric air heating uses direct air, bypassing the risk associated with natural gas-fired systems and the release of moisture from substrates, which can create an explosion risk, they are both a safer and faster alternative to natural gas-fired air heating systems.
- Because electric strip drying/heating elements direct their energy to the metal strip, their use in combination with feedback control systems offers faster response times and, as a result, better product quality/uniformity.

2.6. Ladle preheaters and dryers

Hyundai Steel proposes to install four vertical ladle preheaters (#1-#4), six horizontal ladle preheaters (#1-#6), and four vertical ladle dryers (#1-#4) in association with the ladle metallurgy facility operations that will follow crude iron product melting and refining after the two proposed electric arc furnaces (EAFs).[68] The applicant also states that electrode-heated ladles will be used for steel reheating.[69]

Ladles are routinely used for metallurgical refining activities in steel mills, employing alloying additions and additional impurity removal agents during this process. Because ladle metallurgy is a process carried out with molten steel, the ladles are lined with a refractory layer that must be

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[68] Application at PDF pg. 153, see diagram.

[69] Application at 3-13; Section 3.5.5 NOx BACT Analysis for Electric Arc Furnaces (EAF) and Ladle Furnaces (LF) (pdf 43).

carefully maintained to ensure its lifetime and prevent contamination of the molten steel. Ladle preheating and drying activities are a part of this maintenance plan, ensuring that the refractory layer is sufficiently dry when accepting molten steel and of a sufficiently high (pre-heat) temperature.

Electric ladle preheaters exhibit overall increases in process energy efficiency, because more of the heat generated goes directly into the ladle preheating operation through direct contact. In contrast, natural gas-fired ladle preheaters lose large fractions of heat energy to exhaust gases and through the activity of blowing heated air against the ladle's refractory. Kanthal estimates that using electric ladle preheaters in place of natural gas-fired preheaters can cut a facility's energy use by as much as 70%, depending on the specific parameters of the process.[70] For example, electric ladle preheaters can be up to 95% energy efficient, whereas a comparable natural gas-fired preheating system may be just 20% efficient. Furthermore, by changing how the heat is applied to the ladle's refractory, the lifetime of the refractory layer can be extended by as much as 20% which helps reduce overall operating costs associated with ladle metallurgy operations.[71]

Most importantly, Hyundai Steel states in its application that because these sources "are all designed to exhaust fugitively indoors" this makes "add-on controls not feasible," which further makes "the application of any post-combustion control device … [also] … technically infeasible".[72] As a result, the proposed use of traditional natural gas-fired ladle preheaters and dryers will expose operators to increased levels of indoor air pollution (e.g., NOx, CO, SO2, VOCs) – all of which could otherwise be mitigated by using electric ladle preheaters and dryers instead.

2.6.1. Recommendation

Electric heaters and dryers should be included in the BACT analyses for NOx, CO, SO2, PM, and VOCs, as well as for the GHG BACT analysis for the ladle metallurgy operations.

2.6.2. Product example

Electric heater and dryer technologies are well developed for use in ladle metallurgy applications, although large-scale projects may require custom engineering. Example:

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[70] Kanthal, "Ladle Preheating," (accessed April 2026), *available at* https://www.kanthal.com/en/industries/steel/ladle-preheating/, (attached as Exhibit 27).

[71] *Id.*

[72] Application at 3-28; *see* Section 3.6.7 CO BACT Analysis for Melting Plant Heaters and Dryers (pdf 58).

- Kanthal Flow Heaters[73] and electric heating elements[74] – Note that whereas not all heating elements can achieve the temperatures needed for steel ladle metallurgy (~1,500°C), Kanthal's products are designed to be able to reliably achieve these temperatures.

2.6.3. Relevant system attributes

- Combustion-free, zero fuel

2.6.4. Estimated impact on utilities/OPEX

- Vertical ladle preheaters #1-#4 – Four at 23.88 MMBtu/hr <u>each</u> → 1.47 MW
  - Estimated energy charge for 1 month of operation (electric model) - $3,420 <u>each</u>
  - Estimated gas charge for 1 month of operation (gas model) – $73,913 <u>each</u>
- Horizontal ladle preheaters #1-#6 – Six at 23.88 MMBtu/hr <u>each</u> → 1.47 MW
  - Estimated energy charge for 1 month of operation (electric model) - $3,420 <u>each</u>
  - Estimated gas charge for 1 month of operation (gas model) - $73,913 <u>each</u>
- Vertical ladle dryers #1-#4 – Four at 17.06 MMBtu/hr <u>each</u> → 1.05 MW
  - Estimated energy charge for 1 month of operation (electric model) - $2,443 <u>each</u>
  - Estimated gas charge for 1 month of operation (gas model) - $52,804 <u>each</u>

2.6.5. Environmental benefits

- Because electric ladle preheating and drying technologies are emissions-free (scope 1), they are the most environmentally friendly alternative to traditional natural gas-fired preheating and drying technologies.
- Because electric ladle preheating and drying technologies significantly decrease the point source emissions from the ladle metallurgy operations, they reduce a facility's emissions footprint (GHGs and air toxics).
- Because electric ladle preheating and drying technologies can be up to 95% energy efficient, compared to about 20% for traditional natural gas-fired preheating and drying technologies, even if the electricity used to power them is sourced from a fossil fuel-heavy power grid, the system emissions are still reduced overall.
- Because electric ladle preheating and drying technologies have no burners, they reduce the amount of noise produced by the ladle metallurgy operations.

