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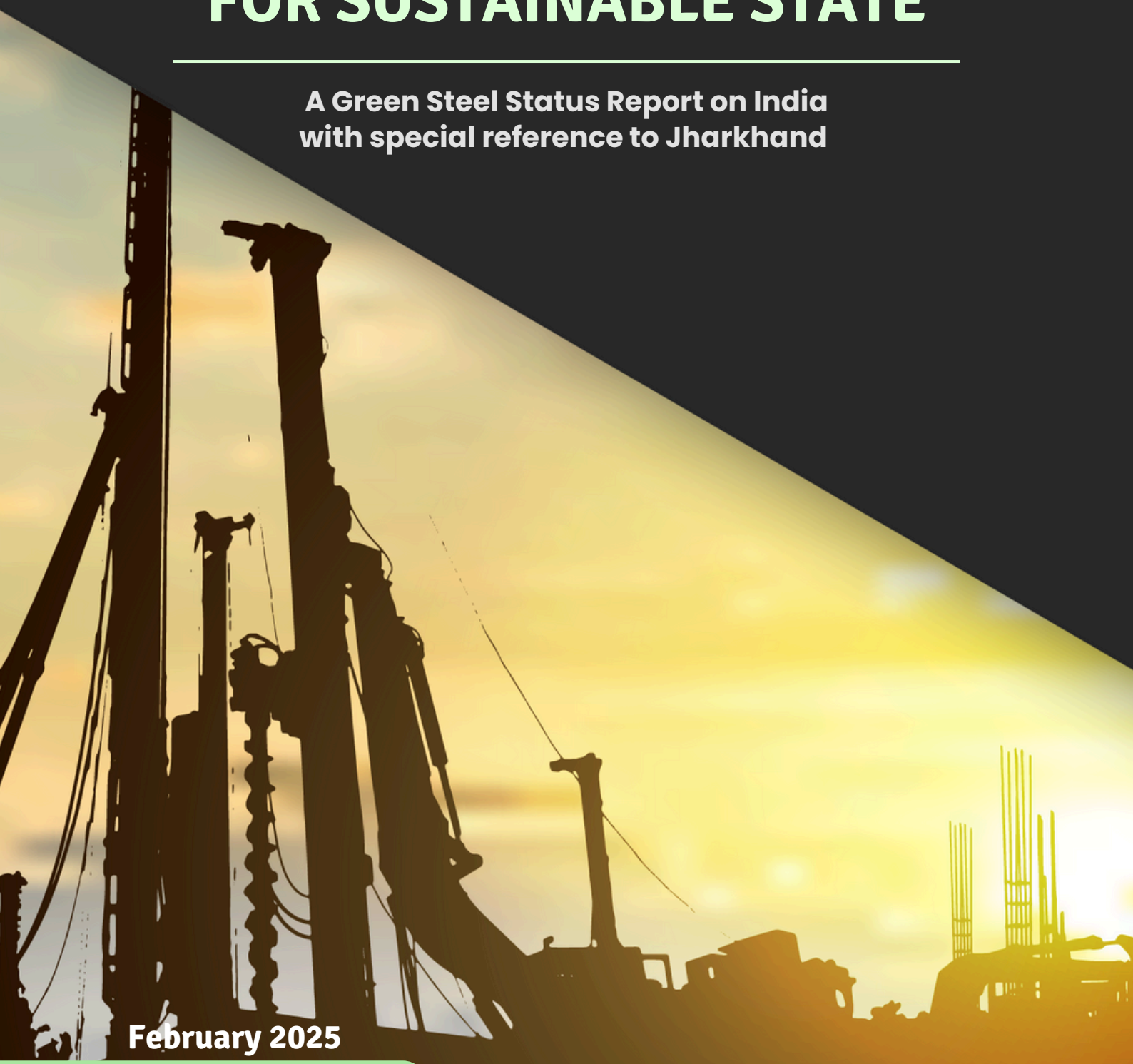
SUSTAINABLE STEEL FOR SUSTAINABLE STATE

A Green Steel Status Report on India with special reference to Jharkhand



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Founded in 2008, the **Environment Conservation Society** (ECS), also known as SwitchON Foundation, actively offers **sustainable solutions** for the vulnerable Indian population. With a commitment to **clean and renewable energy**, climate-resilient agriculture, and **sustainable cities**, ECS is working towards creating opportunities for 10 million people by 2030, promoting equitable growth through innovative business models and technologies.

Recognizing the crucial role of the steel industry in India's green transition, ECS is dedicated to fostering sustainable steel production and consumption. Our work focuses on integrating renewable energy solutions, resource efficiency, and circular economy principles into steel manufacturing. By engaging with industry leaders, policymakers, and research institutions, we aim to drive innovation, reduce emissions, and promote responsible sourcing of raw materials.

Through **evidence-based research** and stakeholder engagement, ECS advocates for policies that encourage low-carbon steel production and responsible mining practices. Our efforts also include capacity-building initiatives to ensure that industries, workers, and communities are equipped to participate in this transition towards sustainable industrialization.

ECS's commitment to sustainability extends to fostering collaborations for green infrastructure and decarbonizing hard-to-abate sectors. This audit report, ***Sustainable Steel for Sustainable Nation***, critically examines the current landscape of green steel in India and Jharkhand as well, identifying challenges and opportunities to align the sector with national and global climate commitments.

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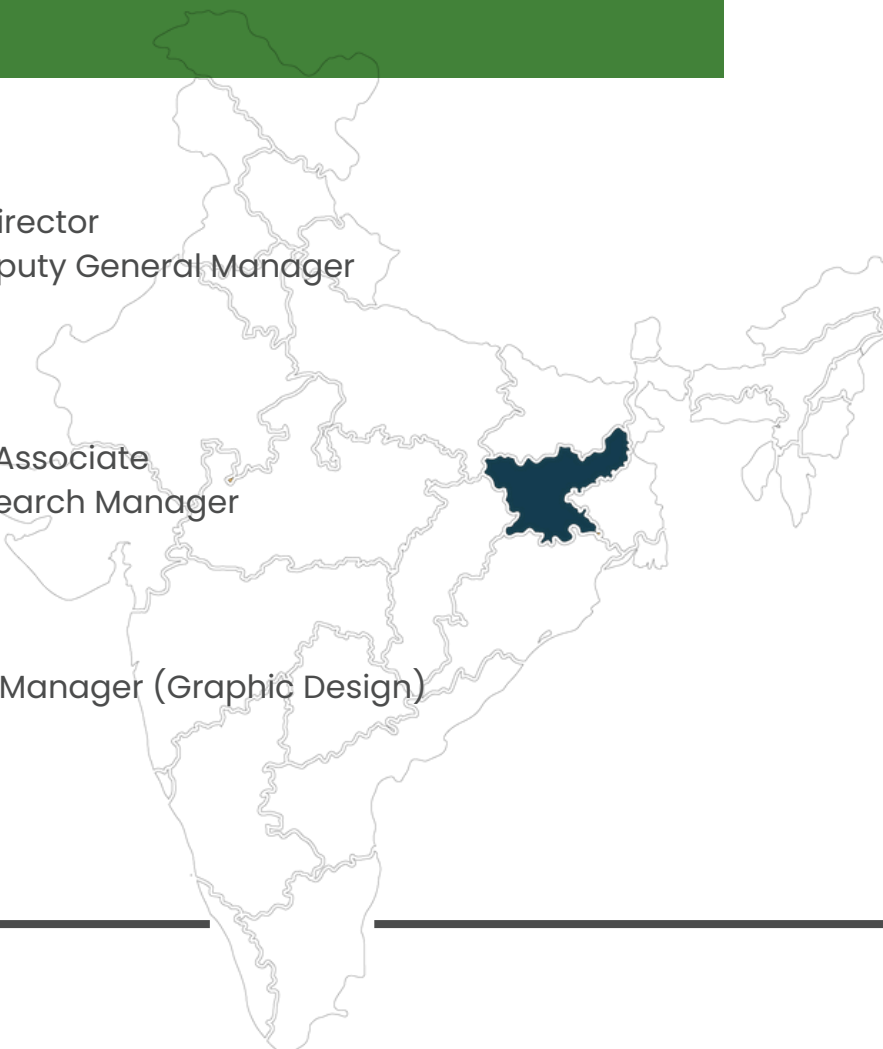

