



## POLICY BRIEF

# INDIA'S GREEN STEEL TURNING POINT

A POLICY ROADMAP FOR GREEN  
HYDROGEN-DRI/EAF STEELMAKING

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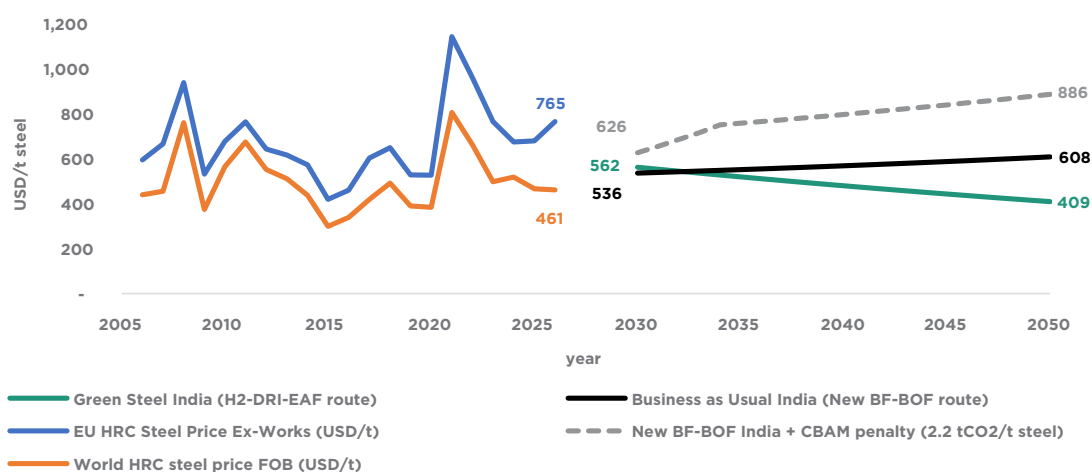
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# EXECUTIVE SUMMARY

India's steel sector remains heavily dependent on imported coking coal. India's next phase of steel expansion would lock the country into more than US\$1 trillion in coking coal imports over the life of these assets, with material implications for energy security, foreign-exchange exposure, and export competitiveness.

The companion IECC technical report, *India is Ready to Scale Up Green Steel Production*, finds that green steel<sup>a</sup> produced through hydrogen-based direct reduced iron with electric arc furnaces (H<sub>2</sub>-DRI/EAF) reaches cost parity with new blast-furnace steel (BF-BOF) by 2030. India can produce green hydrogen at approximately US\$3.00/kg by 2030, roughly half the cost of European benchmarks. At this hydrogen cost, green steel reaches US\$562/t, 5% above new BF-BOF at US\$536/t. That premium reverses once historical coking-coal price increases and INR depreciation are factored in. With continued reductions in electrolyzer and renewable energy costs, delivered green hydrogen falls to approximately US\$2.50/kg by 2035, bringing green steel below US\$500/t. Carbon border measures and low-carbon procurement mandates in major markets will make emissions intensity a determinant of export competitiveness and market access. The chart below shows how these cost trajectories diverge over a plant's operating life.



**FIGURE ES-1:** Steel: Historical Market Prices and Production Cost Projections by Route (Nominal USD/t), 2005-2050.

Sources: European hot-rolled coil (HRC) ex-works price and World HRC free-on-board (FOB) price (historical): SteelBenchmarker. New BF-BOF and H<sub>2</sub>-DRI/EAF projections (2030-2050): IECC (2026). CBAM cost calculation assumes 2.2 tCO<sub>2</sub>/t steel and EU Emission Trading Scheme (ETS) carbon price starting at -US\$85/tCO<sub>2</sub> in 2030 and growing at 2% p.a. (nominal), with the effective CBAM cost adjusted for the legislated free-allowance phase-out schedule (Regulation (EU) 2023/956: 48.5% in 2030, rising to 100% by 2034).

Note: The BF-BOF + CBAM line is illustrative; actual exposure depends on verified emissions, prevailing EU ETS price, and CBAM crediting rules.

<sup>a</sup> IECC defines Green Steel as H<sub>2</sub>-DRI/EAF based steel, as steel produced through the H<sub>2</sub>-DRI process with green hydrogen, with less than 2 kg of CO<sub>2</sub> per kg of hydrogen.

For exports to the EU, green steel is cheaper than new BF-BOF from the first year of operation: US\$562/t versus US\$626/t once CBAM is included. For domestic production, the 5% premium reverses once coal-price and currency adjustments are applied. Green steel costs fall as hydrogen costs decline and electricity contracts remain fixed in rupee terms. BF-BOF costs rise as imported coking-coal prices increase. After factoring in CBAM, the gap widens to nearly US\$480/t by 2050.

## KEY FINDINGS:

- 1. Coal-based expansion locks in over USD 1.2 trillion in import exposure:** India plans approximately 180 MTPA of BF-BOF capacity by 2030–31. With coking-coal prices routinely above US\$200/t, this build-out implies approximately 5.8 billion tonnes of coking-coal imports and over USD 1.2 trillion in import costs over a 40-year asset life. Coking-coal price volatility flows directly through to domestic steel prices.
- 2. Green steel reaches cost parity with new BF-BOF by 2030:** Green steel production costs are approximately US\$562/t in 2030, 5% above new BF-BOF at US\$536/t. This reflects India's advantage in low-cost clean power and competitive green hydrogen. But the BF-BOF estimate does not capture exposure to coking-coal price increases and INR depreciation. When those are included, its effective cost rises to approximately US\$588/t, making green steel roughly 4% cheaper in 2030.
- 3. Carbon border costs widen the BF-BOF cost gap over plant lifetimes:** The EU's CBAM entered its definitive phase on 1 January 2026. Under the legislated phase-in, Indian BF-BOF steel exported to the EU faces an additional border cost of approximately US\$91/t in 2030, rising to over US\$200/t from 2034. For a plant commissioned in 2030, this exposure applies across the asset's entire operating life. As the EU ETS emissions cap approaches zero by 2039, carbon border pricing may give way to product emission standards that exclude non-qualifying imports entirely.
- 4. India's green hydrogen costs are among the lowest globally:** Delivered green hydrogen in India reaches approximately US\$3/kg by 2030. In Europe, comparable costs are two to three times higher. Hydrogen is the largest cost driver in green steel production. India's H<sub>2</sub>-DRI-EAF production costs are among the lowest globally, comparable to China and Brazil and below Australia, Russia, and South Korea.
- 5. India's green steel taxonomy does not yet create a market for near-zero emissions steel:** The taxonomy classifies steel below 2.2 tCO<sub>2</sub>e per ton of finished steel (tfs) as 'green,' from 3★ to 5★. Existing lower-emissions routes can meet this threshold through efficiency measures and renewable electricity procurement, without switching to green hydrogen. Near-zero steel, which the IEA benchmarks at ≤0.4 tCO<sub>2</sub>e/tcs for primary steel, has no dedicated taxonomy tier and therefore no guaranteed demand. We propose Near-Zero Emissions Steel (NZ★, ≤0.40 tCO<sub>2</sub>e/tcs) as a procurement-grade label that creates dedicated demand for near-zero primary steel. A 5% public procurement mandate using NZ★ would create approximately 3.1–3.4 Mt/year of eligible demand

at a budget impact of less than 0.05% of infrastructure spending. Under coal and FX-adjusted scenarios, the mandate becomes cost-saving. The remaining challenge is making first projects financeable and replicable. This brief sets out demand signals (Table ES-1) and policy measures (detailed in Section 3, Table 4) to address two binding constraints: first-plant bankability risk and DR-grade ore/pellet readiness.