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[73] Kanthal, Flow Heaters, (accessed April 2026), *available at* https://www.kanthal.com/en/products/air-heaters/flow-heaters/, (attached as Exhibit 26).

[74] Kanthal, Tubothal Heating Elements, (accessed April 2026), *available at* https://www.kanthal.com/en/products/furnace-products/electric-heating-elements/tubothal-and-industrial-cartridge-heaters/tubothal-heating-element/, (attached as Exhibit 21).

2.6.6. Other relevant considerations

- Because electric ladle preheating offers better control of the preheating process, the lifetime of the refractory layer inside the ladle can be extended by as much as 20% which helps reduce overall operating costs associated with ladle metallurgy operations.
- Because electric ladle preheating and drying technologies can be up to 95% energy efficient, compared to about 20% for traditional natural gas-fired preheating and drying technologies, they can help the facility's operator save on utility bills by delivering an overall energy saving of up to 70%.
- Because electric ladle preheating and drying technologies are combustion-free, they can support healthier indoor air quality for ladle metallurgy process operators. Note that in the application, Hyundai Steel acknowledges that the proposed traditional natural gas-burning ladle preheaters and dryers would exhaust fugitively indoors with any add-on controls "not feasible." According to this, electric ladle preheating and drying technologies are the only control technology that Hyundai Steel could adopt to mitigate the fugitive emissions (e.g., of NOx, CO, SO2, VOCs) from the ladle preheating and drying process (besides "Good Process Operation" and "Use of Pipeline Quality Natural gas," which are the only controls presented in the BACT analysis by the applicant).

2.7. Potential reduction in criteria air pollution by adopting electrified alternatives

The adoption of the electrified alternative technologies proposed above would eliminate combustion emissions from all associated processes. In the table below, I have recorded the associated reductions in PM, NOx, CO, SO2, and VOC air pollutants that the facility could achieve, based on the "Potential to Emit" values recorded by the applicant in Updated Appendix C. In short, electrifying the facility elements identified in this table could prevent the steel mill from emitting 3.38 tons of PM, 447.22 tons of NOx, 175.12 tons of CO, 4.25 tons of SO2, and 34.86 tons of VOCs each year. Based on the Facility Total values specified by the applicant in the same document, these values constitute reductions of 2.6% in PM, 33.8% in NOx, 2.8% in CO, 1.3% in SO2, and 25.2% in VOCs relative to the current facility plan.

Emission Unit ID	Emission Unit Description	Electrified Alternative Technology	Reduction in PM Against Proposed (tpy)	Reduction in NOx Against Proposed (tpy)	Reduction in CO Against Proposed (tpy)	Reduction in SO2 Against Proposed (tpy)	Reduction in VOC Against Proposed (tpy)
DRP.3	Package boiler flue gas	Electric boiler	0.05	3.27	3.05	0.21	0.5
Direct Reduction Process							
SMP.FUG	Vertical ladle preheaters #1-#4	Electric ladle preheaters	0.20	36.72	11	0.2	1.96
SMP.FUG	Horizontal ladle preheaters #1-#6	Electric ladle preheaters	0.30	55.08	16.5	0.3	2.94
SMP.FUG	Vertical ladle dryers #1-#4	Electric ladle dryers	0.12	26.24	7.88	0.16	1.4
Steel Melting Plant							
HRM.1	Walking beam furnace #1	Induction reheat furnace	0.92	108.03	45.1	1.06	9.73
HRM.2	Walking beam furnace #2	Induction reheat furnace	0.92	108.03	45.1	1.06	9.73
Hot Rolling Mill							
CRM.CWH1	Cleaning water heater in CGL1	Electric hot water heater	0.03	1.16	0.37	0.03	0.21
CRM.CWH2	Cleaning water heater in CGL2	Electric hot water heater	0.03	1.16	0.37	0.03	0.21
CRM.CWH3	Cleaning water heater in CVGL	Electric hot water heater	0.03	1.16	0.37	0.03	0.21
CRM.FUR1	CGL Furnace	Electric galvanizing furnace	0.19	29.02	10.6	0.22	1.97
CRM.FUR2	CGL Furnace	Electric galvanizing furnace	0.19	29.02	10.6	0.22	1.97
CRM.FUR3	CVGL Furnace	Electric galvanizing furnace	0.27	38.01	15.16	0.31	2.82
CRM.FSL	Cold-rolling PL of PLTCM boiler	Electric boiler	0.09	5.88	5.48	0.37	0.91
CRM.AAH1	APC air heater for CGL	Electric air heater	0.01	1.14	0.94	0.01	0.06
CRM.AAH2	APC air heater for CGL	Electric air heater	0.01	1.14	0.94	0.01	0.06
CRM.AAH3	APC air heater for CVGL	Electric air heater	0.01	1.14	0.94	0.01	0.06
CRM.CSD1	Cleaning strip dryer for CGL	Electric strip dryer	0.002	0.17	0.12	0.003	0.02
CRM.CSD2	Cleaning strip dryer for CGL	Electric strip dryer	0.002	0.17	0.12	0.003	0.02
CRM.CSD3	Cleaning strip dryer for CVGL	Electric strip dryer	0.002	0.17	0.12	0.003	0.02
CRM.CTSD1	TL strip dryer for CGL	Electric strip dryer	0.002	0.17	0.12	0.003	0.02
CRM.CTSD2	TL strip dryer for CGL	Electric strip dryer	0.002	0.17	0.12	0.003	0.02

