

The background of the entire page is a close-up, slightly blurred photograph of several large, dark-colored steel pipes stacked horizontally. The pipes are arranged in a way that creates a sense of depth and repetition, with their circular ends visible. The lighting is soft, highlighting the metallic texture of the pipes.

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Decarbonise Now: Steel Sector – Heavy Industry, Heavier Emissions

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1. Introduction

The Strategic Importance of Steel for India's Economic Development

Steel is fundamental to India's economic growth, supporting critical sectors like railways, construction, and automotive industries. India's crude steel production capacity grew from 142.236 MTPA in 2018 to 157.585 MTPA in 2022, making it the world's second-largest crude steel producer. Ambitious plans project capacity to reach over 330 MTPA by 2030 and 528 MTPA by 2050, essential for infrastructure development and economic advancement.



India's National Climate Commitments (NDCs, Net-Zero 2070) and the Role of Heavy Industry

India has committed to low-carbon development, revising its Nationally Determined Contributions (NDCs) and targeting net-zero emissions by 2070. Near-term goals include decarbonizing 50% of its energy supply and establishing 500 GW of fossil fuel-free generating capacity by 2030. Heavy industry decarbonization is critical, as the industrial sector was India's second-largest emitter in 2019, contributing 36% of total emissions (excluding LULUCF), with iron and steel being a primary driver.



2. India's Steel Emissions Footprints

Historical and Current Emission Footprint

India's historical contribution to global greenhouse gases (GHGs) is about 4%, rising to 7.4% in 2021, making it the world's third-largest emitter since 1990 . The iron and steel industry is India's largest industrial emitter, responsible for 10–12% of total carbon emissions . Its "hard-to-abate" nature stems from reliance on carbon-intensive processes and difficulty replacing fossil fuels .

Indian steel production primarily uses the Blast Furnace–Basic Oxygen Furnace (BF–BOF) method in the primary sector and Direct Reduced Iron–Electric Arc Furnace (DRI–EAF) or Direct Reduced Iron–Induction Furnace (DRI–IF) routes in the secondary sector. India's steel sector emits about 2.6 tons of CO₂ per ton of steel, 25% higher than the global average of 1.91 tons. This is due to reliance on low-grade coal and iron ore, and integrated steel plants using captive coal-based thermal power plants .

Future Emission Projections and Pathways

India plans to expand steel production capacity from 200 million to over 330 million tonnes per year by 2030, with over 40% of global steel capacity development occurring in India. More than half of this new capacity is projected to use coal-based methods, making India unique among major steel-producing nations. If current plans proceed, the steel sector's share of India's GHG emissions could double within five years.

However, 1.5°C aligned pathways project energy-related CO₂ emissions from the industry sector to halve between 2035 and 2040 compared to 2021 levels, aiming for full decarbonization by 2049. A significant portion of India's planned coal-heavy capacity is still "on paper," offering a window to pivot towards lower-emission technologies.

3. New and Emerging Technological Innovations

1

Hydrogen-based Direct Reduced Iron (H₂-DRI) and Electric Arc Furnaces (EAF)

This combination is central to India's net-zero steel targets by 2070. H₂-DRI replaces traditional reducing agents with hydrogen, and when coupled with EAFs powered by renewable energy and using scrap metal, can reduce emissions by up to 88%, with green hydrogen-based DRI achieving up to 97% reduction .

2

Carbon Capture, Utilization, and Storage (CCUS) Technologies

CCUS is promising for existing BF-BOF plants, offering high CO₂ abatement potential. India has pilot projects for CO₂ capture in its steel industry.

3

Energy Efficiency Measures

Implementing Best Available Technologies (BATs) like Pulverized Coal Injection (PCI), Coke-DRY-Quenching (CDQ), and Top Pressure Recovery Turbine (TRT) can reduce emissions by up to 15% for the BF-BOF route, often with negative abatement costs. India's Perform, Achieve and Trade (PAT) Mechanism avoided approximately 100 MtCO₂e between 2012 and 2019. Estimated cost for these improvements is \$13 billion

4

Increased Electrification of Industrial Processes

The "Deep Electrification" pathway aims to increase electricity's share in industrial energy demand to 48% by 2030, from 18% in 2021. The Energy Conservation Act 2022 mandates around 25% non-fossil fuel usage in heavy industries.