**TABLE ES-1:** Recommended Demand Signals

Demand Levers	Implementing Institutions	Timeline
Define NZ★ label: technology-neutral performance gate; notify Monitoring Reporting, and Verification (MRV), registry/retirement rules, and crude↔finished reporting equivalency.	Ministry of Steel (MoS) + National Institute of Secondary Steel Technology (NISST, the nodal MRV agency of steel in India)	2027 taxonomy review (NZ★ notified; published schedule for progressively lowering the emissions threshold)
Create bankable supply via long-term offtake auctions (Green HBI and H <sub>2</sub> -DRI-based steel).	Solar Energy Corporation of India (SECI) (procurement) + Ministry of Steel (specs/eligibility) + Ministry of New and Renewable Energy (MNRE) (green H <sub>2</sub> certification standard)	2028-29 auction/contracting 2032 deliveries begin
5% dedicated public procurement mandate for H <sub>2</sub> -DRI/HBI-EAF steel (NZ★ as eligibility gate), with a ratchet.	Ministry of Steel + Ministry of Finance/line ministries	FY2026-27: Announce FY2031-32 (or 2032): Start; ratchet every ~2 years

**Implementation decision (FY2026-27):** To execute these recommendations, the Government of India must:

1. Notify the NZ★ label as an additional tier within the Green Steel Taxonomy at the next scheduled review, with MRV rules and a published schedule for progressively lowering the emissions threshold.
2. Authorize SECI (or a designated aggregator) to run NZ★-Primary offtake auctions and to execute back-to-back contracts with payment/performance security.
3. Issue a Department of Expenditure procurement circular establishing a phased NZ★-Primary procurement mandate beginning FY2031-32, including exemptions and audit rules.

**Budget impact:** The budget cost is small. A 5% mandate against the Government of India's infrastructure demand base (62-68 Mt/year) implies ~3.1-3.4 Mt/year of eligible demand. The budget impact is less than 0.05% of infrastructure spending. Under coal and FX-adjusted scenarios, the mandate becomes cost-saving (-US\$82-90M/year).

IECC's analysis shows that green steel reaches cost parity with new BF-BOF by 2030. India's low-cost clean power and competitive green hydrogen, give it a structural advantage that few other steel-producing nations can match. This advantage is time-sensitive: as global green steel capacity scales, India's cost edge will narrow. Policy decisions taken between now and 2029 will determine whether the next steel build-out captures this advantage, or locks in decades of imported coal dependence.



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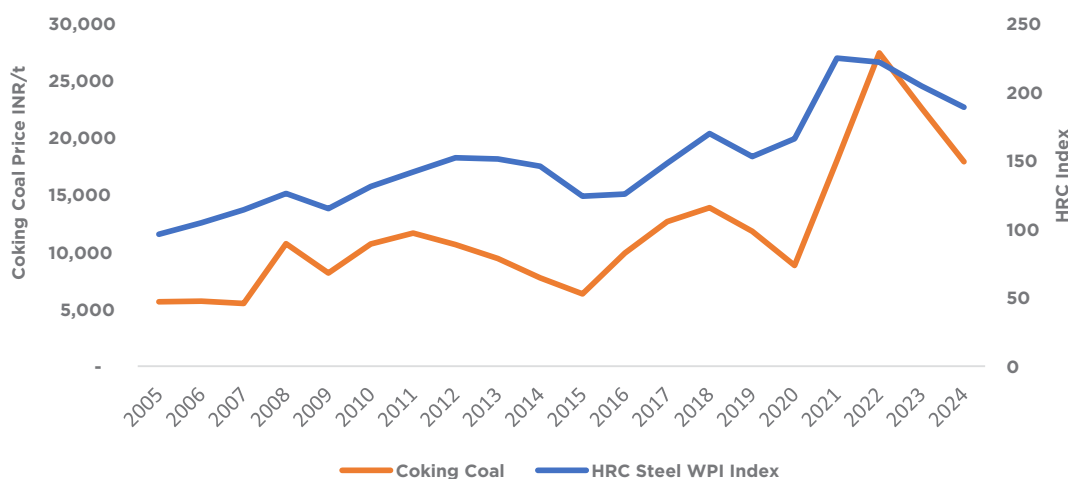
# 1. INDIA'S NEXT STEEL BUILD-OUT: WHAT'S AT STAKE, AND WHY H<sub>2</sub>-DRI/EAF MATTERS

India's steel sector is at a decisive inflection point. The National Steel Policy, 2017 (NSP) targets 300 Mt of installed capacity by 2030–31. 60–65% of capacity is planned on the conventional coal-based BF-BOF route. Because steelmaking assets typically run for 25–40 years, the route chosen for capacity added in the 2030s will shape India's energy security, foreign-exchange exposure, and export competitiveness well into the 2050s and beyond.

## WHAT THE NEXT CAPACITY WAVE PUTS AT STAKE

Five factors, each quantified in this section, make the production route chosen for 2030s capacity additions a strategic decision: over a trillion dollars in coal import exposure, rising carbon border costs (US\$91–200+/t), a cost gap of less than 5% that closes by 2030, inflation-proof rupee-denominated energy inputs, and green hydrogen at roughly half the cost of European benchmarks.

**1. Coal-based steel expansion will lock in long-term import dependence:** On current trajectories, NSP's 2030–31 route mix keeps BF-BOF as the dominant pathway (60–65% of the 300 Mt crude-steel capacity target). Operating BF-BOF at this scale would require on the order of ~161 Mt of coking coal per year once fully ramped.<sup>1</sup> Because domestic availability and usable grades of metallurgical coal are limited, ~90% of coking-coal demand would need to be imported.<sup>2</sup> At recent seaborne coking-coal price of ~US\$200/t,<sup>4</sup> this implies an annual import bill of ~US\$29 billion, and ~US\$1.2 trillion over a ~40-year asset life, running counter to India's stated objective of greater energy independence.<sup>5</sup> Figure 1 illustrates why this import dependence matters for domestic steel-price stability. Over the past two decades, Indian coking-coal import prices (in INR) and domestic hot-rolled coil (HRC) steel prices have moved in close tandem, implying that global coal-market volatility transmits directly into Indian steelmaking costs. Locking the next capacity wave into BF-BOF would perpetuate this structural pass-through for decades.



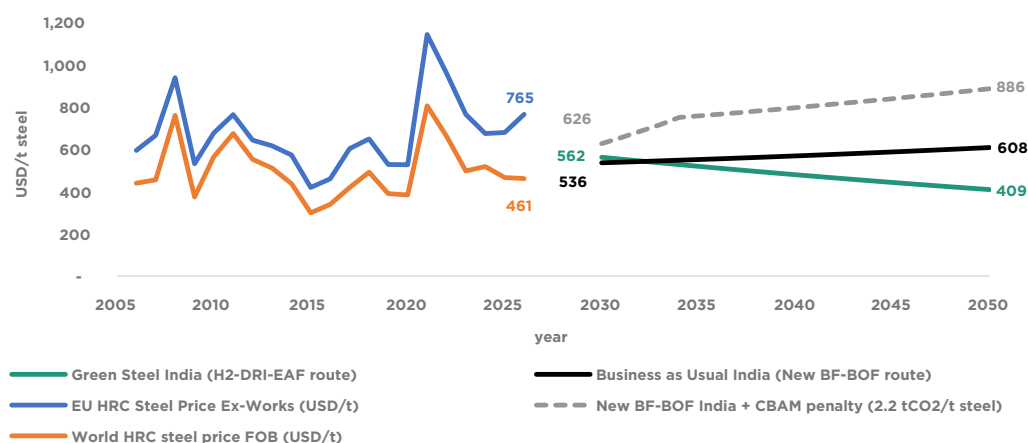
**FIGURE 1:** Coking Coal Import Prices (INR/t) and HRC Steel Wholesale Price Index, 2005–2024.

Sources: Coking coal import prices (INR/t): based on Ministry of Commerce import data and RBI exchange-rate series. HRC Steel Wholesale Price Index: Office of the Economic Adviser, Ministry of Commerce and Industry.

Note: Left axis shows landed coking-coal price in INR per ton; right axis shows the HRC Steel Wholesale Price Index. The two series are closely correlated, illustrating the structural pass-through of imported coal costs into domestic steel prices, underscoring the foreign-exchange and input-price exposure embedded in the BF-BOF production route.

