



Steel Sector Decarbonization

For Prelims: [Performance-Linked Incentives](#), [Carbon capture](#), [Natural gas](#), [Carbon dioxide](#), [Greenhouse Gas \(GHG\)](#), [Fossil fuels](#), [Green hydrogen](#), [Circular economy](#), [PAT \(Perform, Achieve, and Trade\) scheme](#)

For Mains: India's steel industry and greenhouse gas emissions, Significance of decarbonising India's steel sector, Government Initiatives and Policies

[Source: TH](#)

Why in News?

The **Ministry of Steel** is actively considering **funding strategies to support decarbonization initiatives in the steel sector**, in response to increasing environmental concerns and the push for sustainable industry practices.

What Options are Being Considered for Steel Sector Decarbonisation?

- **Performance-Linked Incentives (PLI):** The Steel Ministry is contemplating using [PLI schemes](#) to fund decarbonisation projects. Discussions are in the initial stages, and the exact mechanisms are yet to be finalised.
 - A Steel Ministry report estimates that nearly **USD 300 billion will be needed for comprehensive decarbonisation**. This includes over **USD 13 billion for technology upgrades at small steel mills** and an additional USD 150 billion for advanced technologies like **direct reduction of iron** and [carbon capture](#).
 - Direct reduction of iron is the **removal of oxygen from iron ore or other iron bearing materials in the solid state**, i.e. without melting, as in the **blast furnace**.
 - **India's Green Steel Policy** is in the works, with several PLI schemes being discussed for decarbonisation activities in the sector, though still in initial stages.
- **Natural Gas:** [Natural gas](#) is being considered as a potential substitute for coal or coke in blast furnaces to reduce emissions.
 - Energy consumption in most Indian steel plants is **6-6.5 Gigacalorie (Gcal)/tonne, higher than 4.5-5 Gcal/tonne in foreign plants**, due to coal use and older technologies.
 - India's steel industry [carbon dioxide \(CO₂\)](#) intensity is projected to reduce from 3.1 T/tcs(tonne / tonne of crude steel produced) in 2005 to 2.64 T/tcs by 2020, with a goal of 2.4 T/tcs by 2030 (1% annual reduction).
- **Import Duties and Protection Measures:** Discussions are underway to protect the **domestic industry from foreign imports through mechanisms such as price adjustments, increased import duties** (potentially from 7.5% to 10-12%), and safeguard duties.
 - The **goal is to balance import and export trends**, as India has shifted from being a net exporter to a net importer of steel in fiscal 2024, with a trade deficit of 1.1 million tonnes.
 - These measures are part of the broader strategy to support the steel

sector **decarbonisation efforts while addressing competitive pressures from international markets.**

What is Decarbonisation of the Steel Sector?

- **About:** Decarbonisation of the Steel Sector refers to the process of **reducing carbon dioxide (CO₂) emissions** and overall carbon footprint in steel production and producing **Green Steel**. This is crucial for mitigating climate change and sustainability.
- **India's Steel Industry Overview:** India is the **second-largest crude steel producer**, with 179.5 million tonnes capacity and the largest **sponge iron production** at 55 million tonnes (FY 2023-24).
 - India's per capita **steel consumption is 97.7 kg (FY 2024), below the global average of 221.8 kg (2022)**. The **National Steel Policy 2017** aims to raise consumption to 160 kg by 2030, with rapid growth expected beyond.
 - India remains a net importer of steel, with a **25% increase in imports compared to the previous year**, and a 40% decrease in exports for the April to August (FY25) period of the fiscal.
- **India's Climate Commitment:** India is committed to **low-carbon development despite contributing only 4% to global Greenhouse Gas (GHG) accumulation** while housing 17% of the global population.
 - Revised **Nationally Determined Contributions (NDCs)** focus on **renewable energy** and greening the industrial sectors.
 - To meet the **2070 net-zero target**, **India's industrial sector, including steel**, must decarbonize.
- **Significance of Decarbonization of Steel:** The steel industry accounts for **10-12% of India's total emissions**, making its decarbonisation crucial for meeting the country's climate goals.
 - The Ministry of Steel has formed 14 task forces to address decarbonization, focusing on incentivizing green steel, enabling decarbonization levers, and supporting the transition.
- **Green Steel:** It refers to the manufacturing of **steel without fossil fuels**. **Green hydrogen**, produced via **electrolysis** using renewable electricity, and **blue hydrogen**, produced from fossil fuels with **carbon capture**, are solutions to reduce the steel industry's carbon footprint.
 - Accelerating the transition to green steel is crucial for reducing the steel sector's carbon footprint.