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Executive Summary

Steel production contributes **7–9% of global greenhouse gas (GHG) emissions**, with **India being the second-largest producer**, generating approximately 141 million tons of crude steel in 2023. This sector is responsible for **12% of India's industrial emissions**, primarily due to the carbon-intensive Blast Furnace-Basic Oxygen Furnace (BF-BOF) route and coal-based Direct Reduced Iron (DRI) processes. With steel production expected to expand until 2050, decarbonising this industry is critical for India to meet its net-zero emissions target by 2070. Green steel production, using environmentally friendly technologies and alternative fuels, presents a viable solution.

• Decarbonisation Pathways

Key pathways for decarbonising steel include transitioning from BF-BOF to DRI and Electric Arc Furnace (EAF) technologies, adopting renewable energy, using alternative fuels like green hydrogen and biomass, and implementing **Carbon Capture Utilization and Storage (CCUS)**. The **National Green Hydrogen Mission** focuses on integrating hydrogen into steel production through pilot projects targeting DRI production, blast furnace substitution, and gradual fossil fuel replacement.

• Green Steel Mission and Policy Initiatives

The Government of India's **Green Steel Mission**, with a budget of **₹15,000 crore**, includes a **Production-Linked Incentive (PLI) scheme**, renewable energy incentives, and procurement mandates for green steel. A **Steel Scrap Recycling Policy** and the **Taxonomy of Green Steel** (2024) define standards for low-emission steel production, introducing a star rating system to categorize greenness based on emission intensity. Additionally, the roadmap "**Greening the Steel Sector in India**" outlines 14 actionable strategies to reduce emissions, optimize value chains, and promote innovation.

• Current Status and Pilot Projects

India's crude steel production in 2023 was 124 million tons, with less than 1% classified as green steel. Companies like Tata Steel, JSW Steel, and Kalyani Steels are leading pilot projects. Tata Steel aims to reduce emissions by 20% by 2030, while JSW Steel is integrating renewable energy to target a 42% emission reduction. ArcelorMittal-Nippon Steel India has committed $1 billion toward decarbonisation, focusing on hydrogen-based steel production.

• Jharkhnd Chapter

Jharkhand, contributing **20–25% of India's steel output**, is key to the country's green steel transition. With abundant iron ore and coal reserves, the state has historically relied on carbon-intensive steelmaking. Now, it is advancing sustainability through renewable energy adoption, circular economy practices, and emerging technologies.

Key initiatives include a Task Force on Sustainable Just Transition, hydrogen-based steelmaking, and enhanced steel scrap recycling. Policies like the National Green Hydrogen Mission and India's Green Steel Taxonomy support this shift by setting emission benchmarks and offering incentives.

However, challenges persist, including **high costs, infrastructure gaps, and limited renewable energy capacity**. To accelerate its transition, Jharkhand must scale hydrogen adoption, strengthen recycling networks, and expand clean energy investments. By addressing these barriers, the state can emerge as a leader in India's green steel transformation while balancing economic growth with sustainability.

Challenges in Decarbonisation

Several barriers hinder the transition to green steel:

1. Technical:	High renewable energy requirements, inadequate infrastructure, and costlyhydrogen storage solutions.
2. Economic:	Green steel production costs ₹55,000–₹65,000 per ton, compared to ₹45,000–₹50,000 for traditional steel, with limited investment and high green hydrogen costs.
3. Policy:	Weak carbon regulations and limited R&D investments.
4. Supply Chain:	Green steel production costs ₹55,000–₹65,000 per ton, compared to ₹45,000–₹50,000 for traditional steel, with limited investment and high green hydrogen costs.
5. Market Dynamics:	Green steel production costs ₹55,000–₹65,000 per ton, compared to ₹45,000–₹50,000 for traditional steel, with limited investment and high green hydrogen costs.

• Strategic Focus and Way Forward

India's roadmap emphasizes renewable energy adoption, value chain optimization, CCUS technology integration, and the development of hydrogen-based production. Increased investments, robust policies, enhanced R&D, and international collaborations are crucial to overcoming current challenges. The focus on recycling, innovation, and partnerships will ensure the competitiveness and sustainability of India's steel industry while aligning it with global climate goals.

In summary, while India's steel sector faces significant decarbonisation challenges, the government's proactive measures and private sector initiatives provide a pathway for transforming the industry into a low-carbon, sustainable model.

1. Introduction

Steel production is one of the most carbon-intensive industrial processes worldwide, contributing to 7–9% of global greenhouse gas (GHG) emissions (Kim et al. 2022). As the second-largest steel producer (PIB Delhi, 2024), India plays a significant role in this context. In 2023, India produced approximately 141 million tons of crude steel (PIB Delhi, 2024), with the sector responsible for 12% of the country's industrial emissions (Garg et al. 2023).

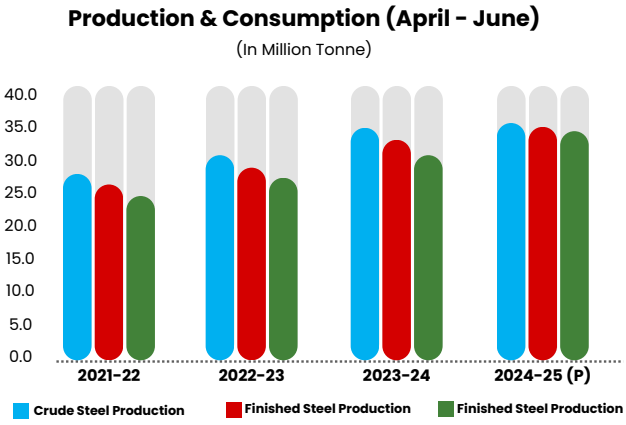


Figure: Steel Production and Consumption Scenario of India
Source: Ministry of Steel, 2024