2. **The cost gap between green steel and the new BF-BOF closes by 2030:** Across major studies, the premium for green steel relative to BF-BOF narrows sharply through the 2030s, with many placing cost parity in the 2030–2040 window.<sup>6 11 12 13</sup> IECC’s analysis shows the production cost of green steel reaches US\$562/t by 2030, just 5% above a new BF-BOF at US\$536/t. But this static comparison understates BF-BOF’s true cost. BF-BOF depends on USD-priced imported coking coal, so its costs rise in rupee terms as coal prices increase and the INR depreciates. Green steel’s electricity input can be secured through long-term INR-denominated PPAs (typically 25 years), locking in the main cost in rupee terms. Even under a conservative adjustment that uses half the historical rates for INR depreciation and coking-coal price increases, new BF-BOF rises to -US\$588/t, shifting green steel from a small premium to a cost advantage.<sup>14</sup>
  
3. **Coal-based BF-BOF steel faces rising carbon cost risks and declining export competitiveness over plant lifetimes:** BF-BOF assets commissioned in the 2030s will face rising carbon border costs for their 25–40 year operating lives. The EU’s CBAM entered its definitive phase on 1 January 2026, requiring importers to purchase certificates linked to verified embedded emissions.<sup>36</sup> The effective border cost on Indian BF-BOF steel starts at approximately US\$91/t in 2030 and rises to over US\$200/t from 2034 as free allowances phase out. Other major importing jurisdictions are introducing comparable measures.<sup>7 8 9</sup> Under current legislation, the EU ETS emissions cap reaches

zero by 2039.<sup>52</sup> At that point, CBAM as currently designed has no carbon price to mirror. In road transport, the EU already uses a product emission standard that reaches zero in 2035, effectively excluding non-zero-emission vehicles from the EU market.<sup>53</sup> A comparable standard, if applied to steel, would exclude non-qualifying imports entirely. Green steel is not exposed to these constraints. India's H<sub>2</sub>-DRI-EAF production costs are among the lowest globally, comparable to China and Brazil and below Australia, Russia, and South Korea.<sup>10</sup> Figure 2 illustrates how the cost gap between BF-BOF and green steel widens over a plant's lifetime. It plots historic EU and global finished steel prices (hot-rolled coil) alongside production cost projections for new BF-BOF and new green steel plants in India, both commissioned around 2030. For exports to the EU, green steel is cheaper than new BF-BOF from the first year of operation: US\$562/t versus US\$626/t once CBAM is included. Green steel costs fall as hydrogen costs decline and electricity contracts remain fixed in rupee terms. BF-BOF costs rise as imported coking-coal prices increase. After factoring in CBAM, the gap reaches nearly US\$480/t by 2050.



**FIGURE 2:** Steel: Historical Market Prices and Production Cost Projections by Route (Nominal USD/t), 2005-2050

Sources: EU HRC ex-works price and World HRC FOB price (historical): SteelBenchmarker. New BF-BOF (business as usual) and H<sub>2</sub>-DRI/EAF (green steel) cost projections (2030-2050): IECC (2026), "India is Ready to Scale Up Green Steel Production"; see Annex A for methodology. CBAM cost calculation assumes 2.2 tCO<sub>2</sub> per ton of BF-BOF steel, EU ETS carbon price starting at approximately US\$85/tCO<sub>2</sub> in 2030 and growing at 2% p.a. (nominal), with the effective CBAM cost adjusted for the legislated free-allowance phase-out schedule (Regulation (EU) 2023/956; 48.5% in 2030, rising to 100% by 2034). The BF-BOF + CBAM line is illustrative; actual exposure will depend on verified embedded emissions, the prevailing EU ETS price, and any crediting of carbon prices paid in the country of origin. Green steel costs decline as green hydrogen costs fall from approximately US\$3.00/kg in 2030 toward approximately US\$1.90/kg by mid-century, with renewable electricity locked in via long-term INR-denominated PPAs. Historical series show realized market prices. Forward series show levelized production costs for new plants.

**4. India's green hydrogen costs are among the lowest globally, enabling competitive green steell:** Hydrogen is the dominant cost driver in green steel. IECC estimates delivered green hydrogen in India at ~US\$3.00/kg by 2030, anchored in recent SECI auction results for green ammonia (Sep 2025) and solar-plus-storage (Jan 2026).<sup>14</sup> European costs are two to three times higher: the European Hydrogen Observatory reports €6.71/kg for renewable electrolysis in 2024,<sup>15</sup> and S&P Global reports €10.23/kg for EU-compliant renewable hydrogen production in Spain as of January 2026.<sup>16</sup> As border carbon costs rise in key export markets,<sup>7</sup> this cost advantage positions India to supply verified low-emissions steel or green iron/HBI at prices that undercut both domestic European production and conventional Indian BF-BOF exports. With continued reductions in electrolyzer and renewable energy costs, the technical report estimates that delivered green hydrogen costs fall to approximately US\$2.50/kg, bringing green steel production costs below US\$500/t.

## WHY H<sub>2</sub>-DRI/EAF IS CENTRAL TO INDIA'S NEXT CAPACITY WAVE

Global net-zero roadmaps<sup>17</sup> broadly agree that deep decarbonization of steel rests on two pillars: expanded scrap-based EAF and new low-emissions primary routes such as H<sub>2</sub>-DRI/EAF. In India, multiple studies<sup>13 18</sup> note that limited domestic scrap availability and weak collection systems will constrain the extent to which scrap-EAF can grow in the medium term, especially while in-use steel stocks are still building up. That makes green H<sub>2</sub>-DRI/EAF the most credible near-to-medium-term option for adding large volumes of new primary steel while avoiding deeper long-term dependence on imported coking coal. Efficiency upgrades in existing BF-BOF and coal-DRI units, along with improved scrap utilization, remain essential and should continue. Still, policy must also clearly prioritize and enable step-change routes such as green H<sub>2</sub>-DRI/EAF, so that efficiency measures and renewable electricity procurement in existing routes do not absorb all green procurement demand before H<sub>2</sub>-DRI/EAF reaches scale.

## PURPOSE AND SCOPE OF THIS POLICY BRIEF

Building on the companion IECC technical report's techno-economic findings for green hydrogen-DRI/EAF in India, this policy brief sets out policy recommendations to scale H<sub>2</sub>-DRI/EAF as a near-zero primary route for India's next wave of new steel capacity (with green iron/HBI as an intermediate where relevant). It translates the cost-convergence pathway into an implementable package of actions that can bring early projects to financial close and support replication at scale.

The brief, therefore, combines demand levers with policy measures. On the demand side, it proposes a sequenced set of signals—a Near-Zero Emissions (NZ★) label within India’s green steel taxonomy<sup>29</sup>, long-term offtake tenders/auctions through a government-backed intermediary, and a time-bound green public procurement tranche with a clear NZ★ carve-out as supply scales. In parallel, it specifies policy enablers mapped to the two constraints detailed in Section 2—high-hydrogen DRI operational risk and DR-grade ore/pellet readiness, so that first plants can be deployed with manageable technical and supply-chain risk. For each element, the brief identifies the responsible institutions and indicative timelines, which are consolidated in tables 1 and 4.



## 2. RESPONDING TO TWO KEY CONSTRAINTS

This section focuses on two practical constraints repeatedly highlighted in policy and industry discussions that can delay investment decisions: high-hydrogen DRI operational risk and DR-grade ore/pellet readiness. First, operating DRI furnaces on very high hydrogen shares is technically and operationally risky. Second, that H<sub>2</sub>-DRI requires DR-grade ore and pellets, and that India may not be able to supply these reliably at scale, either because suitable ore is scarce or because beneficiation and pelletization are too difficult or costly. The subsections that follow summarize the evidence for each concern. The policy response is then consolidated in the policy recommendations section, which also identifies the key implementing institutions.

**Concern 1 - “Using 100% hydrogen in DRI furnaces is technologically too risky.”** In conversations with industry and policymakers, a recurring concern is that there are no operating plants that run continuously on 100% green hydrogen, and that most demonstrations use blends. This is often taken as evidence that high-hydrogen DRI is not technically ready, or that moving from natural gas to hydrogen will expose operators to unacceptable risks to process and product quality.