CRM.CTSD3	TL strip dryer for CVGL	Electric strip dryer	0.002	0.17	0.12	0.003	0.02
Cold Rolling Mill							
		Total Reductions	3.38	447.22	175.12	4.25	34.86
		Proposed Facility Total (Appendix C)	127.83	1,321.45	6,224.57	335.73	138.06
		% Reduction Against Proposed Facility Total	2.6%	33.8%	2.8%	1.3%	25.2%

2.8. Emergency generators

Hyundai Steel proposes to install eight diesel-powered emergency generators throughout the facility (EMGEN1-EMGEN5 in the HRM and CRM, EMGEN6 in the SMP, and EMGEN7 and EMGEN8 in the DRP),[75] to support different aspects of operation in the event of loss of grid power. Accompanying these generators is the proposed additional installation of 8 diesel storage drums, each with a capacity of 8,000 gallons.[76] Hyundai Steel further proposes that only ultra-low-sulfur no. 2 diesel fuel will be used to power these generators.[77] At the rated heat capacity of 6.79 MMBtu/hr recorded by the applicant for EMGEN8,[78] for example, 8,000 gallons of diesel would supply power for nearly 1 week, assuming a diesel combustion rate of about 50 gallons per hour.

An alternative combination of generators and battery energy storage systems (BESS) could help reduce the size of the generators (and thus the potential emissions during emergency periods) and the amount of diesel needed to be stored on the property. The BESS case would be most economical to Hyundai Steel if an alternative rate structure could be negotiated with Entergy Louisiana LLC that would allow large-load industrials such as Hyundai Steel to access time-of-use pricing. In this case, the BESS could be used more regularly to buy and store electric power at times when it is cheaper, allowing for more regular charge and discharge cycles, which would make their adoption economical. Alternatively, an iron-air battery system might be a more environmentally friendly option than traditional BESS.

In addition to these points, Hyundai Steel only presents its BACT analysis after stating that “the emergency engines will be operated intermittently and will not exceed 100 hours per year of operation for non-emergency purposes.”[79] Accordingly, the calculations presented for proposed emission rates[80] convert average hourly rates into annual tons per year, based on this 100-hour limit for non-emergency purposes. However, if the facility were to consume its entire diesel

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[75] Application at 1-6; Table 1-1 Proposed Air Emission Sources (pdf 18).
[76] Application at PDF pg. 170.
[77] Application at 3-40; Section 3.7.10 SO2 BACT Analysis for Emergency Engines (pdf 70).
[78] Application at PDF pg. 289.
[79] Application at 3-20 (pdf 50), 3-31 (pdf 61), 3-40 (pdf 70), 3-55 (pdf 85), and 3-68 (pdf 98).
[80] Application at PDF page 289 for EMGEN8.

storage during one prolonged outage period, the generators could exhaust for an estimated additional 160 hours.

In light of this, I recommend Hyundai Steel consider local Entergy outage history and factor those findings into its BACT analysis for the emergency generators, to be reflective of actual anticipated generator usage, assuming the facility would continue to operate during standard outage periods.

3. GHG BACT

The applicant provides a GHG BACT analysis[81] that effectively groups all possible GHG control technologies into one long list.[82] The applicant further states that "all measures identified are aimed at enhancing energy efficiency of the equipment",[83] and thus focus on reducing fuel and/or energy inputs. In the following review of the applicant's GHG BACT analysis and list of possible GHG control technologies, I present my comments in three sections, each with its own focus: 1) CO2e emissions from the direct reduction plant (DRP), 2) the reducing gas supply for the DRP, and 3) electrified alternative technologies (consistent with the technologies presented in **Section 2** of these comments, above).

3.1. The full picture of CO2e emissions from the direct reduction plant is unclear

Hyundai Steel contends that its facility has the potential to emit 1,937,739 tons of CO2e per year, with 882,227 tons per year (45.5%) associated with its direct reduction process (DRP) for ironmaking.[84] Of this, Hyundai Steel contends that 813,626 tons per year (42.0% of total, 92.2% of DRP activities) will be exhausted as flue gas from its process gas heater.[85] Although limited description of the direct reduction plant's configuration is provided in the air permit application, both sections 1.2.1.2 Reduction Furnace and 4.1.1.2 Reduction Furnace provide the following description: "Spent reducing gas exists from the top of the tower, is cooled, compressed, and then run through an amine scrubbing system to reduce CO2 content. CO2 is recovered from the amine scrubbing medium and is then condensed and sent to long-term storage locations to the extent feasible."[86] This text is referring to the selective CO2 removal from the recycled process gas stream that can be achieved by using the amine scrubbing system.

Several additional points reference GHG emissions and the DRP:

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[81] Application at 3-70 (pdf 100).
[82] Application at 4-13; Table 4-77 Potential GHG BACT Controls (pdf 122).
[83] Application at 3-70; Section 3.11.1 Site-Wide GHG BACT Analysis (pdf 100).
[84] Updated Appendix C Calculations (pdf 3).
[85] Updated Appendix C.
[86] Application at 1-2; 1.2.1.2 Reduction Furnace, 4-3; 4.1.1.2 Reduction Furnace (pdf 14).