What are the Unique Challenges to Decarbonizing India's Steel Sector?

- **Scrap and Pellet Usage:** Developed countries rely more on scrap, have higher pellet uptake, and access low-carbon fuels, while **India lacks sufficient scrap and has expensive natural gas**.
- **Energy Sources:** India uses **low-grade coal and iron ore**, increasing emissions and energy consumption.
 - **Emission intensity of Indian steel: 2.54 tonne of CO₂/tonne of crude steel (tCO₂/tcs), higher than the global average of 1.91.**
 - Integrated steel plants in India use coal-based captive power plants, leading to **higher emissions compared to cleaner grids elsewhere**.
- **Research, Development, and Demonstration (RD&D):** RD&D is critical to achieving sustainability in the steel industry, with emerging technologies like **hydrogen-based DRI production** playing a key role.
 - India's RD&D expenditure is **relatively low compared to global standards, with only 0.64% of Gross Domestic Product (GDP) allocated**, and only 36% of this coming from the private sector.
 - There is a lack of coordinated efforts and consortiums in RD&D, driven by concerns like sharing intellectual property rights.
- **Finance:** Decarbonizing the steel sector requires massive financial investments. The global cost to make the sector net-zero is **estimated between USD 5.2-USD 6.1 trillion**.
 - **Indian steel plants alone will need around 283 billion to transition to green technologies.**
- Barriers to finance include the **complexity of steel production processes, high capital costs, and lack of knowledge regarding low-carbon technologies**.

- **CO₂ Emissions Monitoring:** Integrated Steel Plants (ISPs) in India use the **World Steel Association (WSA)** methodology for emissions disclosure. Challenges in this process include **complex supply chains, unreliable and fragmented data, inadequate measurement infrastructure**, and a shortage of skilled experts for carbon management, hindering **effective CO₂ emissions monitoring across the sector**.

What are the Government Initiatives for Promoting Decarbonisation in the Indian Steel Industry?

- **Task Forces and Roadmap:** 14 Task Forces were formed under the Ministry of Steel to explore and recommend strategies for decarbonizing the steel sector.
- **Steel Scrap Recycling Policy, 2019:** This policy promotes **circular economy and green transition** by enhancing the availability of domestically generated scrap.
 - It provides a framework for establishing metal scrapping centres and includes guidelines for scrap processing and the **scrapping of End-of-Life Vehicles (ELVs)**.
- **National Green Hydrogen Mission:** Launched by the Ministry of New and Renewable Energy (MNRE), this mission focuses on **green hydrogen production and usage**, with the steel industry being a stakeholder.
- **Motor Vehicles Scrapping Rules, 2021:** These rules increase the availability of scrap for the steel sector by establishing a framework for vehicle scrapping.
- **National Solar Mission:** Launched in January 2010, this mission promotes **solar energy use**, contributing to emission reductions in the steel industry.
- **Perform, Achieve, and Trade (PAT) Scheme:** Under the **National Mission for Enhanced Energy Efficiency**, this scheme incentivizes energy savings in the steel sector.
 - By the end of **PAT Cycle -III**, the sector had saved **5.583 Million Tonnes of Oil Equivalent (MTOE) of energy**, leading to a reduction of **20.52 million tonnes of CO₂ emissions**.
- **Carbon Credit Trading Scheme (CCTS):** Established in June 2023, this scheme provides a framework for **trading carbon credits** to reduce greenhouse gas emissions. It aims to help both public and private sector companies reduce their emission costs.

What are Decarbonisation Strategies to Reduce Carbon Emissions in the Indian Steel Industry?