**What the evidence shows:** The IECC technical review, Feasibility of Green Hydrogen Use in Natural Gas DRI Furnaces<sup>19</sup>, finds that, for mainstream shaft-furnace technologies such as MIDREX and ENERGIRON, shifting from natural-gas-based syngas to hydrogen-rich gas is an incremental retrofit, not a fundamental redesign. The core reactor, burden handling, and gas-circulation concepts remain the same; the main changes are in auxiliary systems, including process-gas compression, heat recovery, cooling circuits, instrumentation, and safety systems.

Laboratory and pilot work, and vendor experience, show that hydrogen reduces iron oxides faster than carbon monoxide at typical DRI temperatures, enabling equal or higher metallization at similar residence times. Product carbon content is lower under pure hydrogen, but this can be managed either through small hydrocarbon additions in the shaft or through standard adjustments in electric-arc-furnace practice.

The technical review also documents projects already operating with high hydrogen shares. For example, HBIS’s ENERGIRON module at Xuanhua illustrates the direction of travel: vendor/project reporting indicates operation at hydrogen shares above 60% and a design that includes CO<sub>2</sub> removal/capture and utilisation, with claimed net emissions on the order of ~125 kg CO<sub>2</sub> per ton of DRI.<sup>49</sup>

While these disclosures are not a substitute for a harmonised MRV standard, they demonstrate that high-hydrogen operation and deep emissions reductions are technically plausible when paired with appropriate process design and CO<sub>2</sub> management. In the Middle East, Emirates Steel has successfully used green hydrogen to replace part of the natural-gas feed in an operating MIDREX module. India now has its own early reference points. At Vijayanagar in Karnataka, JSW Steel is investing in green hydrogen to supply its DRI unit, enabling lower-carbon DRI production. At Salav in Maharashtra, JSW has a 0.9 million ton per year DRI unit and plans to expand the site to around 4 million tons per year as a green-steel facility built around hydrogen-based DRI.<sup>20 21</sup>

Available evidence suggests the binding constraints are currently economic and infrastructural (hydrogen cost, continuous availability, and permitting), rather than core process feasibility, because multiple projects have demonstrated high H<sub>2</sub> substitution rates under specific operating conditions. As noted earlier, in Europe and other advanced markets, power and hydrogen remain expensive and uncertain, which makes full substitution commercially unattractive today. Under India's lower renewable-power costs and emerging hydrogen price signals, the constraint is primarily commercial and financial, not a question of whether shaft furnaces can, in principle, run on hydrogen.

**Policy implication:** Addressing perceived technical risk around high-hydrogen DRI requires clearer risk allocation in contracts, targeted use of existing innovation support, and, where appropriate, modular deployment models.

**Concern 2 – “H<sub>2</sub>-DRI requires 67% Fe ore, and India's iron ore is not suitable or is too costly to upgrade”** Vendor guidance and industry practice indicate that shaft furnaces perform best on higher-grade, low-gangue feed. Pellets in the 66–67% Fe range are commonly referenced as a DR-grade benchmark because higher quality reduces slag volumes, energy use, and iron losses in DRI-EAF steelmaking.<sup>22</sup> Hematite accounts for roughly three-quarters of India's iron-ore resources, with around 40–45% of those hematite resources in a medium-grade band (about 62–65% Fe) and a significant share in lower-grade categories below 60% Fe<sup>1</sup>. Production and processing practices generate large volumes of fines and slimes in the 50–60% Fe range, often with elevated alumina content, that require beneficiation before they can be used efficiently in direct-reduction routes. This has raised concerns that India either lacks the required ore quality for H<sub>2</sub>-DRI or would face technically difficult, prohibitively expensive, and environmentally burdensome beneficiation to achieve DR-grade quality.

**What the evidence shows:** Indian studies and international practice point to a more nuanced picture. They show that low-grade hematite and magnetite can, in many cases, be upgraded to pellet-grade and even DR-grade concentrates using established flowsheets, and that, for shaft-furnace DRI, ore quality is often treated as a trade-off between beneficiation costs and downstream slag and energy costs rather than as a single hard cut-off.<sup>23</sup>

Work by Indian research groups, including CSIR–National Metallurgical Laboratory (CSIR–NML), demonstrates that hematite slimes and fines with Fe contents around 50–55% can be beneficiated, through combinations of washing, gravity separation, magnetic separation, and flotation, to concentrates in the mid-60s to high-60s percent Fe with impurity levels suitable for pelletization and ironmaking.<sup>24</sup> A recent technical review of low-grade iron-ore beneficiation techniques reaches similar conclusions, noting that such ores can be upgraded to meet steel-industry requirements using conventional circuits, while emphasizing that energy use, water consumption, and tailings need careful management.<sup>25</sup> International experience provides a benchmark: Brazilian producers such as Vale have supplied pellets with Fe contents at or above 67% to shaft-furnace DRI plants for many years, using beneficiated itabirite ore, typically containing about 35–60% Fe, as pellet feed<sup>26</sup>.

The companion IECC technical report adopts cost assumptions broadly consistent with this evidence. For India, it assumes base fines of around US\$80 per ton and adds about US\$37 per ton for beneficiation, pelletization, and logistics, yielding DR-grade pellets at approximately US\$117 per ton.<sup>14</sup> By comparison, international DR-grade pellet benchmarks often exceed US\$150 per ton once base ore and pellet premiums are combined. These figures suggest that, for suitable deposits and locations, upgrading a portion of India's ore to DR-grade quality could be economically competitive with importing DR-grade pellets, although project-specific analysis will still be needed.

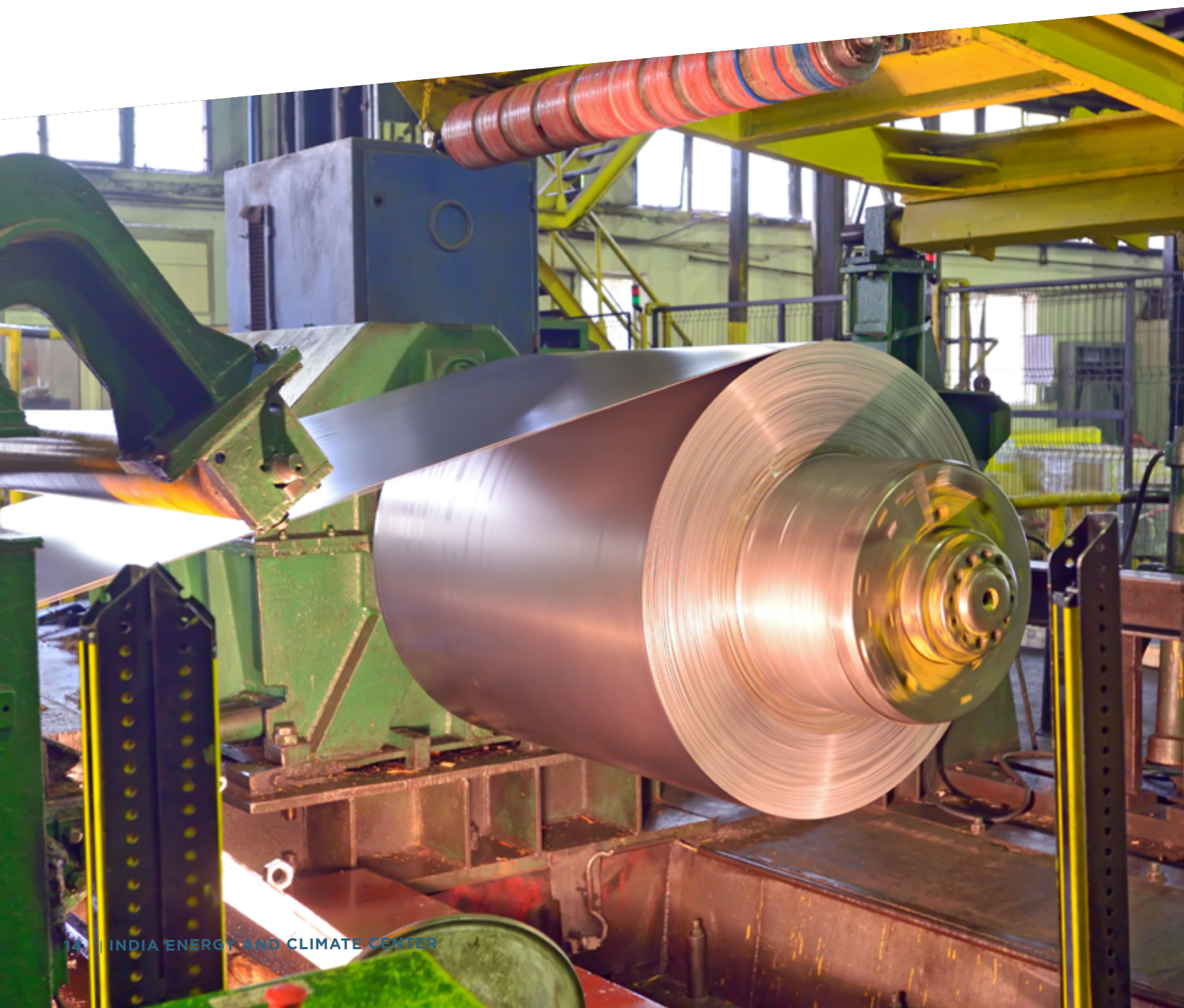
In addition to hematite, resource assessments report magnetite resources totaling 10–11 billion tons in India.<sup>1</sup> Concentration studies on Indian magnetite indicate that these materials can be upgraded to pellet-grade concentrates with Fe levels suitable for DRI and that pellets produced from such concentrates can meet the required metallurgical performance.<sup>27</sup> This suggests that, in principle, magnetite may offer an additional source of high-grade pellet feed for H<sub>2</sub>-DRI, provided deposits are developed in locations and on scales that make economic and environmental sense.