1) 1.1 Project Description[87] lists "Carbon capture and sequestration" as a process occurring in the DRP
2) Table 3-79 Potential GHG Control Measures for Iron/Steel Industries[88] identifies "CO2 Capture and Storage" as control technology with the corresponding description that "CO2 can be removed from the process gas to decrease GHG emissions from the system"
3) Table 3-80 Rank of Remaining GHG Control Technologies[89] ranks "CO2 Recovery from Process Gas" as "1" and identifies a ~80% recovery of CO2 from process gas using this approach
4) Table 4-77 Potential GHG BACT Controls[90] also includes "CO2 Recovery from Process Gas" as a possible DRP control with ~80% recovery of CO2 in process gas (which presumably is a reference to the amine scrubbing system built into the Energiron ZR process).

No further description of any form of a carbon capture and sequestration project is provided.

Reviewing these various descriptions, the full picture of CO2e emissions from the direct reduction plant is unclear. It is accurate that the Energiron process does include an amine scrubber for selective CO2 removal from the spent reducing gas, which is used to purify the gas before either recycling it back into the direct reduction process or burning it to power the DRP process gas heater. Once an amine scrubber has become saturated with CO2, it must be regenerated. This process creates a highly concentrated CO2 stream that is an ideal candidate for carbon capture and either utilization as a feedstock by another industrial facility or sequestration within the ground. According to Energiron's own materials,[91] this selective CO2 removal has the potential to capture 45% of the carbon from the system (0.27 ton CO2/ton hot iron product), with 30% being exhausted from the process gas heater's exhaust (0.22 ton CO2/ton hot iron product), and up to 25% contained in the direct reduction furnace's iron product (carbon has a high tendency to dissolve in iron at elevated temperatures). This means that 45% of the carbon input to the direct reduction furnace, when utilizing Energiron's process, has the potential to be scrubbed, condensed, and sent to long-term sequestration locations.

Because Hyundai Steel does not provide details on a planned carbon capture and sequestration project (or alternatively, a carbon capture and utilization project, as an industrial feedstock), the process by which the amine scrubbing system will be regenerated will presumably also vent its captured CO2 into the atmosphere. As noted, in Updated Appendix C,[92] Hyundai Steel contends

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[87] Application at 1-1 (pdf 13).

[88] *Id.* at 3-71 (pdf 101).

[89] Application at PDF pg. 180.

[90] Application at 4-13 (pdf 122).

[91] Duarte, Pablo E., Tavano, Andrea, Zendejas, Eugenio, Energiron "Achieving Carbon Free Emissions via the ENERGIRON DR Process" (attached as Exhibit 28).

[92] *See* Hyundai Steel January 2026 Supplemental Emissions Calculations, *available at* https://edms.deq.louisiana.gov/app/doc/view?doc=15068105 [hereinafter "Updated Appendix C"].

that 813,626 tons of CO2e will be exhausted per year (42.0% of facility total, 92.2% of DRP activities) as flue gas from its process gas heater. Based on Energiron's documentation of its own process, this 813,626 tons of CO2e constitutes the 30% of input carbon exhausted via the process gas heater's exhaust. Relative to that value, an amine scrubbing system selectively removing 45% of input carbon would therefore capture an estimated 1,220,439 tons of CO2e per year, which would then either be vented to the atmosphere during amine scrubber regeneration or piped to a carbon capture and utilization/sequestration project. Separately Energiron's own value of 0.27 ton CO2/ton hot iron product can be used to estimate the amount of CO2 that could be captured by the amine scrubber. At an anticipated annual steel production rate of 2.7 million tons,[93] these values would yield an estimated 729,000 tons of CO2 per year captured by the amine scrubber. Regardless, without a clear utilization or sequestration off-take mechanism, the CO2 "removed from the process" by the amine scrubber is not in fact a carbon capture mechanism, but rather a separate CO2 venting point. Inspecting Updated Appendix C, this carbon appears to be unaccounted for, either through venting or a carbon capture and sequestration project.

In summary, I have two primary concerns with the applicant's GHG potential to emit and its associated GHG BACT analysis as related to the DRP: 1) the applicant has no clear stated plans for carbon capture and either utilization or storage (CCUS, or CCS) project development, and 2) the applicant appears to have improperly accounted for (or entirely failed to account for) the CO2 selectively removed by the amine scrubber. This possible oversight could significantly affect the CO2e tabulated under the applicant's potential to emit in Updated Appendix C (somewhere in the estimated range of 729,000 to 1,220,439 tons of CO2 per year).

3.2. An alternative reducing gas supply should be more thoroughly considered for the DRP

Hyundai Steel contends that its facility has the potential to emit 1,937,739 tons of CO2e per year, with 882,227 tons per year (45.5%) associated with its direct reduction process (DRP) for ironmaking.[94] Of this, Hyundai Steel contends that 813,626 tons per year (42.0% of total, 92.2% of DRP activities) will be exhausted as flue gas from its process gas heater.[95]

Hyundai Steel demonstrates a clear plan to exhaust the flue gas from the process gas heater to the atmosphere. This is likely because the flue gas, which is typically a relatively dilute gas stream (especially in comparison to the CO2 selectively removed by the amine scrubber during spent reducing gas recycling), is of insufficient concentration for cost-effective carbon capture and sequestration.[96] Therefore, mitigation of the process gas heater's flue gas GHG emissions may be

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[93] Application at 4-1 (pdf 110).

[94] Updated Appendix C.

[95] *Id*.