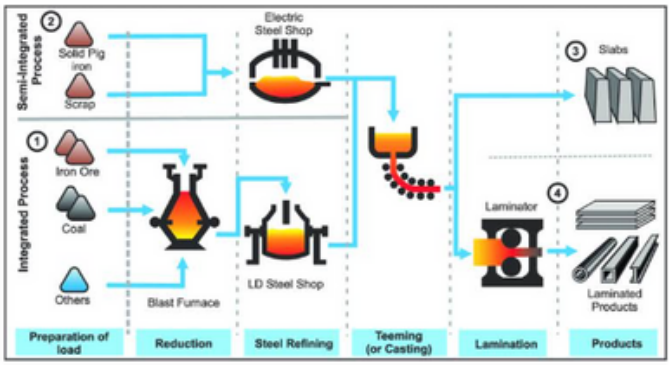


Image: Stages of Steel Production in India
Source: de Magalhães Ozorio et al. 2013

With the expansion of steel production in India, primarily driven by the carbon-intensive Blast Furnace-Basic Oxygen Furnace (BF-BOF) route, emissions are projected to rise until 2050 (Vipul, 2024). India's reliance on coal-based Direct Reduced Iron (DRI) processes, fueled by domestic coal availability, presents additional challenges to the country's steel decarbonisation efforts. In this context, alternative green steel has become a futuristic alternative. Acknowledging the urgent need for decarbonisation, India has committed to transitioning to green steel as part of its goal to achieve net-zero carbon emissions by 2070. This report audits the present status of the green steel sector in India.

2. Green Steel Production and Decarbonization Pathways

Green steel production seeks to address the challenges of decarbonising the carbon-intensive steel industry by adopting environmentally friendly alternatives. Key decarbonisation pathways include transitioning from the Blast Furnace (BF) to Direct Reduced Iron (DRI) and Electric Arc Furnace (EAF) technologies, adopting renewable energy, utilising alternative fuels like natural gas, green hydrogen, and biomass, and incorporating Carbon Capture Utilization and Storage (CCUS).

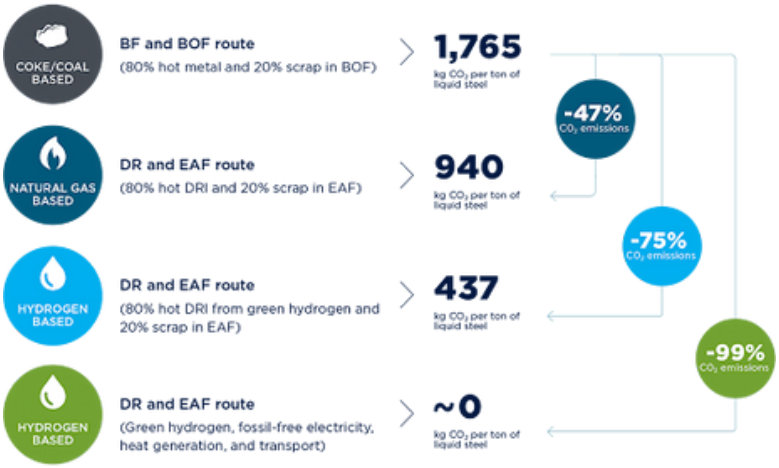


Figure: Comparing CO2 emissions reduction potential of different process routes for liquid steel.
Source: Primetals Technologies, 2024

• Energy Audit of Green Steel Production

Green steel production offers a significant reduction in energy consumption compared to conventional steelmaking methods by utilizing renewable energy sources and innovative processes such as electric arc furnaces (EAF). This approach has the potential to lower energy usage by up to **80% per ton of steel produced** (Afry, 2022). In contrast, conventional steelmaking relies heavily on fossil fuels, particularly coal, leading to higher energy consumption and increased carbon emissions.

Energy Consumption in Green Steel Production

For the production of **one ton of crude steel from iron ore,** the energy requirements are as follows:

- **Hydrogen Generation:** The production of green hydrogen, which serves as a reducing agent instead of coke, requires approximately **2,633 kWh (2.6 MWh) of power** (Mishra, 2023).
- **Direct Reduction & Electric Arc Furnace (EAF) Operations:** The EAF process and direct reduction consume an additional **816 kWh (0.8 MWh)** of electricity.
- **Total Energy Requirement:** The overall energy needed for green steel production ranges between **3 to 4 MWh per ton** of crude steel (Worldsteel, n.d.).

Energy Mix and Cost Considerations

For the production of one ton of crude steel from iron ore, the energy requirements are as follows:

- The **energy mix** in green steel production includes a higher proportion of electricity, accounting for up to **50% of total energy input,** with a significant share coming from renewable sources.
- Despite its environmental benefits, the **cost of green steel production** is estimated to be **20-30% higher** than conventional methods due to higher energy and infrastructure expenses (Mishra, 2023).
- While the total energy consumption for green steel production is around **3.6 MWh per ton**, conventional steelmaking still relies on **89% of its energy from coal** and only **7% from electricity,** underscoring the shift in energy sources with green steel technologies.

Aspect	Conventional Steel Production	Green Steel Production
Energy Requirement (MWh/ton)	3.6	3 to 4
Main Energy Source	Coal (89%)	Electricity (up to 50%)
CO2 Emissions (tonnes/ton)	1.5 - 2.0	Minimal to none
Recycling Rate	Low	Up to 93%
Technologies Used	BF-BOF	EAF, Hydrogen Reduction

By integrating renewable energy and reducing fossil fuel dependency, green steel production presents a viable path toward a more **sustainable and energy-efficient** steel industry.

• Green Steel Mission

The Government of India is advancing steel sector decarbonisation through the Green Steel Mission, with an estimated budget of ₹15,000 crore. This mission includes a PLI Scheme for Green Steel, renewable energy incentives, and mandates for government agencies to procure green steel. The National Green Hydrogen Mission, led by MNRE, integrates the steel sector, with ₹455 crore allocated for pilot projects until FY 2029-30. Key projects include producing Direct Reduced Iron (DRI) using 100% hydrogen and hydrogen injection in blast furnaces to reduce coal consumption.

A Steel Scrap Recycling Policy enhances resource efficiency, while the Taxonomy of Green Steel (released on December 12, 2024) defines standards for low-emission steel and establishes green star ratings. The taxonomy supports green steel production, market creation, and financial assistance. The "Greening the Steel Sector in India" roadmap, based on recommendations from 14 task forces, was released on September 10, 2024, outlining actionable decarbonisation strategies.

