



## 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 \(CO<sub>2</sub>\)](#) 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 (CO<sub>2</sub>) 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 CO<sub>2</sub>/tonne of crude steel (tCO<sub>2</sub>/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**.

- **CO<sub>2</sub> 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 CO<sub>2</sub> 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 CO<sub>2</sub> 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 CO<sub>2</sub> 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 CO<sub>2</sub> 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 CO<sub>2</sub> 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)**