[96] Baylin-Stern, Adam, Berghout, Niels, International Energy Agency, "Is carbon capture too expensive?", February 17, 2021, (accessed April 2026), *available* at https://www.iea.org/commentaries/is-carbon-capture-too-expensive, (attached as Exhibit 29).

better addressed through alternative technology means. For example, natural gas can be substituted by hydrogen (either entirely or in part), which would reduce the CO2 emissions from the heater's exhaust or, in the right configuration (i.e., 100% hydrogen feedstock with electric process gas heating), nearly eliminate the GHG emissions. This is why the applicant identifies "green" hydrogen produced through electrolysis as a possible control technology for GHG emissions from the DRP in its GHG BACT analysis.[97]

However, even though Hyundai Steel acknowledges the potential for hydrogen to be used as a GHG control to reduce the GHG emissions from its direct reduction process, the applicant also eliminates this option as a feasible control, stating that "it is currently not feasible to replace reformed natural gas with hydrogen as a reducing gas"[98] and "Hyundai intends to utilize green hydrogen when its production reaches the scale necessary to meet Hyundai's demand," further stating "the production of green hydrogen has not yet reached the scale, nor cost, necessary for feasible implementation to replace natural gas".[99] While it is true that there is no immediately available supply of "green" hydrogen in the region today and that sourcing "gray" hydrogen from fossil fuel sources would not reduce the GHG emissions attributable to the DRP,[100] there is also no explicit technical barrier to Hyundai producing its own supply of green hydrogen and/or producing hydrogen via an alternative electrochemical method.

A range of iron- and steelmaking companies have either implemented demonstration projects at their existing facilities or designed new-build facilities to include on-site hydrogen production. For example, U.S. steelmaker Cleveland-Cliffs previously agreed to host a 250-kW solid oxide electrolyzer cell pilot project at its Toledo HBI plant, located in Toledo, Ohio. The project, approved for funding by the U.S. Department of Energy in 2024, would produce hydrogen on-site from pressurized steam.[101] In Europe, both the new Stegra[102] (2.5 million tons of steel per year) and HYBRIT[103] (1.2 million tons of steel per year) integrated steel mills will use green hydrogen produced on-site via water electrolysis as the reducing agent in the direct reduction process. While the European projects will benefit from greater enabling conditions, such as ready access to renewable electricity at scale and market adjustments due to the EU's Carbon Border Adjustment Mechanism, nonetheless it is important to recognize that hydrogen production and blending into the reduction process gas stream can be carried out in a scalable fashion. That is, it

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[97] Application at 3-70 (pdf 100).
[98] Application at 3-76 (pdf 106).
[99] *Id.* at 3-77 (pdf 107).
[100] *Id.* at 3-76 (pdf 106).
[101] U.S. DOE, Office of Energy Efficiency and Renewable Energy NEPA Determination, "Demonstration of SOEC Hydrogen Direct Reduction (HDR) at the Toledo, OH Steel Plant," May 30, 2024 (accessed April 2026), *available at* https://www.energy.gov/sites/default/files/2024-07/CX-030809.pdf, (attached as Exhibit 30).
[102] ME Steel, "Stegra secures financing to complete Boden green steel plant,"(accessed April 2026), *available at* https://news.mesteel.com/stegra-secures-financing-to-complete-boden-green-steel-plant/, (attached as Exhibit 31).
[103] HYBRIT, "Fossil-free steel – a joint opportunity!,"(accessed April 2026), *available at* https://www.hybritdevelopment.se/en/, (attached as Exhibit 32).

is not necessary to entirely swap the reducing gas to green hydrogen. Instead, Hyundai Steel could produce smaller quantities of hydrogen on-site, and use that hydrogen to offset incremental fractions of its natural gas consumption and associated GHG emissions from the ironmaking process.

Additionally, water electrolysis is not the only way to produce hydrogen for use in a DRP furnace, as Hyundai Steel acknowledges. In fact, Hyundai Steel's DRP as designed will rely on a "syngas" mixture of carbon monoxide (CO) and hydrogen (H2) produced from fossil natural gas. In the proposed system, spent reducing gas (spent syngas) will be captured, cleaned, and either recycled back into the DRP furnace or burned by the process gas heater. This is a form of recycling, but it nonetheless relies heavily on new inputs of fossil natural gas and, as a result, creates significant GHG emissions (some exhausted from the process gas heater, and some captured by the amine scrubber and either vented after scrubber regeneration or perhaps directed to sequestration). Electrochemical reformers offer an approach that is closer to a closed-loop system, minimizing the need for new fossil gas inputs because the CO2 and H2O in the spent reducing gas that would either be exhausted or vented are instead captured and split back into their CO and H2 constituents using electricity, to be circulated again through the DRP furnace.

For example, Helix Carbon[104] has developed an early-stage electrochemical reforming technology that is entirely powered by electricity, and offers the potential for this type of closed-loop system. While the company has some projects installed in crude oil refineries, where natural gas reformers and hydrogen are also frequently used, their technology is also appropriate for use in systems such as the DRP proposed by Hyundai Steel. According to Helix Carbon, the precise ratio of CO and H2 reducing gases (both of which the Energiron ZR process will also supply to the DRP furnace) can also be tailored to accommodate customer specifications for attributes such as carbon content in the metallized hot/cold DRI pellets. Like water electrolysis, electrochemical reforming can be implemented on a sliding scale (small capacity to offset some natural gas needs all the way to larger scale and greater natural gas offset) to accommodate cost constraints.

In summary, I recommend that Hyundai Steel be requested to provide a thorough analysis of the potential to incorporate an alternative reducing gas supply into its production process and to more clearly articulate the proactive steps that the company will follow to secure clean hydrogen for its DRP.