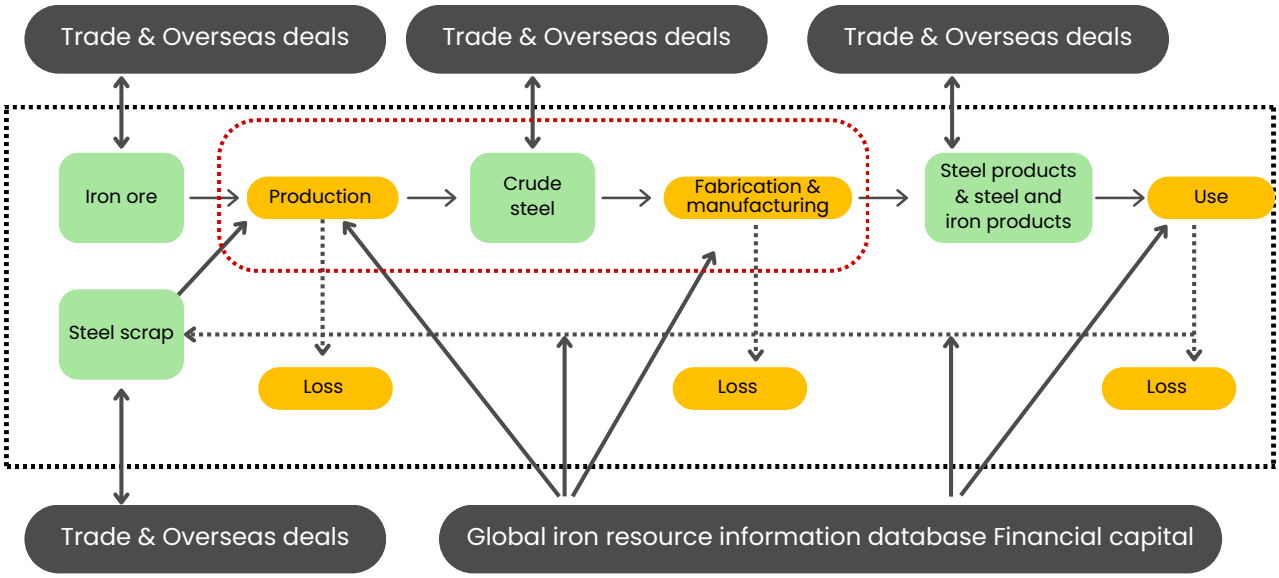


Figure. Target processes in the production process for GHG reduction

Source: Liu et al., 2017

• National Green Hydrogen Mission for the Steel Sector

The Government of India, under the National Green Hydrogen Mission, issued the "Scheme Guidelines for Implementation of Pilot Projects for Use of Green Hydrogen in the Steel Sector" on February 2, 2024 (PIB Delhi, 2024a). These guidelines, issued by the Ministry of New and Renewable Energy (MNRE), focus on pilot projects aimed at replacing fossil fuels with green hydrogen and its derivatives. The scheme supports greenfield projects that aim for 100% green steel production, aligning with global sustainability goals.

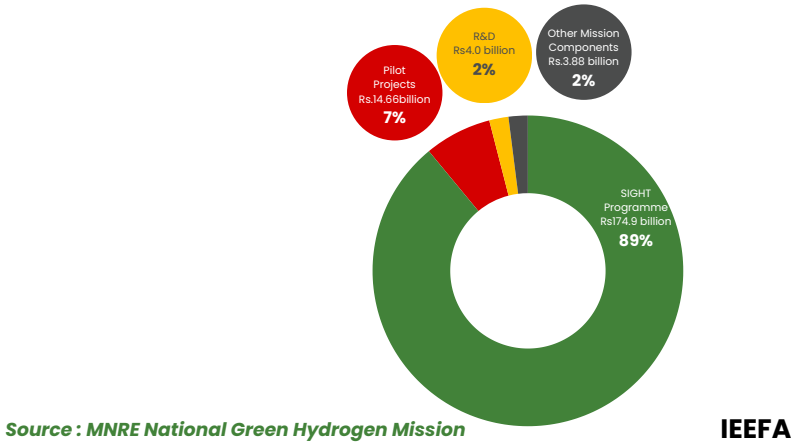


Figure: Capital outlay allocation in the National Green Hydrogen Mission

Source: MNRE & IEEFA, 2024

Pilot Projects and Focus Areas

The scheme identifies three thrust areas for pilot projects in the steel sector:

i. Hydrogen in DRI Production:
Incorporating green hydrogen into the direct reduction process.

ii. Hydrogen in Blast Furnaces:
Introducing hydrogen as a substitute for coal in blast furnaces.

iii. Gradual Fossil Fuel Replacement:
Progressively substituting fossil fuels with green hydrogen.

The scheme also encourages other innovative uses of hydrogen for reducing carbon emissions in steel production.