- **Energy Efficiency (EE):** The **PAT (Perform, Achieve, and Trade) scheme** has driven significant energy savings, with the **sector achieving 6.137 million tonnes of oil equivalent (Mtoe) in savings, surpassing the target**.
 - Further reductions in energy intensity are possible by adopting **Best Available Technologies (BATs)**. However, penetration rates are currently low, and challenges include retrofitting constraints and high capital costs.
- **Material Efficiency:** Enhancing beneficiation and pelletisation processes of Iron Ore can improve productivity and **reduce coke consumption**. The Ministry of Steel is considering incentives and support for these technologies.
- **Green Hydrogen:** Green hydrogen can substitute fossil fuels in blast and shaft furnaces and is being explored for **100% hydrogen-based direct reduced iron (DRI)**. Research is underway, with Tata Steel and JSW leading efforts in India.
 - Hydrogen injection can reduce coke consumption and CO₂ emissions. If **green hydrogen costs decrease to around USD 1/kg, consumption could rise significantly**.
- **Carbon Capture, Utilisation, and Storage (CCUS):** CCUS is crucial for achieving deep decarbonisation in the steel sector, **potentially mitigating 56% of emissions from existing technologies**.
 - India has some experience with CCUS, including a few pilot projects. However, **high costs and the need for high-purity CO₂ are significant obstacles**. The Ministry of Steel is exploring non-green hydrogen-based CCU applications and new technologies like carbon recycling.
- **Biochar:** It is produced from **biomass** such as crop residues, bamboo, forest residues, and bagasse, which can significantly reduce carbon emissions in the iron and steel sector.
 - It offers comparable **metallurgical properties to coal and coke** and has the potential to

partially or fully substitute these fossil fuels.

- **Biochar** can be used in various processes, including iron ore sintering, pellet making, coke production, and in electric arc furnaces. It has an **emission reduction potential of up to 1.19 tonnes of CO₂ per tonne of steel**.
- **Challenges** include inadequate **biomass supply chains, lack of mechanisation, absence of storage infrastructure**, and limited scientific data.
 - The Ministry of Steel is exploring measures to support the development of biochar technologies, including R&D support, blending mandates, and market mechanisms.

Way Forward

- **Defining Green Steel:** A clear definition of Green Steel is essential for decarbonising the steel sector and fostering demand for low-emission steel products.
 - Currently, there is no universally accepted definition of green steel, though many organizations and countries are working towards it.
- **Policy Support:** Adopting BATs in both **blast furnace-basic oxygen furnace (BF-BOF) and direct reduction iron-electric arc furnace** processes can help meet global energy consumption norms.
 - The Ministry can work with the **Bureau of Energy Efficiency (BEE)** to set benchmarks and energy-saving targets.
- **Scrap Recycling:** Enhancing scrap recycling can save significant resources and reduce emissions. The Ministry of Steel is focusing on formalising the scrap recycling sector and supporting circular economy initiatives.
- **International Focus:** The global steel industry requires international collaboration for effective decarbonization. **India can leverage global experiences by coordinating with international platforms**, building a global advisory council, and forming a domestic consortium.
 - India should explore multilateral financial options and **establish a National Green Steel Think Tank** to lead in steel decarbonisation while integrating global expertise and financial support.
- **Skill Development:** Transitioning to a green steel industry will require upskilling the workforce to adapt to new technologies and processes, including hydrogen-based production, CCUS, and other low-carbon innovations.
 - Collaborative efforts between the government, educational institutions, and the private sector can ensure that the workforce is prepared for these changes.

Drishti Mains Question:

Discuss the role of steel sector decarbonization in achieving India's climate commitments. How can India balance the need for industrial growth with environmental sustainability?

UPSC Civil Services Examination, Previous Year Questions (PYQs)

Prelims:

Q1. In the 'Index of Eight Core Industries', which one of the following is given the highest weight? (2015)

- (a) Coal production
- (b) Electricity generation
- (c) Fertiliser production
- (d) Steel production

Ans: (b)

Q2. In India, the steel production industry requires the import of (2015)

- (a) saltpetre

- (b) rock phosphate
- (c) coking coal
- (d) All of the above

Ans: (c)

Q3. Which of the following are some important pollutants released by steel industry in India? (2014)

1. Oxides of sulphur
2. Oxides of nitrogen
3. Carbon monoxide
4. Carbon dioxide

Select the correct answer using the code given below:

- (a) 1, 3 and 4 only
- (b) 2 and 3 only
- (c) 1 and 4 only
- (d) 1, 2, 3 and 4

Ans: (d)

Q4. Steel slag can be the material for which of the following? (2020)

1. Construction of base road
2. Improvement of agricultural soil
3. Production of cement

Select the correct answer using the code given below:

- (a) 1 and 2 only
- (b) 2 and 3 only
- (c) 1 and 3 only
- (d) 1, 2 and 3

Ans: (d)

Mains:

Q. Account for the present location of iron and steel industries away from the source of raw material, by giving examples. **(2020)**

Q. Account for the change in the spatial pattern of the Iron and Steel industry in the world. **(2014)**