3.3. Electrified alternatives for heat supply should be considered in GHG BACT analysis

In alignment with the electrified alternative technologies proposed in **Sections 2.1-2.6** above, the table provided below identifies which facility elements and emitting units these technologies apply to, and the impact their adoption would have on GHG emissions from the proposed

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[104] Helix Carbon, "Closing the Carbon Cycle," (accessed April 2026), *available at* https://helixcarbon.co/, (attached as Exhibit 33).

facility. Based on the Updated Appendix C, I find that even without supplying hydrogen to the DRP or installing CCS on the DRP, electrification of other facility elements could reduce anticipated facility GHG emissions in CO2e by 764,518.89 tpy against a proposed GHG emission limit of 1,937,739.35 tpy. This amounts to a potential reduction of 39.5% if electrified alternatives are adopted. In other words, whereas the applicant states that green hydrogen is not available as a control for reducing GHG emissions from the DRP, and states no plans to for a CCS project to manage the GHG emissions from the DRP process gas heater's exhaust, electrification of all these facility elements could achieve facility-wide GHG reductions at nearly the same level *and all the identified technologies are available in the market*.

Emission Unit ID	Emission Unit Description	Electrified Alternative Technology	Reduction in CO2e Against Proposed (tpy)
DRP.3	Package boiler flue gas	Electric boiler	10,945.10
Direct Reduction Process			
SMP.FUG	Vertical ladle preheaters #1-#4	Electric ladle preheaters	42,993.48
SMP.FUG	Horizontal ladle preheaters #1-#6	Electric ladle preheaters	64,490.22
SMP.FUG	Vertical ladle dryers #1-#4	Electric ladle dryers	30,709.64
Steel Melting Plant			
HRM.1	Walking beam furnace #1	Induction reheat furnace	211,247.51
HRM.2	Walking beam furnace #2	Induction reheat furnace	211,247.51
Hot Rolling Mill			
CRM.CWH1	Cleaning water heater in CGL1	Electric hot water heater	5,817.40
CRM.CWH2	Cleaning water heater in CGL2	Electric hot water heater	5,817.40
CRM.CWH3	Cleaning water heater in CVGL	Electric hot water heater	7,853.49
CRM.FUR1	CGL Furnace	Electric galvanizing furnace	42,806.37
CRM.FUR2	CGL Furnace	Electric galvanizing furnace	42,806.37
CRM.FUR3	CVGL Furnace	Electric galvanizing furnace	61,203.90
CRM.FSL	Cold-rolling PL of PLTCM boiler	Electric boiler	19,672.37
CRM.AAH1	APC air heater for CGL	Electric air heater	1,333.15
CRM.AAH2	APC air heater for CGL	Electric air heater	1,333.15
CRM.AAH3	APC air heater for CVGL	Electric air heater	1,333.15

CRM.CSD1	Cleaning strip dryer for CGL	Electric strip dryer	484.78
CRM.CSD2	Cleaning strip dryer for CGL	Electric strip dryer	484.78
CRM.CSD3	Cleaning strip dryer for CVGL	Electric strip dryer	484.78
CRM.CTSD1	TL strip dryer for CGL	Electric strip dryer	484.78
CRM.CTSD2	TL strip dryer for CGL	Electric strip dryer	484.78
CRM.CTSD3	TL strip dryer for CVGL	Electric strip dryer	484.78
Cold Rolling Mill			
		Total Reductions	764,518.89 tpy CO2e

Appendix A.

A.1. Methodology for determining natural gas costs to Hyundai Steel

Large industrial gas customers typically purchase their natural gas from third-party marketers, not from local distribution companies, as a small commercial or residential customer might. These contracts typically specify prices per volume of gas that are valid for 1-3 years. Most, but not all, large industrials take transport service of that gas volume from a local distribution company, but only pay a transport fee to that company. Others, if residing sufficiently close to an interstate natural gas pipeline and having consistent, sufficient demand, may bypass the local distribution company entirely by contracting with the interstate pipeline company, who then constructs a separate large-diameter pipeline ‘lateral’ pipeline off the main interstate pipeline to reach the facility. In this case, the industrial gas customer would likely contract at a fixed, firm service rate for an extended amount of time, with that contracting also reflecting the costs for the pipeline company to maintain and operate the ‘lateral’ pipeline to the facility.

Louisiana is a high-volume participant in both the generation and interstate export market of natural gas and the LNG export market through regional ports. As a result, compared to many states, Louisiana has a greater density of interstate gas pipelines. Consulting ArcGIS map layers specific to the interstate gas pipeline network reveals that one such pipeline passes close to the Hyundai Steel site in Ascension Parish. This means it is likely that Hyundai Steel will connect directly to an interstate gas pipeline network, bypassing transport charges that the local gas utility would otherwise charge. As a result, a full estimate of the cost of natural gas to Hyundai Steel cannot be precisely determined, because it is unknown exactly how the steel mill will receive gas service and/or what the costs to the facility would be relevant to lateral service contract.

The energy cost associated with purchasing bulk natural gas volumes through a third-party marketer most closely align with the prices tallied by the Henry Hub. The Henry Hub is a physical junction point (a ‘hub’) that reports daily supply-demand-based ‘spot prices’ for the natural gas market. Because it serves as the physical delivery point for natural gas futures contracts that trade under NYMEX (the New York Mercantile Exchange), the U.S. Energy Information Administration captures and reports a volume-weighted average of these transactions as average daily 'spot prices' on its website. Data for Henry Hub spot prices extend back to January 7, 1997. Coincidentally, the Henry Hub is located within 100 miles of the proposed Hyundai Steel facility. This means that using historical average Henry Hub spot price data[105] to estimate the cost of natural gas for the steel mill is not only a practical choice but also even more applicable than it might otherwise be for some industrial facilities (i.e., those located farther away).