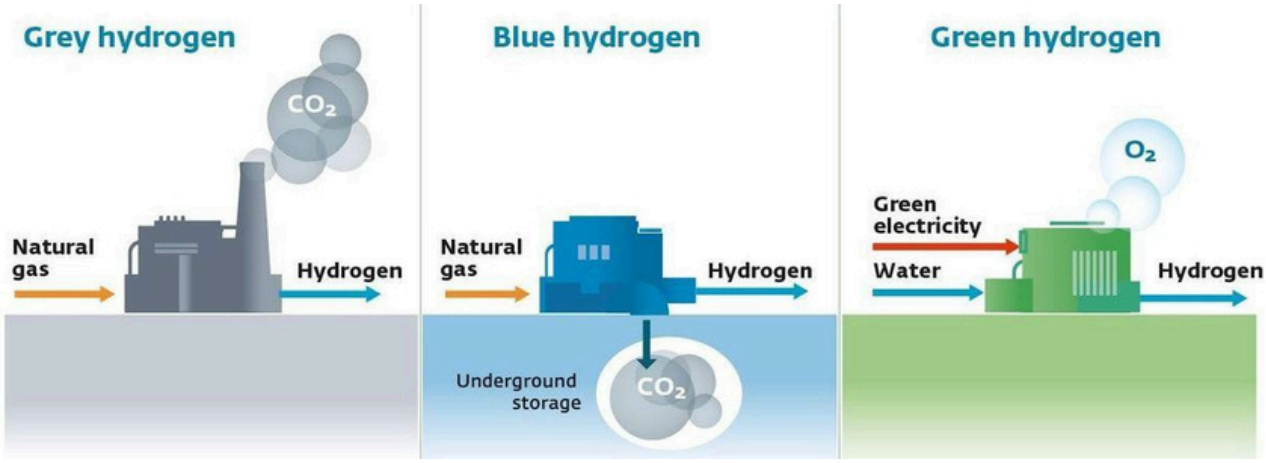


Figure: Synthesis Pathway for Grey, Blue, and Green Hydrogen

- Blending and Future Readiness

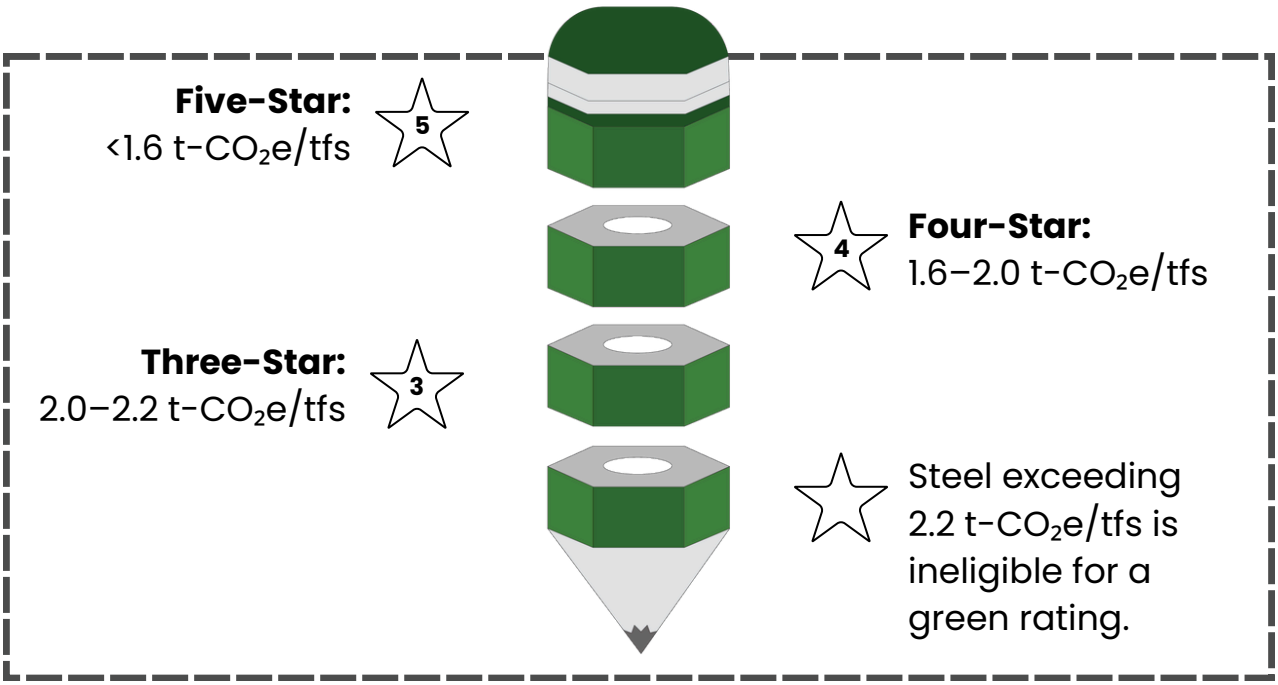
Given the high current cost of green hydrogen, steel plants are encouraged to start by blending a small percentage of green hydrogen, increasing the proportion as technology advances and costs improve. Additionally, new steel plants should be designed to operate with green hydrogen to ensure their future participation in global low-carbon steel markets..

3. India's Green Steel Taxonomy

India released its Green Steel Taxonomy on December 12, 2024 (PIB Delhi, 2024c), aligning with its net-zero emission intensity target by 2070. The taxonomy defines "Green Steel" based on emission intensity and assigns star ratings to promote low-emission steel production.

- Definition and Rating System

- Green Steel is defined as steel produced with CO_2 equivalent emissions below **2.2 tonnes per tonne of finished steel (tfs).**
- The **"greenness"** is expressed as a percentage, reflecting how much emissions fall below the threshold.
- Star ratings are assigned based on emission intensity:



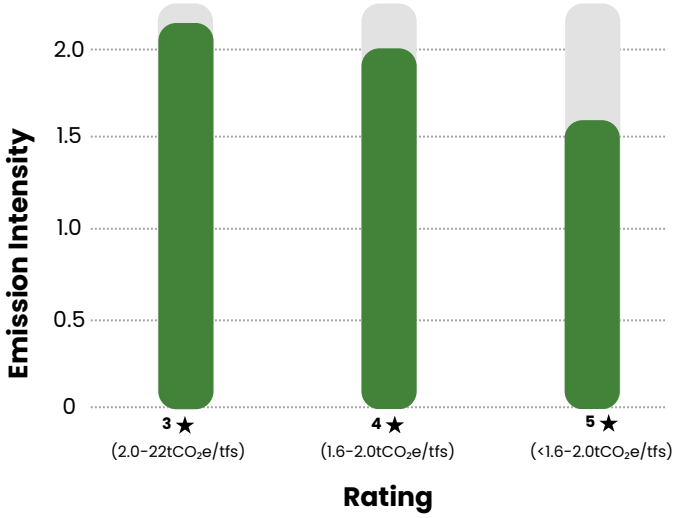


Figure: Green Steel Taxonomy
Source: Gulati, 2024

- Thresholds will be reviewed every three years.

• Scope of Emissions

- Includes Scope 1 (direct emissions), Scope 2 (indirect emissions from purchased energy), and limited Scope 3 emissions up to finished steel production.
- Scope 3 covers agglomeration (e.g., sintering, pellet making, coke making), beneficiation, and embodied emissions in purchased raw materials but excludes upstream mining, downstream, and transportation emissions.

• Monitoring and Certification

- The National Institute of Secondary Steel Technology (NISST) will act as the nodal agency for measurement, reporting, and verification (MRV) and issuing greenness certificates.
- Certificates will be issued annually but can be updated more frequently based on MRV as required.

This taxonomy provides a robust framework for encouraging sustainable practices and monitoring progress in India's steel sector decarbonisation journey.

4. India's Present Capacity on Green Steel

- India's Steel Production

India's crude steel production in 2023 was 124 million tons, with less than 1% categorized as green steel (Stanway, 2024). Traditional blast furnaces dominate 90% of production, with electric arc furnaces (EAFs) contributing the rest.

- Current Green Steel Projects

Kalyani Steels Ltd was the first steel company in India to produce green steel in 2023. Other Indian steel companies are also transitioning to green steel production (Shetty, 2023).

Tata Steel was the first steel company in India to produce green steel in 2023. Other Indian steel companies are also transitioning to green steel production (Shetty, 2023).

JSW Steel In 2023, JSW Steel produced over 23 million tons of steel, using 1,700 MW of renewable energy, targeting a 42% reduction in CO_2 emissions by 2030.

ArcelorMittal-Nippon Steel India (AM/NS India) This joint venture has committed $1 billion toward decarbonisation, including exploring hydrogen-based steel production.

5. Past and Timeline

2010s: India's decarbonization efforts began in the 2010s, driven by rising emissions. By 2015, steel production contributed 275 million tons of CO_2 annually, highlighting the sector's environmental impact.

2015–2020

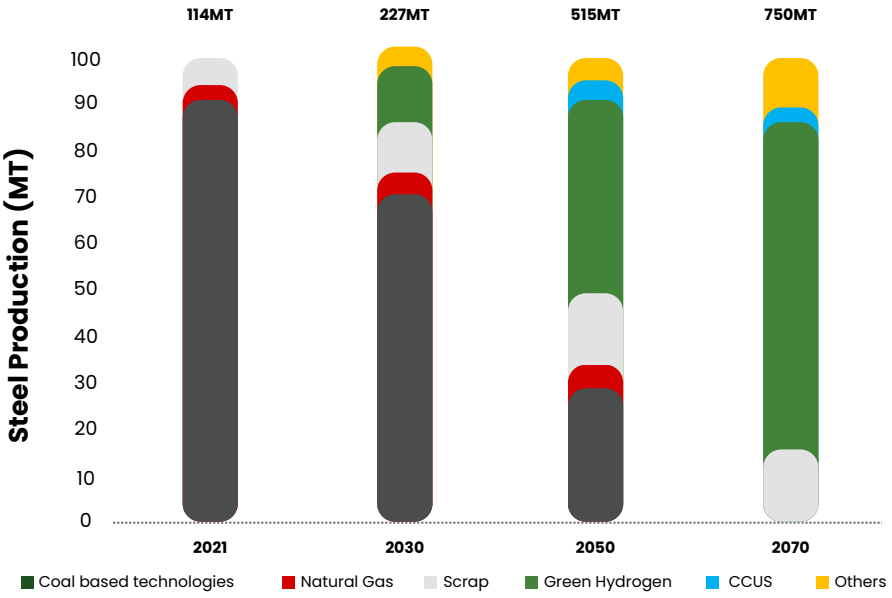
Paris Agreement (2015): India pledged to reduce its emissions intensity by 33–35% by 2030, emphasising industrial decarbonisation

Renewable Energy Integration: The adoption of solar and wind power in auxiliary steelmaking processes began, contributing to 2.8% of the sector's energy consumption by 2020.