4. Pilot Projects and Adoption Potential in India

India is making significant strides in decarbonizing its steel industry through hydrogen-based technologies. Under the National Green Hydrogen Mission (NGHM), the Ministry of Steel has approved seven pilot projects to demonstrate the technical and commercial feasibility of green hydrogen use in steel production. These include hydrogen injection into Direct Reduced Iron (DRI) units and blast furnaces, with commissioning expected within three years. Tata Steel has already completed a successful hydrogen injection trial in April 2023, showcasing early progress.

The NGHM, launched in January 2023 with an outlay of ₹19,744 crore (approximately \$2.4 billion), targets the production of 5 million tonnes of green hydrogen annually by 2030. However, high production costs remain a major hurdle—current levels are \$3–3.75/kg, whereas commercial viability demands a price of around \$1/kg. Despite this, industrial players like Adani and JSW are investing in green hydrogen infrastructure. Adani commissioned India's first 5 MW electrolyzer plant in June, while JSW plans to commercialize a 25 MW hydrogen facility. However, the sector faces a 30% "green premium" and first-mover disadvantage. To scale green steel, government support must go beyond R&D—focusing on policy incentives, market creation, and de-risking mechanisms to make early adoption financially attractive and sustainable.



Role of Circular Economy and Scrap Recycling

Enhanced scrap steel collection and recycling are major decarbonization routes. The Ministry of Steel aims to increase scrap's share in total steel production from 15% to 50% by 2047. This requires substantial additional supplies, currently planned through imports, as India imported 9.39 million tons by end of 2024, projected to double.

To boost domestic scrap, authorities are developing a nationwide electronic platform for trading and considering restricting scrap exports.

A car scrapping incentive program is also in place. Recycling stainless steel scrap uses up to 75% less energy than virgin production, significantly reducing GHG emissions. India faces challenges in both quantity and quality of domestic scrap, necessitating imports. Global scrap access may face future restrictions. Achieving 50% scrap utilization by 2047 is challenging given current domestic collection (approx. 25 MT) and imports. Robust collection, sorting, and processing infrastructure is critical.

Green Steel Taxonomy Criteria

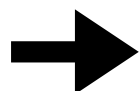
The Ministry of Steel of India (MSI) published the Green Steel Taxonomy on March 21, 2025, effective FY 2026–2027. This system provides quantifiable targets for producers based on CO2 emissions per ton of finished steel.

The taxonomy categorizes steel "greenness" into three star ratings:

Star Rating	CO2 Emissions per 1 ton of finished steel (tCO2/tfs)	Scope of Emissions Accounted For	Responsible Agency for Rating/Certification	Review Period for Criteria
5*	Less than 1.6	Scope 1, 2 (fully); Scope 3 (partially)*	National Institute of Secondary Steel Technology (NISST)	Every three years
4*	1.6 – 2.0	Scope 1, 2 (fully); Scope 3 (partially)*	National Institute of Secondary Steel Technology (NISST)	Every three years
3*	2.0 – 2.2	Scope 1, 2 (fully); Scope 3 (partially)*	National Institute of Secondary Steel Technology (NISST)	Every three years

5. Challenges and Opportunities for Indian Steel Industries

Category	Key Challenges	Opportunities
Financial	• High capital investment needs for new technologies and infrastructure (e.g., \$283B for existing plants, \$297–304B for H2 by 2070). • Difficulty accessing green finance for projects not fully "green" (e.g., transition finance for BF–BOF plants). • High cost of green hydrogen (\$3–3.75/kg vs. \$1/kg needed for viability) and CCUS (unviable at \$45–60/tCO₂ capture).	• Strategic economic opportunity for green growth and global leadership in low-carbon steel. • Attracting green investments and leveraging transition finance mechanisms. • Potential for new revenue streams through carbon credit sales
Technological	• Lack of commercially available near-zero emission technologies at scale. • Maturity gaps for advanced technologies like H2–DRI and CCUS.	• Prioritizing R&D and scaling pilot projects for H2–DRI, EAF, and CCUS. • Fostering innovation in green hydrogen production and carbon capture to reduce costs