Plant-level practice in India also supports the view that there is no single hard Fe cut-off from a process standpoint. ArcelorMittal Nippon Steel (AM/NS) India has indicated that its gas-based DRI plant in Gujarat operates with pellets at about 64% Fe rather than 67% Fe, because beyond that point, the extra beneficiation cost would exceed the savings from lower slag and energy use in the EAF. For that ore body, the appropriate Fe grade is therefore determined by the overall cost balance, not by an absolute technical minimum.

Taken together, these findings suggest that, for commercial shaft-furnace H<sub>2</sub>-DRI in India, ore quality may be best viewed as a design and cost parameter rather than as an absolute technical barrier at 67% Fe. Fe grades in the mid-60s may be workable where the trade-off between beneficiation cost and downstream slag and energy use is favorable. Where very high-grade pellets are required, Indian hematite and magnetite can, in many cases, be beneficiated to DR-grade quality using established technologies, and, under the IECC

cost assumptions, such pellets could be produced at costs that are competitive with international DR-grade pellet prices. At the same time, low-grade iron-ore beneficiation is energy- and water-intensive and generates tailings that can affect water and soil quality if not managed carefully. Those environmental aspects will require further assessment and mitigation planning, but a full treatment of them lies outside the scope of this policy brief.

**Policy implication:** Policy can address ore-quality concerns by making the ore and pellet strategy for H<sub>2</sub>-DRI explicit and by improving the economics of upgrading and using higher-quality feed, hematite, and magnetite, where that is efficient and consistent with environmental and societal objectives.



# 3. POLICY RECOMMENDATIONS TO SCALE H<sub>2</sub>-DRI/HBI-EAF

Recent India-focused analyses <sup>6 11 12 13</sup>, including the Ministry of Steel report on Greening the Steel Sector in India <sup>28</sup>, converge on three requirements for scaling low-emissions primary steel: MRV-backed definitions, bankable demand through offtake and green public procurement, and enabling measures that reduce first-plant risk. This brief translates those requirements into specific policy instruments — a Near-Zero Emissions Steel (NZ★) label, a SECI-style pooled offtake auction, a dedicated public procurement mandate, and targeted enablers — with identified implementing institutions and timelines.

The brief proposes NZ★ as an additional top-tier within India’s green steel taxonomy/certification architecture <sup>29</sup>, distinct from the existing 3★/4★/5★ ladder. NZ★ is defined as steel with verified emissions intensity  $\leq 0.40$  tCO<sub>2</sub>e per ton of crude steel, assessed under the taxonomy’s notified MRV boundary, aligned with the IEA near-zero benchmark for primary steel. It is performance-based and route-neutral: any production route that meets the threshold can qualify, including scrap-based EAF, H<sub>2</sub>-DRI/EAF, or other emerging pathways. However, because the immediate policy goal is to de-risk first-of-a-kind investments in primary near-zero steel, the demand instruments proposed in Steps 2 and 3 are targeted to NZ★-eligible steel produced with H<sub>2</sub>-DRI/HBI as the primary iron input. Other NZ★-eligible routes remain eligible for certification but do not draw on the FOAK offtake budget unless explicitly included via a separate window.

The economic case for green steel is established in Section 1. The remaining barrier is bankability. This brief addresses it through three demand signals — an NZ★ label (Step 1), a SECI-style pooled offtake auction <sup>30, 31</sup> (Step 2), and a dedicated public procurement mandate (Step 3) — paired with export-oriented accelerators and policy enablers mapped to the two constraints identified in Section 2. In premium importing markets, carbon border measures and the EU’s Industrial Accelerator Act<sup>51</sup> are creating mandated demand for low-carbon steel. Alongside India’s recent FTAs with the EU and the UK, export-linked value chains can provide an early market for NZ★ volumes. Table 1 summarizes the demand signals, and Table 4 links policy measures to the two binding constraints.

**TABLE 1:** Recommended Demand Signals

Demand Levers	Implementing Institutions	Timeline
Define NZ★ (Near-Zero Emissions Steel) label: technology-neutral performance gate; notify MRV, verification, registry/retirement rules, and crude↔finished reporting equivalency.	Ministry of Steel + NISST (nodal MRV agency)	2027 taxonomy review (NZ★ notified; published schedule for progressively lowering the emissions threshold.)
Create bankable supply via long-term offtake auctions (Green HBI and H <sub>2</sub> -DRI-based steel).	SECI (procurement) + Ministry of Steel (specs/eligibility) + MNRE (green H <sub>2</sub> certification standard)	2028-29 auction/contracting 2032 deliveries begin
5% dedicated public procurement mandate for H <sub>2</sub> -DRI/HBI-EAF steel (NZ★ as eligibility gate), with a ratchet.	Ministry of Steel + Ministry of Finance/line ministries	Announce in FY2026-27 FY2031-32 / 2032 start; ratchet every ~2 years

## DEMAND SIGNALS

**Step 1 (2027): Define a Near-Zero Emissions label (NZ★):** India’s Green Steel Taxonomy defines ‘green’ finished steel as emission intensity below 2.2 tCO<sub>2</sub>e per tfs, with the most stringent band (5★) set at below 1.6 tCO<sub>2</sub>e/tfs.<sup>29</sup> Gas-based DRI-EAF plants can reach 4★-5★ with renewable electricity procurement, and BF-BOF at global best practice can reach 3★-4★.<sup>50</sup> If green procurement mandates reference this broad definition, they can be met by these existing routes, without creating a dedicated demand signal for first-of-a-kind near-zero volumes such as H<sub>2</sub>-DRI/HBI-EAF.

Step 1 is therefore to use the taxonomy review (target 2027)<sup>28</sup> to introduce NZ★ as an additional tier within India’s green steel certification framework, operating as an additional eligibility gate above the 3★/4★/5★ ladder. The NZ★ threshold is set at ≤0.40 tCO<sub>2</sub>e per ton of crude steel, aligned with the IEA near-zero benchmark for primary steel.<sup>30</sup> Scrap-based EAF, the lowest-emission steelmaking route currently operating in India, reports emissions of 0.55-0.65 tCO<sub>2</sub>e/tcs, above the NZ★ threshold.<sup>28</sup>

**NZ★ measurement boundary and unit alignment:** NZ★ certification will use the same MRV boundary and accounting rules as India's Green Steel Taxonomy: Scope 1 and Scope 2 emissions plus the taxonomy's defined 'limited Scope 3' up to the finished-steel boundary (including agglomeration, beneficiation, and embodied emissions in purchased raw materials/intermediates), excluding upstream mining and transportation emissions. NZ★ will be reported in both tCO<sub>2</sub>e/tcs (for process comparability) and tCO<sub>2</sub>e/tfs (for consistency with the taxonomy), using audited plant- and product-specific yield factors disclosed in the NISST registry.