2021–2023

India launched the National Hydrogen Mission (2021), allocating ₹25,000 crores to develop green hydrogen infrastructure.

Steelmakers pledged to cut emissions by 30–50% by 2050, with Tata Steel and JSW leading pilot projects.

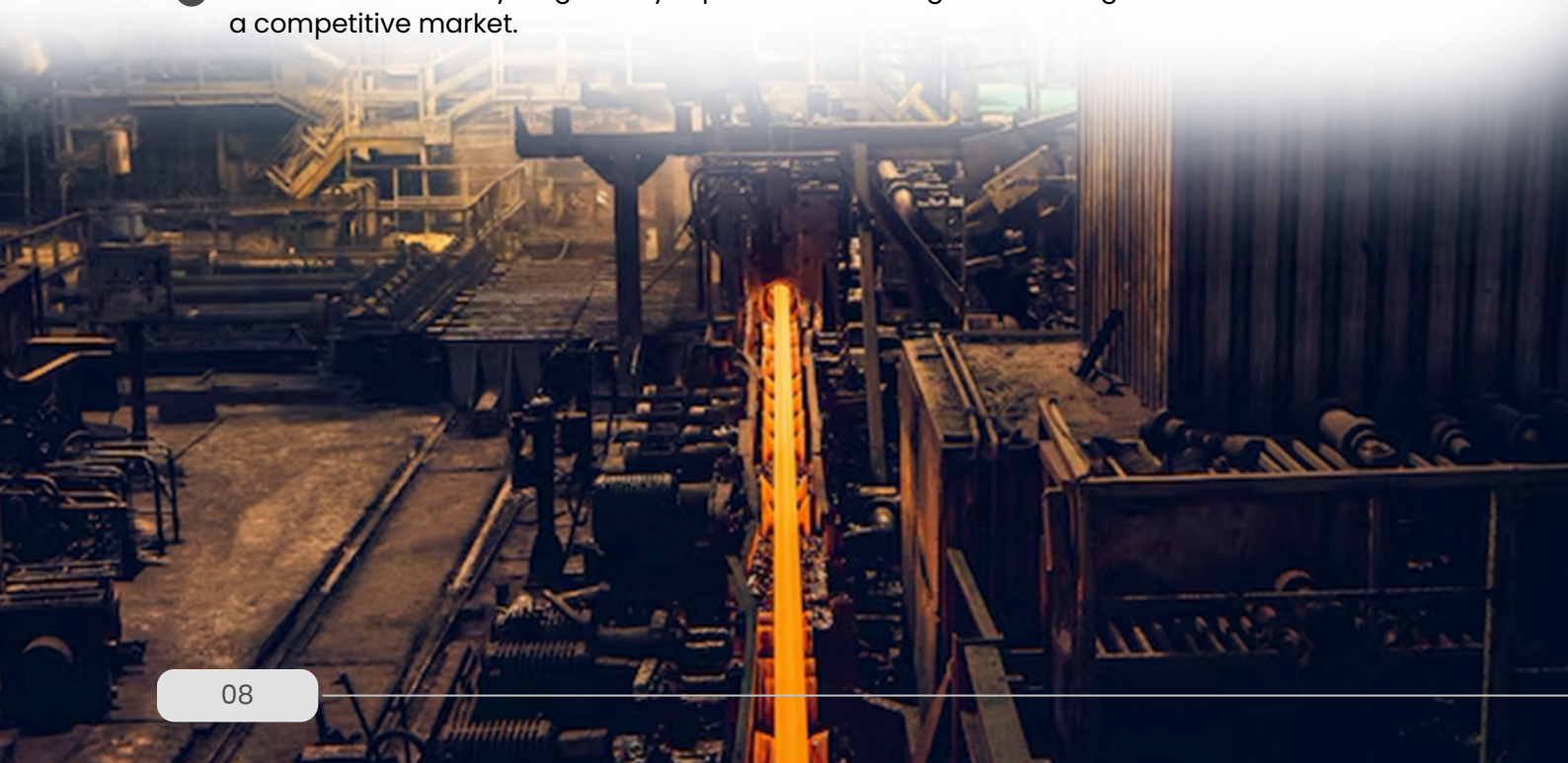


Source : Industry Reports, JMK Research

Note : Coal Based Technologies include EAF , EIF and BO, Others can include Molten Oxide Electrolysis, Electrowinning etc.

As per IEEFA & JMK Research (2024), To make hydrogen technology viable and green steel competitive, the price should be US$1-2/kg, with a carbon penalty of at least US$50 per tonne of emissions on traditional steel. This could catalyze a 150-million-tonne shift to hydrogen-based steelmaking. India's steel sector decarbonization trajectory until 2070 is projected as follows:

- **Up to 2030:** Coal-based technologies' share reduces from 92% (2021) to 70%, with green hydrogen replacing coal in EAF/EIF routes. Commercial-scale green hydrogen production will start by 2030.
- **2030-2050:** Large-scale green hydrogen adoption phases out coal-based routes; 25-30% of grey hydrogen is replaced by green hydrogen, increasing to 80% by 2050.
- **2050-2070:** Green hydrogen fully replaces coal and gas technologies as costs decline in a competitive market.



6. Decarbonization Roadmap: Greening the Steel Sector in India

The Ministry of Steel has introduced "Greening the Steel Sector in India," a 14-point action plan aimed at creating a sustainable and competitive steel industry aligned with India's climate goals. Key Themes in the Roadmap are as follows.

i. Value Chain Optimization and Monitoring

- Development of a taxonomy for green steel, including certified systems to monitor emissions.
- Focus on optimising the entire value chain, from raw material procurement to final processing, to enhance cost efficiency and reduce emissions.

ii. Carbon Capture and Utilization

- Emphasis on carbon capture, utilisation, and storage (CCUS) technologies to mitigate emissions.

iii. Renewable Energy and Hydrogen Transition

- Increased reliance on renewable energy for steel production.
- Transitioning from coal-based Direct Reduced Iron (DRI) to gas-based DRI, using natural gas as a bridge fuel for green hydrogen.

iv. Sustainable Alternatives

- Exploration of sustainable substitutes for coal and coke, such as biochar from biomass, through its widespread adoption, faces economic challenges.
- Utilising industrial waste gases, synthesised gas, and coal bed methane (CBM) for process conversion.

v. Recycling and Circular Economy

- Increasing the use of recycled steel to reduce the need for primary steel production and associated emissions.

vi. Innovation and Collaboration

- Promotion of hydrogen-based steel production and other innovative technologies.
- Partnerships with global steel companies and technology providers like SMS Group and Primetals Technologies to advance research and development in efficient and sustainable production processes.

- **Strategic Focus**

  The roadmap maintains growth targets while addressing India's heavy dependence on coal. It underscores the importance of renewable energy, innovation, and international collaboration to transition toward a low-carbon steel sector

7. Jharkhand Chapter

Jharkhand holds a key position in India's steel industry due to its abundant iron ore reserves and the presence of major steel plants, including Tata Steel in Jamshedpur—often referred to as the "Steel City of India." The state's proximity to coal reserves has further facilitated the growth of steel manufacturing. Over the years, Jharkhand's steel production has significantly increased, reaching approximately 20-25% of India's total steel output.