Category	Key Challenges	Opportunities
Infrastructural	• Challenges in renewable energy grid integration (transmission bottlenecks). • Underdeveloped natural gas pipeline network in steel hubs. • Lack of mature infrastructure for hydrogen, CCUS, and battery storage	• Investments in renewable energy infrastructure and grid modernization . • Development of dedicated hydrogen hubs and pipeline networks. Enhanced. • domestic scrap collection and processing infrastructure .
Policy & Market	• Potential oversupply of carbon credits, enforcement gaps, and market volatility in domestic carbon market . • High "green premium" on low-carbon products hindering market adoption • Impact of carbon border taxes (e.g., EU CBAM) on export competitiveness.	• Development of a robust domestic market for green steel through public procurement and labeling. • Leveraging international partnerships for technology transfer and market access. • Gaining a competitive edge in global markets through early decarbonization.



6. Implications in International and Indian Carbon Markets (CCTS)



CCTS Design & Operation: India's Carbon Credit Trading Scheme (CCTS), launched in June 2023 under the Energy Conservation (Amendment) Act, 2022, is an intensity-based market mechanism covering key sectors including iron and steel. It rewards entities that reduce emission intensity below set benchmarks and penalizes non-compliance.



Steel Sector Compliance: The steel sector, as one of nine obligated sectors, includes 253 entities required to meet phased Greenhouse Gas Emission Intensity (GEI) targets. Large producers aim for 13% GEI reduction by 2030 from a 2023–24 baseline.



Trading and Penalty Framework: Companies exceeding targets earn tradable Carbon Credit Certificates (CCCs). Non-compliance leads to penalties twice the average CCC price. Unlimited banking is allowed; no borrowing permitted. Trading occurs via power exchanges.



Link to International Markets: Though not currently linked internationally, CCTS positions India to participate in carbon trading under Article 6.2 and 6.4 of the Paris Agreement, potentially exporting credits as ITMOs.



Response to CBAM: With EU's Carbon Border Adjustment Mechanism (CBAM) impacting Indian steel exports, a robust domestic carbon market like CCTS helps India mitigate CBAM risks, lower embedded emissions, and strengthen trade negotiations.



Challenges Ahead: Key challenges include credit oversupply, monitoring complexity, and price volatility. Long-term success depends on robust enforcement and expanding market scope.

7. Strategic Pathways for Steel Sector Decarbonization

Robust Policy and Regulation

Strengthen the Green Steel Taxonomy with mandatory reviews every three years, and develop clear, sector-specific transition pathways. Consistent, stable policy signals are vital to guide industry investments and avoid regulatory uncertainty.

Technology and Infrastructure Development

Accelerate R&D and pilot deployment of hydrogen-based steelmaking, CCUS, and advanced electrolysis technologies. Enforce design mandates for new plants to be hydrogen-ready to prevent future carbon lock-in.

Financing the Transition

Mobilize an estimated \$283–304 billion through a mix of production-linked incentives, tax breaks, subsidies, and Public–Private Partnerships (PPPs). Scaled transition finance is critical to support decarbonization of existing BF–BOF plants and early adoption of green hydrogen.

International and Resource Strategy

Secure quality scrap and renewable energy through domestic investments and incentives. Engage in global trade dialogues (e.g., CBAM), leverage Article 6 of the Paris Agreement for credit generation/export, and collaborate on technology transfer and best practices.

Conclusion

India's steel sector is at a critical juncture, with its rapid growth and ambitious decarbonization efforts holding profound implications for global climate goals. As the world's second-largest steel producer, India's success in greening its steel industry will serve as a bellwether for global steel decarbonization. The imperative to "Decarbonise Now" is not merely an environmental necessity but a strategic economic opportunity that will redefine India's industrial landscape.

Achieving net-zero emissions by 2070 while meeting surging domestic steel demand requires a delicate balance between economic growth and ambitious climate action. This transformative journey demands substantial and sustained financial investment, continuous technological innovation, robust and consistent policy support, and proactive international engagement. While significant challenges persist, including the high costs of emerging green technologies, infrastructure gaps, and complexities of international trade policies, the concerted efforts by the Indian government and industry, coupled with immense opportunities for green growth, job creation, and global leadership, position India to lead a transformative shift towards a sustainable steel future. The path ahead demands a holistic and integrated strategy that leverages domestic strengths, addresses existing bottlenecks, and strategically engages with global partners to realize the vision of a truly green Indian steel industry.



If you are building the future of green steel, partner with us.



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