The average Henry Hub spot price for natural gas since January 3, 2023, is $4.24 per million BTU (a unit of heat energy, which originates when the natural gas is combusted). This value reflects seasonal changes and volatility due to weather/market conditions. For example, on January 23, 2026, the spot price was $30.72 per million BTU, whereas March 30, 2026, the spot price had fallen to just $2.88 per million BTU.

I have used this average value of $4.24 per million BTU to estimate the monthly cost of natural gas to Hyundai Steel, based on the rated heat capacities (in million BTU/hr) of the natural gas-consuming units identified in the air permit application as totaling to $4.93M. Again, the facility would also incur some additional costs from either a transport service fee or maintaining and operating its own lateral pipeline, which would increase the costs that I have estimated in the table below slightly.

A.2. Methodology for determining electricity costs to Hyundai Steel

Electricity bills for industrial customers are largely constituted by two costs: energy and demand. Entergy's "Large load, high load factor power service rate schedule"[106] specifies both the energy cost ($0.00318/kWh) and the tariff structure for evaluating a facility's anticipated monthly demand cost. Often, the demand cost, which reflects the costs to the utility for developing and maintaining adequate generation and supply, can far exceed the energy cost. Therefore, to estimate the facility's monthly electricity costs for the cases in which I have commented natural gas-powered units could be swapped for electricity-powered units, I have first estimated the anticipated power needs in MW based on (1) the stated million BTU of each corresponding gas-powered unit, (2) the relative efficiencies of the corresponding gas- and electricity-powered units, and (3) the resulting anticipated power needs in MW of each proposed electricity-powered

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[105] U.S. Energy Information Administration, Natural Gas, (accessed April 2026), *available at* https://www.eia.gov/dnav/ng/hist/rngwhhdD.htm, (attached as Exhibit 34).

[106] Entergy Louisiana, LLC, Large Load, High Load Factor Power Service Rate Schedule, Aug. 30, 2024 (accessed April 2026), *available at* https://www.entergylouisiana.com/wp-content/uploads/ell_elec_llhlfps-l.pdf, (attached as Exhibit 1).

unit. All input values are contained in the table below. Next, I summed all the estimated power needs in MW to estimate the monthly demand costs for electricity consumption *for these units*.

The sum of all proposed additional electricity-powered units is 288.24 MW. Breaking down the tariff structure recorded for Entergy's "Large load, high load factor power service rate schedule" gives an estimate for the associated demand costs, as follows:

- First Demand Block:
    - Applies to the greater of 41,000 kW (41 MW) or 50% of average demand (50% of 288.2 MW = 144.1 MW) <u>but not less than</u> the lesser of 400,000 kW (400 MW) or 25% of maximum (25% of 288.2 MW = 72.1 MW) is 400,000 kW, where 25% of 400,000 kW (400 MW) is 100,000 kW (100 MW).
    - Because 144.1 MW is not less than 100,000 kW (100 MW), the first demand block is 144.1 MW.
    - The cost is $10.55/kW for the first demand block. At 144,100 kW (144.1 MW), the demand charge from the first demand block will be about $1.52M.
- Second Demand Block:
    - The second demand block states that for the next 15,000 kW (15 MW), the demand charge will be calculated at $7.32/kW.
    - The demand charge for the second demand block totals to $109,800 per month (15,000 kW times $7.32/kW).
- Third Demand Block:
    - The third demand block is computed as the difference between (a) the lesser of the current monthly Maximum Demand or the Average Demand and (b) the First Demand Block + the Second Demand Block (but is not less than zero).
    - In this case, the lesser value among the current monthly Maximum Demand or the Average Demand is assumed to be the full value of 288.2 MW.
    - Taking the difference between this value and the sum of the First and Second Demand Blocks gives: 288.2 MW – (144.1 MW + 15.0 MW) = 129.1 MW (129,100 kW).

    - The demand charge for the third demand block is thus 129,100 kW times $4.36/kW, which totals to $562,876.

- Fourth Demand Block:
    - The fourth demand block is specified as the difference between the Maximum Demand and the sum of the First through Third Demand Blocks.
    - Again assuming that 288.2 MW is the Maximum Demand, 288.2 MW – (150 MW + 15 MW + 129.1 MW) = -5.9 MW, which is less than zero. So, the Fourth Demand Block is tabulated at 0 kW, yielding a monthly demand charge of $0 for this demand block.

- Total Demand Charge:
    - The total monthly demand charge is the sum of all demand charges for the First through Fourth Demand Blocks (in order): \$1.52M + \$109,800 + \$562,876 + \$0 = \$2.19M.

To estimate the monthly electricity cost to the facility further requires estimating the monthly energy cost. The work for this is recorded in the table below. But briefly, the methodology is as follows: beginning with the heat rating of the corresponding natural gas-powered unit in million BTU/hr, then factoring in the difference in efficiencies of the corresponding gas- versus electricity-powered units, converting from million BTU/hr to kW according to 1 million BTU/hr = 293.07 kW, scaling for an average of 730 hours per month, and then multiplying by the stated energy charge of \$0.00318/kWh, the monthly energy cost for each proposed electrified unit was calculated. For 288.2 MW (288,200 kW) of electric load operating at 730 hours each month, the total monthly energy cost is estimated as \$699,130. Summing the estimated monthly demand charge (\$2.19M) with the estimated monthly energy cost (\$699,130) gives an estimated total monthly electric bill of \$2.86M.