However, with India's commitment to achieving net-zero emissions, Jharkhand is actively transitioning towards a low-carbon economy. This includes integrating renewable energy, adopting energy-efficient technologies, promoting a circular economy, and involving local communities in the transition process.

7.1. Current Steel Industry Scenario in Jharkhand

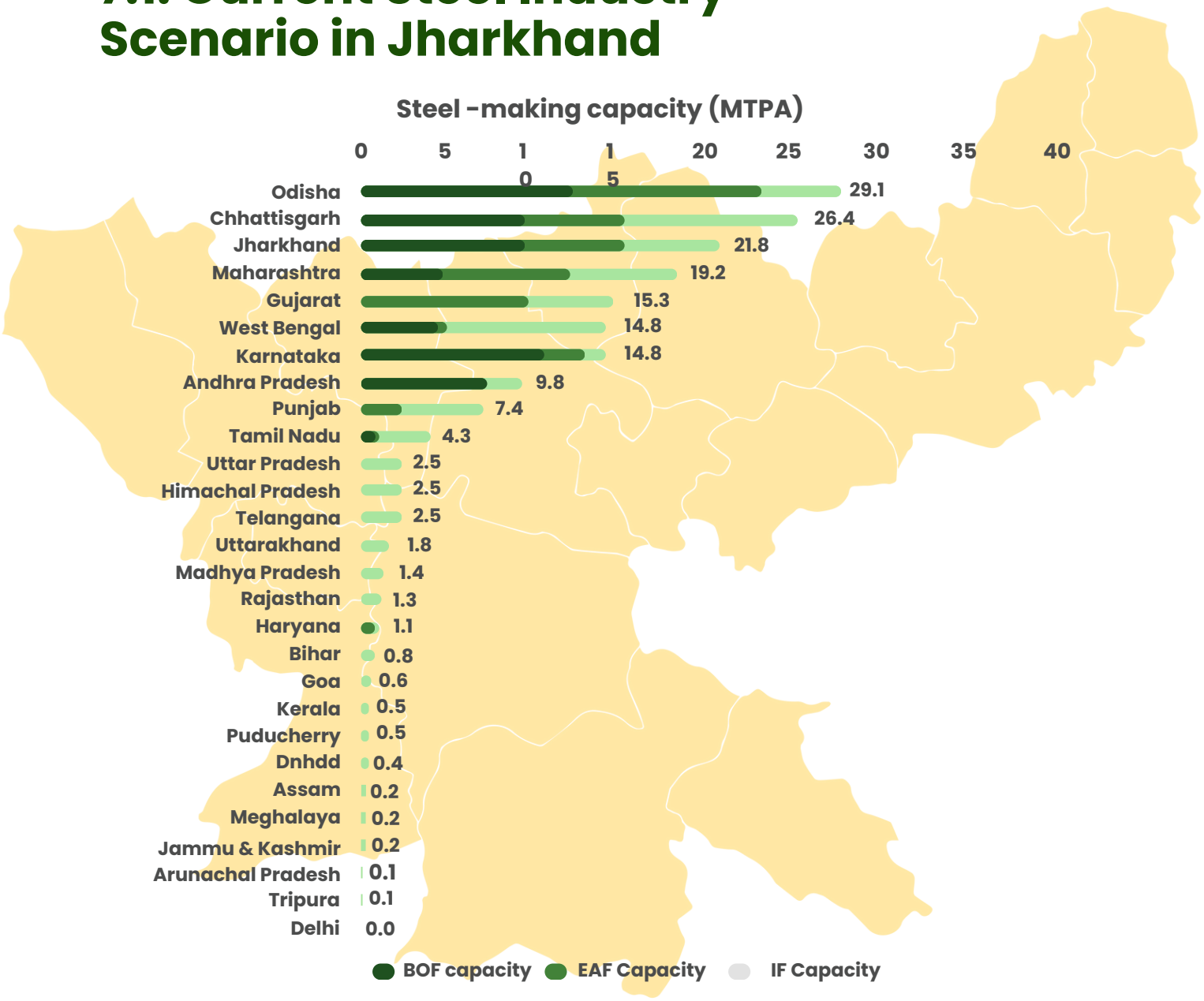


Figure: State-wise steel production capacity

Source: GSI Report, 2024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7.2. Transition to Green Steel in Jharkhand

Given the carbon-intensive nature of the steel industry, Jharkhand has undertaken various initiatives to transition towards a low-carbon future:

7.2.1. Key Initiatives and Strategies

1. Task Force on Sustainable Just Transition

- Formed by the Jharkhand government to develop a roadmap for a low-carbon economy.
- Includes a **sub-task force on the Green Hydrogen Mission** to explore hydrogen energy applications.

2. Renewable Energy and Technology Adoption

- Focus on integrating solar and green hydrogen energy.
- Adoption of advanced technologies such as waste heat recovery, coke dry quenching, and AI-based process optimization.

3. Circular Economy and Steel Recycling

- Policies to enhance steel scrap recycling and reduce reliance on virgin raw materials.
- Development of carbon trading frameworks and carbon capture & storage (CCS) infrastructure.

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- Development of carbon trading frameworks and carbon capture & storage (CCS) infrastructure.

5. Sustainability and Stakeholder Collaboration

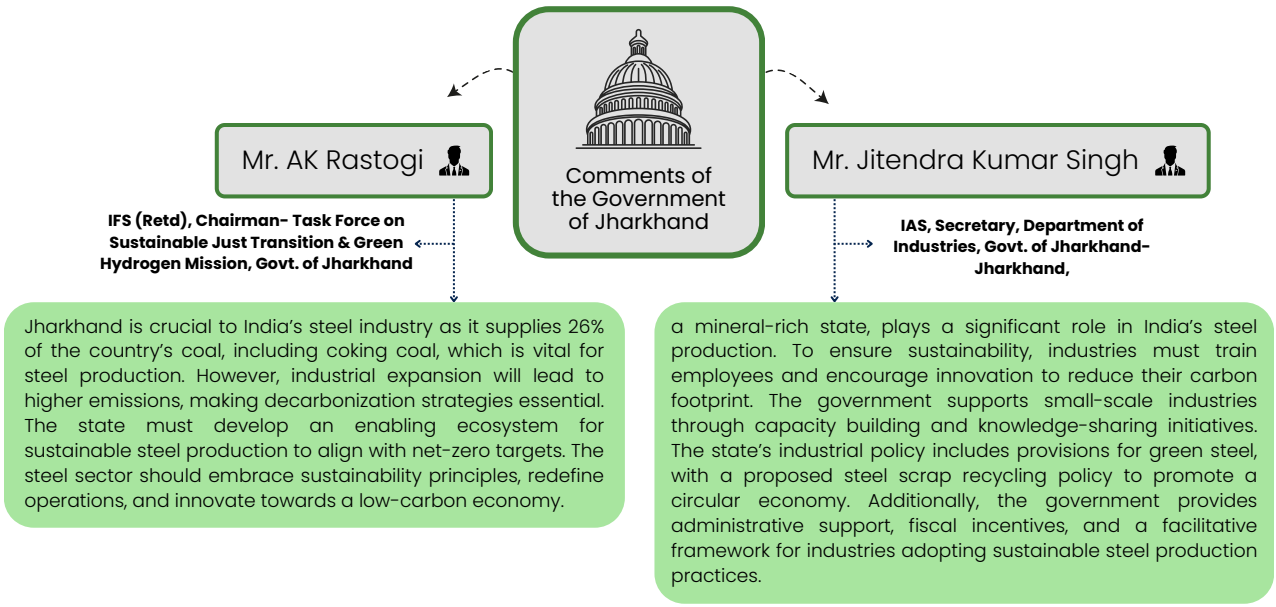
- Engagement of government, industries, and communities to address decarbonization challenges.
- Training programs to build workforce capacity in sustainable steel production.