**NZ★ implementation requirements:** To make NZ★ usable in procurement and offtake contracts, MoS/NISST should publish at notification: (i) the applicable emissions-factor and calculation rules within the Taxonomy boundary (including electricity emission-factor treatment and renewable-attribute rules), (ii) minimum audited disclosures (electricity sourcing/emission factor, metallic charge composition including scrap share, fuels/reductants, and process emissions), and (iii) third-party verification requirements (including verifier qualifications, audit frequency, and assurance level).

**Claims management and tightening:** NZ★ claims in procurement and offtake should be backed by a digital registry in which certificates are issued for verified tons and retired by the claiming entity at sale or delivery (one ton = one claim). NZ★ should be notified with a published schedule for progressively lowering the emissions threshold (e.g., every three years) to track grid decarbonization and international market expectations while providing investment visibility.

**Step 2 (2028/29): Create bankable supply for H<sub>2</sub>-DRI-based steel via a SECI-style auction for 2032 delivery:** SECI's green-ammonia procurement under the National Green Hydrogen Mission provides a workable template: it aggregated demand at scale (724,000 t/year across 13 plants) and awarded 10-year offtake through an intermediary structure with e-reverse-auction price discovery, backed by a payment security mechanism.<sup>31 32</sup> It also benefited from whole-of-government governance — demand creation and competitive bidding overseen by an Empowered Group chaired by the Cabinet Secretary, a useful precedent for aligning stakeholders behind a steel offtake instrument.<sup>33</sup>

Step 2 applies the same architecture to NZ★-eligible green HBI and green steel, with a steel-appropriate contract model that avoids the intermediary taking full commodity price risk. By 2028/29, a designated intermediary (SECI or an equivalent notified agency) should run a competitive auction to award long-term offtake for (i) green HBI/DRI as a tradable intermediate and (ii) a limited set of standard primary-steel products/grades where feasible, with deliveries beginning in 2032. The bid variable should be a simple, auditable near-zero premium (₹/t) on top of a transparent reference index price for the underlying product, rather than a fully fixed delivered steel price; this preserves bankability while minimizing fiscal and commodity-price exposure.

Eligibility should remain simple and verifiable. 'Green hydrogen' for NZ★ eligibility will mean hydrogen meeting India's notified standard of  $\leq 2$  kg CO<sub>2</sub>e per kg H<sub>2</sub>, calculated on a 12-month average, with certification per MNRE's notified methodology.<sup>34</sup> All deliveries must meet NZ★ requirements and be traceable through batch IDs with registry issuance and retirement of NZ★ claims at sale or invoicing. Failure to deliver contracted NZ★ volumes triggers standard remedies under the offtake agreement and the payment-security mechanism.

**Step 3 (2032): Dedicated public procurement mandate for H<sub>2</sub>-DRI/HBI-EAF steel (NZ★ as eligibility gate):** This brief proposes a time-bound public procurement mandate to anchor early H<sub>2</sub>-DRI/HBI-EAF capacity by converting a small share of government demand into a predictable offtake stream for NZ★-certified steel. The mandate should be notified in FY2026-27 and take effect from FY2031-32, applying to steel procured for centrally funded infrastructure projects (including government of India agency procurements and Engineering, Procurement, and Construction contracts) above a defined tender threshold, with the obligation placed on the procuring entity. Covered categories should be specified upfront (e.g., rebar, structural steel, plate, and other high-volume infrastructure steel categories).

Annual reporting should disclose mandated volumes procured, average premiums paid, number of waivers, and verified emissions intensity of supplied NZ★ steel. The mandate should increase on a predictable cadence (e.g., every two years), conditional on verified supply build-out and MRV readiness.

## OPERATIONALIZING THE PUBLIC PROCUREMENT MANDATE

The Government of India should notify the mandate through a Department of Expenditure circular under the General Financial Rules, applicable to Central Ministries/Departments, CPSEs, and all EPC contracts financed wholly or partly by the Central Government. Beginning FY2031-32, at least 5% of eligible steel tonnage procured for covered public works shall be sourced as NZ★-Primary certified steel, where technically feasible.

**Eligibility and verification:** Compliance will be demonstrated through NISST-issued certificate IDs linked to each delivery batch and recorded in the procurement system (e.g., GeM/CPWD contract documentation).

**Exemptions:** A time-bound exemption may be granted only when (i) NZ★-Primary supply is unavailable at required specification/lead time, (ii) safety-critical grades cannot be met, or (iii) premium exceeds a notified cap; exemptions must be recorded and published for auditability.

**Ratchet and review:** The mandate share shall be reviewed every two years and increased in line with verified domestic supply and cost trends.

## FISCAL SIZING AND INFRASTRUCTURE BUDGET IMPACT

This brief uses the Ministry of Steel’s infrastructure demand base for 2030–31 (62–68 Mt/year of government steel consumption for infrastructure).<sup>28</sup> A 5% mandate implies ~3.10–3.40 Mt/year of NZ★-eligible demand (Table 2). Budget impacts are estimated using 2030 Levelized Cost of Steel (LCOS) from the IECC technical report:<sup>14</sup> new BF-BOF at ~US\$536/t and new H<sub>2</sub>-DRI/EAF at ~US\$562/t, implying a ~US\$26/t premium. The infrastructure budget impact is reported as a percentage of total infrastructure cost, assuming steel constitutes ~20% of total government expenditure<sup>28</sup>

**TABLE 2:** Mandated volume under a 5% public procurement mandate

Infrastructure Steel Demand (Mt/yr), 2030–31	Mandated Share	NZ★-eligible Mandated H <sub>2</sub> -DRI/HBI-EAF Volume (Mt/yr)
62	5%	3.10
68	5%	3.40

Table 3 reports the annual procurement cost (or saving) under 2030 cost scenarios from the IECC technical paper, alongside an indicative share of total infrastructure budget (with steel assumed at ~20% of total expenditure).<sup>28</sup> Budget impacts are estimated using 2030 base case LCOS from the IECC technical paper.<sup>14</sup>

**TABLE 3:** Budget impact of a 5% H<sub>2</sub>-DRI/HBI-EAF mandate (2030–31)

BF-BOF Scenario (2030)	BF-BOF Cost (US\$/t)	H <sub>2</sub> -DRI/EAF Cost (US\$/t)	Δ Cost (H <sub>2</sub> -BF) (US\$/t)	Impact at 62 Mt (US\$ m/yr)	Impact at 68 Mt (US\$ m/yr)	% Impact on Total Infrastructure Budget
BF-BOF (base)	536.00	562.00	+26.00	+80.6	+88.4	+0.0485%
BF-BOF (INR/USD depreciation + coal inflation)	588.46	562.00	-26.46	-82.03	-89.98	-0.0450%

The budget impact is less than 0.05% of infrastructure spending. Under coal and FX-adjusted scenarios, the mandate becomes cost-saving.

## ENABLING MEASURES TO DE-RISK EARLY H<sub>2</sub>-DRI/HBI-EAF DEPLOYMENT

Demand signals alone may not be sufficient. Even with an NZ★ designation, bankable pooled offtake, and a public procurement mandate, investment can stall unless two binding constraints are addressed: (1) bankability risk for early plants operating at high hydrogen shares, and (2) reliable access to suitable ore and pellets at scale. The enabling measures below are mapped to those constraints, and to a cross-cutting deployment objective: use export-linked demand to accelerate the first commercial-scale plants, then transfer learning for domestic replication.