One final note here is that this calculation effectively <u>overestimates</u> the monthly demand charge associated with the incremental addition of 288.2 MW of proposed electrified load. This is because the highest demand block is associated with the First Demand Block, of which a significant fraction will actually be constituted by Hyundai Steel's base demand whether or not these additional units are electrified. Again, without greater insight into Hyundai Steel's estimated load based on its proposed facility design, it is impossible to more accurately estimate the monthly incremental cost of electricity service to the steel mill that would result from adding the additional electrified units proposed in this work.

A.3. Table summarizing my estimated cost comparison

Provided below is my worksheet for estimating the cost of gas versus electricity for the various electrified alternative technologies proposed in Section 2, and in support of the findings described in A.1 and A.2.

Category	**Mill Area**	**Unit**	**MMBtu/hr**	**Gas Efficiency**	**Electric Efficiency**	**kW Size Estimate**	**MW Size Estimate**	**Gas Cost**	**Electric Cost**
Boilers	DRP	DRP.3	23.37	0.95	0.995	6,539	6.54	$ 72,335	$ 15,180
	CRM	CRM.FSL	40	0.95	0.995	11,193	11.19	$ 123,808	$ 25,983
Hot water heaters	CRM - Galvanizing	CRM.CWH1	12	0.95	0.995	3,358	3.36	$ 37,142	$ 7,795
	CRM - Galvanizing	CRM.CWH2	12	0.95	0.995	3,358	3.36	$ 37,142	$ 7,795
	CRM - Galvanizing	CRM.CWH3	16.2	0.95	0.995	4,533	4.53	$ 50,142	$ 10,523
Walking beam furnaces	HRM - Hot strip mill	HRM.1	432	0.6	0.9	84,404	84.40	$ 1,337,126	$ 195,936
	HRM - Hot strip mill	HRM.2	432	0.6	0.9	84,404	84.40	$ 1,337,126	$ 195,936
Galvanizing line furnaces	CRM - Galvanizing	CRM.FUR1	88.3	0.75	0.98	19,805	19.80	$ 273,306	$ 45,975
	CRM - Galvanizing	CRM.FUR2	88.3	0.75	0.98	19,805	19.80	$ 273,306	$ 45,975
	CRM - Galvanizing	CRM.FUR3	126.25	0.75	0.98	28,316	28.32	$ 390,769	$ 65,734
Air heaters and strip dryers	CRM	CRM.AAH1	2.75	0.85	0.99	692	0.69	$ 8,512	$ 1,606
	CRM	CRM.AAH2	2.75	0.85	0.99	692	0.69	$ 8,512	$ 1,606
	CRM	CRM.AAH3	2.75	0.85	0.99	692	0.69	$ 8,512	$ 1,606
	CRM	CRM.CSD1	1	0.85	0.99	252	0.25	$ 3,095	$ 584
	CRM	CRM.CSD2	1	0.85	0.99	252	0.25	$ 3,095	$ 584
	CRM	CRM.CSD3	1	0.85	0.99	252	0.25	$ 3,095	$ 584
	CRM	CRM.CTSD1	1	0.85	0.99	252	0.25	$ 3,095	$ 584
	CRM	CRM.CTSD2	1	0.85	0.99	252	0.25	$ 3,095	$ 584
	CRM	CRM.CTSD3	1	0.85	0.99	252	0.25	$ 3,095	$ 584
Ladle preheaters and dryers	LM	VLP1	23.88	0.2	0.95	1,473	1.47	$ 73,913	$ 3,420
	LM	VLP2	23.88	0.2	0.95	1,473	1.47	$ 73,913	$ 3,420
	LM	VLP3	23.88	0.2	0.95	1,473	1.47	$ 73,913	$ 3,420
	LM	VLP4	23.88	0.2	0.95	1,473	1.47	$ 73,913	$ 3,420
	LM	HLP1	23.88	0.2	0.95	1,473	1.47	$ 73,913	$ 3,420
	LM	HLP2	23.88	0.2	0.95	1,473	1.47	$ 73,913	$ 3,420

	LM	HLP3	23.88	0.2	0.95	1,473	1.47	$ 73,913	$ 3,420	
	LM	HLP4	23.88	0.2	0.95	1,473	1.47	$ 73,913	$ 3,420	
	LM	HLP5	23.88	0.2	0.95	1,473	1.47	$ 73,913	$ 3,420	
	LM	HLP6	23.88	0.2	0.95	1,473	1.47	$ 73,913	$ 3,420	
	LM	VLD1	17.06	0.2	0.95	1,053	1.05	$ 52,804	$ 2,443	
	LM	VLD2	17.06	0.2	0.95	1,053	1.05	$ 52,804	$ 2,443	
	LM	VLD3	17.06	0.2	0.95	1,053	1.05	$ 52,804	$ 2,443	
	LM	VLD4	17.06	0.2	0.95	1,053	1.05	$ 52,804	$ 2,443	
						Monthly load	**288.24**	**$ 4,775,608**	**$ 669,130**	**Monthly energy charge**
								(Unknown)	**$ 2,190,000**	**Monthly cost of service / dem**
								$ 4,775,608	**$ 2,859,130**	**TOTAL**