7.2.2. Industry Participation and Key Events

- National Workshop on Green Steel (December 2024, IIT ISM Dhanbad)

- Focused on decarbonization in steel manufacturing and its role in climate change mitigation.
- **Key topics:** Hydrogen-based steelmaking, CCS, recycling strategies, and efficient scrap material usage.

7.2.3. Comments from the Government of Jharkhand



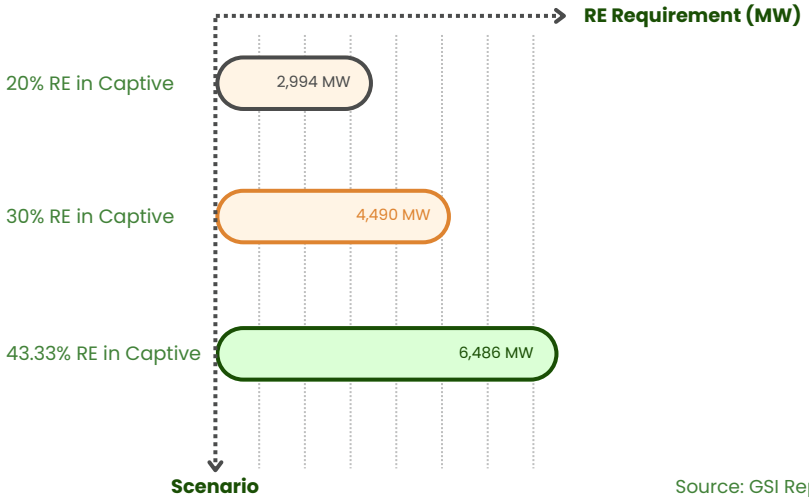
7.3. Challenges in Decarbonization

- **High Costs:** Green steel production costs ₹55,000–₹65,000 per ton, compared to ₹45,000–₹50,000 for traditional steel.
- **Infrastructure Barriers:** Limited renewable energy supply and expensive hydrogen storage solutions.
- **Policy Gaps:** Weak carbon regulations and insufficient investment in R&D.

7.3.1. Renewable Energy Integration Challenges

Jharkhand, like other steel-rich states (Odisha, Chhattisgarh, West Bengal), faces challenges in renewable energy adoption due to its RE-deficient status (limited solar/wind potential). Procuring renewable energy from other states such as Rajasthan via open access mode is costly due to high State Transmission Utility (STU) charges.

Projected Renewable Energy Demand in Steel Sector (2030-31)



Source: GSI Report, 2024

8. Challenges in Decarbonizing Steel Production in India

Technical Challenges

- **High Energy Requirements**: Producing one ton of green hydrogen demands approximately 50 kWh of renewable energy, which exceeds India's current renewable energy capacity.
- **Infrastructure Deficit**: Only 10% of India's steel plants have infrastructure for renewable energy or hydrogen integration, limiting the adoption of green technologies.
- **Advanced Storage Needs**: Storing green hydrogen requires sophisticated and costly solutions, with expenses exceeding ₹12,000 per ton.

Economic Constraints

- **High Production Costs**: Green steel production costs ₹55,000–₹65,000 per ton, significantly higher than traditional steel at ₹45,000–₹50,000 per ton.
- **Investment Deficit**: India requires $10 billion annually for steel sector decarbonisation but currently attracts only $3 billion in investments.
- **Expensive Green Hydrogen**: Green hydrogen, crucial for reducing emissions, costs $4–$7 per kilogram, compared to $1.8 per kilogram for grey hydrogen, making it economically impractical for widespread adoption.

Policy and Governance Issues

- **Weak Carbon Regulations**: India's carbon tax is a mere ₹400 per ton of CO_2, significantly lower than Europe's $60–$100 per ton, providing insufficient motivation for decarbonisation efforts.
- **Limited Research and Development (R&D**: With only 0.7% of GDP spent on R&D, minimal focus is placed on green steel technologies, hindering innovation and progress.

Supply Chain Constraints

- **Low Scrap Recycling Rates**: India's steel scrap recycling rate stands at just 20%, far below the global average of 35%, which limits the adoption of Electric Arc Furnaces (EAF) that rely on scrap for emission reduction.
- **Limited Scrap Availability**: An underdeveloped scrap market further complicates the transition to EAF-based steel production.
- **Inadequate Carbon Capture Technology**: Carbon Capture Utilization and Storage (CCUS) technologies are expensive, energy-intensive, and lack the necessary storage infrastructure for scalability.

- **Market Dynamics**
  - **Price-Sensitive Market**: The Indian market is unwilling to bear the premium associated with green steel unless backed by targeted legislative support or subsidies.
  - **Demand Challenges**: Without adequate legislative and market incentives, the demand for green steel remains subdued.

These challenges collectively highlight the need for technological advancements, policy reforms, increased investments, and market transformation to enable the decarbonisation of the steel industry in India.

9. Recommendations

Recommendations to decarbonise the steel sector of India as per Vipul (2024) are as follows:

- **1. Promote Green Hydrogen Adoption**
  - Implement policies to reduce the cost of green hydrogen through domestic manufacturing initiatives and financial incentives.
  - Support the establishment of hydrogen corridors to streamline industrial decarbonisation efforts.
- **2.Enhance Scrap Recycling and Utilization**
  - Strengthen the scrappage policy to improve scrap collection rates and streamline the scrap supply chain.
  - Develop robust recycling infrastructure to facilitate the adoption of Electric Arc Furnaces (EAF) for low-emission steel production.
- **3. Incentivize Green Steel Production**
  - The Government can create demand for green steel through government procurement and can mandate customer demand terms.
  - Mandate renewable energy usage in steel manufacturing processes and provide financial support through green bonds and other green financing instruments.
- **4. Expand Renewable Energy Capacity**
  - Increase investments in renewable energy to ensure a steady and sustainable supply of green hydrogen production.
  - Focus on decentralised renewable energy systems to cater to diverse industrial needs.

10. Way Forward

Advancing green steel production in India requires a comprehensive approach involving policy reforms, technological advancements, market development, and consumer engagement. Robust carbon pricing mechanisms and subsidies are essential to incentivise low-carbon practices. Investments in R&D for green steel technologies, CCUS, and energy-efficient processes, alongside certification systems, will enhance transparency and trust. Aligning domestic standards with international regulations and fostering public-private partnerships can boost global competitiveness. Additionally, promoting awareness and incentivising the use of certified green steel in infrastructure projects will drive demand. Together, these measures will transition India's steel industry toward sustainability and support global decarbonisation goals.

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