**TABLE 4:** Export Accelerators and Policy Enablers linked to the two binding constraints

Cross-Cutting Deployment Accelerators	Enabler	Policy Levers	Implementing Institutions
1.Export-oriented deployment accelerators	Special Economic Zone-enabled Green Steel Acceleration Zones	Notify 2-3 fast-track zones with single-window clearances, priority grid connections for contracted clean power/hydrogen systems, coordinated rail/port access, time-bound incentives; eligibility tied to NZ★ certification; include learning/MRV disclosure requirements.	State governments + MoCI (SEZ/ industrial facilitation) + MoS/NISST (NZ★ certification/MRV gate) + utilities/ports/ rail
	Export Credit Agency-backed buyer credit/ guarantees	Create a targeted export finance window that supports export receivables/credit enhancement and enables ECA-backed buyer credit for imported technology packages; standardize documentation tied to NZ★ eligibility.	MoF + Exim Bank/ ECGC + commercial lenders + MoCI; foreign ECAs; MoS/NISST (eligibility/MRV)
	Priority lending	Fast-track domestic lending for enabling infrastructure and eligible NZ★ projects; provide External Commercial Borrowing facilitation for export-hedged projects with standardized templates and MRV gating.	RBI + MoF + DFIs/ banks + MoS/NISST

Cross-Cutting Deployment Accelerators	Enabler	Policy Levers	Implementing Institutions
2. H <sub>2</sub> -DRI operational / bankability risk	Performance guarantees	Make performance guarantees a standard requirement in early H <sub>2</sub> -DRI EPC/technology contracts, supported by model clauses.	Steel producers (contracting) + technology providers; MoS (model clauses / guidance)
	Targeted technical-risk cover	Use Research Development and Innovation Fund <sup>35</sup> (or equivalent) as partial risk cover for clearly defined technical under-performance in early projects (limited, milestone-linked).	Steel producers (proposals) + DST (approval/design)
3. DR-grade ore/pellets availability at scale	Modular/staged deployment	Enable standalone Green HBI modules with long-term offtake to EAF steelmakers (reduces integration risk; allows traded intermediate).	Industry consortia (H <sub>2</sub> + DRI + steelmakers) + MoS; MoCI (siting/ approvals)
	Ore & pellet strategy (incl. magnetite)	Convene and publish an H <sub>2</sub> -DRI ore-and-pellet strategy: map hematite + magnetite supply potential, Fe-range performance guidance, and projected DR-grade pellet demand as H <sub>2</sub> -DRI capacity scales.	MoS + Ministry of Mines; technical working group (GSI, CSIR-NML, MECON, states, industry)

## EXPORT-ORIENTED DEPLOYMENT ACCELERATORS

**Green Steel Acceleration Zones (SEZ-enabled):** Export-oriented near-zero steel projects face a coordination problem: land, statutory clearances, grid connection, and port/rail logistics sit across multiple agencies and levels of government, and delays can quickly undermine bankability.<sup>44 45</sup> A practical approach is to notify 2–3 Green Steel Acceleration Zones using an SEZ-enabled mechanism anchored in the SEZ framework’s single-window clearance model,<sup>47</sup> offering a minimum package: streamlined land processes, single-window statutory clearances with published timelines, priority grid connection for contracted renewable power, and coordinated rail/port handling for export shipments.

The zones should not be for exports only. They can serve as a test-and-scale mechanism to prove operating performance, establish contracting templates, and reduce execution risk so the model becomes replicable for domestic procurement. Eligibility should be restricted to NZ★-compliant output, incentives should be time-bound and tied to commissioning and verified production, and annual scorecards should track time-to-commission, verified emissions intensity, and grid/port performance.

**Export Credit Agency (ECA)-backed financing for imported technology packages:** Major H<sub>2</sub>-DRI packages (DR modules, EAFs, and associated equipment) often involve non-Indian OEMs,<sup>41</sup> making ECA-backed buyer credits a practical accelerator: they reduce lender risk, improve tenor, and lower borrowing costs when equipment is sourced from ECA-covered jurisdictions. There is a direct precedent: Salzgitter secured a €500 million ECA-backed financing package for a DRI plant and EAF, covered by SACE (Italy) and OeKB (Austria).<sup>42</sup> The IEA has also noted that export credit agencies can expand guarantee programs for first-of-a-kind projects.<sup>43</sup> India could establish an inter-agency ECA facilitation desk to standardize the documentation ECAs require — NZ★ MRV evidence, offtake and payment security, clean-power sourcing — and coordinate domestic approvals so ECA financing remains executable on project timelines.

**Priority lending/ECB facilitation window:** Green steel projects are capex-heavy and face longer construction cycles,<sup>38</sup> making financing terms a material cost driver. The RBI's Priority Sector Lending directions already include renewable energy as an eligible category.<sup>37</sup> Building on this precedent, a green-steel financing window could (i) clarify bank-lending eligibility for clean-power and grid infrastructure contracted to NZ★ projects, and (ii) establish a fast-track processing lane with standardized documentation for large-ticket project finance via development finance institutions and consortium lending.

For offshore funding, an External Commercial Borrowing (ECB)<sup>39 40</sup> facilitation lane is relevant for export-oriented NZ★ capacity where revenues are partially FX-linked, improving natural hedging. The facility should be explicitly conditioned on FX risk management: export offtake, a natural hedge, or a defined hedging plan.

## **CONSTRAINT 1 ENABLERS: H<sub>2</sub>-DRI OPERATIONAL AND BANKABILITY RISK**

Even where levelized costs converge, early green steel projects face lender and buyer hesitation because commissioning and performance outcomes are not explicitly allocated in contracts or bounded by credible risk-sharing instruments.

**Performance guarantees:** A core constraint in early H<sub>2</sub>-DRI deployment is that lenders and buyers treat commissioning and operational outcomes as 'technology risk' when they are not translated into measurable, enforceable obligations. A practical response is to make performance guarantees a standard requirement in early H<sub>2</sub>-DRI EPC/technology packages, supported by model clauses that define (i) measurable performance outcomes (module availability, throughput, DRI metallisation and product-quality envelopes, specific energy-consumption ranges, and safety compliance), (ii) a commissioning and sustained-operation test regime (including minimum continuous run requirements and ramp profiles), and (iii) enforceable remedies (liquidated damages with cure periods, step-in rights for repeated non-performance, and explicit warranty interfaces between OEM and EPC). The intent is not to over-specify engineering design, but to ensure that early projects have standardised performance evidence that financiers can underwrite.

This approach has clear GoI precedent. The General Financial Rules (Rule 171) already require performance security in the 3–5% range for goods and services, with validity beyond contractual obligations including warranties. More directly, SECI's Green Ammonia auctions require selected bidders to submit a Performance Bank Guarantee before contract signing, with verification and enforceable consequences for non-compliance.<sup>51</sup> The same contracting architecture, performance-linked securities, verification before contract execution, and enforceable consequences, can be adapted for early H<sub>2</sub>-DRI/HBI offtake and EPC packages.

**Targeted technical-risk cover:** A limited, milestone-linked technical-risk cover can help first-of-a-kind near-zero steel projects reach financial close by addressing a narrow set of clearly defined under-performance risks.<sup>43</sup> The Government of India has repeatedly used rules-based risk-sharing for this purpose. The Partial Risk Guarantee Fund for Energy Efficiency<sup>48</sup> under the Ministry of Power/BEE framework provides partial risk coverage to commercial banks with defined caps and payout rules. India's RDI Fund/ANRF framework<sup>35</sup> offers commercialisation finance (including loan/equity/hybrid instruments up to a defined share of project cost) for higher-TRL deployment. Either vehicle could be adapted for early H<sub>2</sub>-DRI projects.

The instrument should be limited to FOAK projects, time-bound, and capped per project, with objective and independently verifiable triggers — for example, a sustained-operation test shortfall against a pre-defined performance envelope. It should include co-insurance so sponsors retain meaningful exposure, and should favour structures that preserve discipline, such as contingent support or a partial guarantee layer.

**Modular deployment (Green HBI modules):** A practical staged pathway is to enable standalone Green HBI/DRI modules, supported by long-term offtake, as a modular deployment route that reduces integration risk while creating a tradable intermediate for EAF steelmakers and export-oriented buyers. Using the same SECI intermediary template described in Step 2, Green HBI can be treated as a tradable intermediate with multiple buyer pathways, domestic EAFs or export contracts, so early projects are not dependent on a fully integrated green steel demand ramp in the first wave. This shortens the critical path to first revenues and broadens the buyer set, making offtake more bankable.

## **CONSTRAINT 2 ENABLER: ENSURING DR-GRADE ORE/PELLETS AND COORDINATED SITING/LOGISTICS**

**Ore and pellet strategy:** Section 2 establishes that ore quality should be treated as a design and cost parameter rather than a single hard cut-off, and that beneficiation and pelletisation pathways are plausible but require coordination. A credible policy response is a published ore-and-pellet strategy for H<sub>2</sub>-DRI that maps hematite and magnetite supply potential with clearly cited sources, provides practical guidance on DR performance across relevant Fe ranges, outlines projected DR-grade pellet demand as H<sub>2</sub>-DRI capacity scales, and sets safeguards and siting guidance for water, tailings, and energy requirements.

## 4. CONCLUSION

India's planned BF-BOF build-out of approximately 180 MTPA locks in over \$1 trillion in imported coking-coal costs, rising carbon border costs in export markets, and structural foreign-exchange exposure — all over asset lives of 25 to 40 years. Green steel reaches cost parity with new BF-BOF by 2030 once historical coking-coal price increases and INR depreciation are factored in. India's low-cost clean power and competitive green hydrogen give it a production-cost advantage that few other steel-producing nations can match.

The barrier is not economics. It is bankability. India's Green Steel Taxonomy does not yet distinguish near-zero steel from conventionally improved steel. No pooled offtake mechanism exists for near-zero volumes. Early projects face bankability risks that standard project finance cannot address. This brief sets out a practical sequence to close these gaps: an NZ★ label within the taxonomy (Step 1, 2027), a SECI-style pooled offtake auction (Step 2, 2028/29), and a 5% public procurement mandate (Step 3, 2032) — supported by export-oriented accelerators and targeted enablers for the two binding constraints: H<sub>2</sub>-DRI bankability risk and DR-grade ore/pellet readiness. The budget impact of the 5% mandate is less than 0.05% of infrastructure spending. The proposed package is implementable within existing institutions and timelines set out in Tables 1 and 4.

The decisions that matter will be taken between now and 2029. They will determine whether the next steel build-out captures India's cost advantage in green steel, or commits another generation of critical infrastructure to imported coal dependence.



# ANNEX: METHODOLOGICAL NOTES ON FIGURES 1 AND 2

## FIGURE 1: COKING COAL IMPORT PRICES AND HRC STEEL WPI INDEX

Figure 1 plots two series over the period 2005–2024 (fiscal years, aligned to calendar year for display):

(a) Coking coal import price (INR/t), left axis. Calculated from annual aggregate import values and volumes reported by the Ministry of Commerce and Industry (Directorate General of Commercial Intelligence and Statistics), converted to landed cost per ton in Indian rupees. The INR values incorporate the average annual INR/USD exchange rate (Reserve Bank of India reference rate) and therefore capture both international coal-price movements and currency depreciation. Raw data aggregate fiscal-year import statistics from the Ministry of Coal’s annual publications and DGCIS trade data; the underlying calculations are documented in the companion IECC technical report, “India is Ready to Scale Up Green Steel Production” (IECC, February 2026).

(b) HRC Steel Wholesale Price Index (WPI), right axis. The Hot Rolled Coil (HRC) Steel WPI is sourced from the Office of the Economic Adviser, Ministry of Commerce and Industry, Government of India. The series used is the WPI sub-index for Hot Rolled Coils under the “Basic Metals” commodity group. Data are sourced from the Office of the Economic Adviser and aligned to the coking-coal series in the companion IECC technical report. For fiscal years 2017 onward, the WPI series was extended using the updated base-year series published by the Office of the Economic Adviser, indexed to the same scale for visual continuity.

The two series are closely correlated, illustrating the structural pass-through of global coking-coal price movements into domestic Indian steel prices. Because India imports approximately 90% of its metallurgical coal requirements, international coal-price spikes (e.g., 2008, 2021–22) transmit directly into Indian steelmaking costs with limited buffering. This relationship underpins the argument in Section 1 that BF-BOF capacity additions embed long-lived foreign-exchange and commodity-price exposure.

## FIGURE 2: STEEL PRICES AND PRODUCTION COSTS IN NOMINAL US DOLLARS

Figure 2 combines two historical market-price series (2005–2025) with forward cost projections (2030–2050) for three scenarios, all representing new capacity commissioned around 2030. The break between historical and projected data is indicated by a visual discontinuity on the x-axis between 2025 and 2030.

Historical series: European HRC ex-works price (USD/t). Annual average European hot-rolled coil (HRC) ex-works prices in nominal US dollars, sourced from SteelBenchmarker. This series is included to provide market-price context for realized steel prices over two decades, showing the cyclical volatility (range: ~US\$419/t to ~US\$1,142/t) that characterizes global steel markets. It is not a projection and does not represent Indian domestic prices directly, but it serves as a widely referenced international benchmark for flat-product steel pricing. A second historical series, the World HRC FOB price (USD/t), is shown alongside the EU HRC ex-works price. This series, sourced from S&P Global Platts / SteelBenchmarker, provides a global flat-product benchmark that reflects the discount to EU ex-works levels from transport costs and regional market conditions. Projected series (2030–2050) — common assumptions. All three forward cost lines are levelized costs of steel (LCOS) in nominal US dollars, calculated from the IECC cost model and documented in detail in the companion IECC technical report, “India is Ready to Scale Up Green Steel Production” (IECC, February 2026). Key common assumptions include:

2030 base-year INR/USD exchange rate: 90. Annual INR depreciation rate: 1.6% (half of 20-year historical average of ~3.35%). Discount rate / WACC: as specified in the companion IECC technical report. Plant capacity utilization: standard for each route as specified in the IECC model.

(i) Business as Usual — New BF-BOF route (black line). Base-case 2030 LCOS: ~US\$536/t. The non-coking-coal share of operating cost (~US\$387/t) is held constant in real terms. The coking-coal share (~US\$148/t in 2030) inflates at 2.0% p.a. in nominal USD terms (based on the 20-year historical average of seaborne coking-coal price inflation). The total BF-BOF cost therefore drifts upward modestly over the projection horizon, reaching approximately US\$608/t by 2050 in nominal terms.

(ii) Green Steel — H<sub>2</sub>-DRI-EAF route (green line). Base-case 2030 LCOS: ~US\$562/t. Green hydrogen is the dominant cost driver; the 2030 delivered green hydrogen price is ~US\$3.00/kg, anchored in recent SECI auction price discovery (green ammonia, Sep 2025; solar-plus-storage, Jan 2026). The hydrogen cost trajectory declines over time as electrolyzer costs fall and renewable-electricity costs continue to decrease, with the INR-denominated PPA cost held flat (locked in via long-term contracts) and converted to USD at the depreciating exchange rate. By 2050, the model shows the green-steel cost trajectory

reaching approximately US\$409/t in nominal terms. All other operating costs are modelled as described in the IECC companion technical report.

(iii) The gross CBAM cost at full application is  $2.2 \times -\text{US\$}85 = -\text{US\$}187/\text{t}$  in 2030. Under the legislated schedule 52, free allowances for CBAM-covered sectors are phased out progressively: 48.5% in 2030, 61% in 2031, 73.5% in 2032, 86% in 2033, 100% from 2034. Figure 2 applies this schedule. The effective CBAM cost in 2030 is approximately US\$91/t (48.5% of -US\$187/t), yielding a BF-BOF + CBAM cost of approximately US\$626/t. From 2034, the full penalty applies. By 2050, BF-BOF + CBAM reaches approximately US\$886/t. The CBAM overlay reflects the legislated phase-in schedule as of March 2026. Actual exposure will depend on verified plant-level embedded emissions, the prevailing EU ETS price, any future changes to the phase-in schedule, and any crediting of carbon prices paid in the country of origin.

#### Data Availability

The underlying data and calculations for both figures are documented in the companion IECC technical report, “India is Ready to Scale Up Green Steel Production” (IECC, February 2026). The full LCOS methodology, including all input assumptions (capex, opex components, feedstock costs, financing terms, and sensitivity parameters), is set out in that report. Primary data sources for Figure 1 include Ministry of Commerce and Industry import statistics (via DGCIS), Ministry of Coal annual publications, and the Office of the Economic Adviser WPI series. Figure 2 projections are derived from the IECC cost model.

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