Decarbonising Sponge-Iron Industries

Transitioning Towards a Low Carbon Future

Background

As one of the most essential building and engineering materials, steel is used in many facets of modern life. It is one of the fundamental cornerstones of today's modern infrastructure. However, the industry must now contend with demands to lessen its carbon footprint from an economic and environmental perspective. With roughly 8% of the world's energy sector emissions going to the steel industry, fulfilling climate targets is crucial.

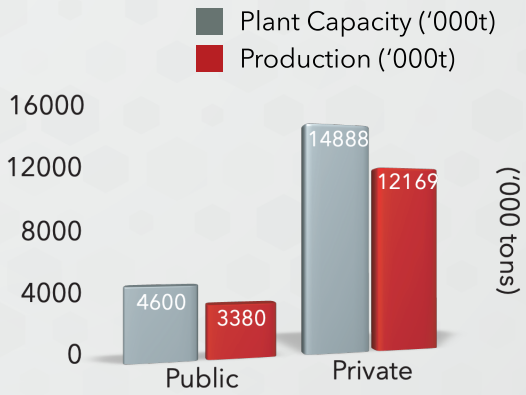
With economic growth, infrastructure expansion, and rapid urbanisation in India, steel's significance in fostering the country's growth will rise. By 2050, the sectors' emissions are predicted to increase by 200 percent. To ensure that India achieves its economic objectives and climate mitigation goals, the steel sector must be decarbonised. Approximately 23% of India's gross value addition is attributed to this sector (2022), but it also accounts for the highest percentage of industrial emissions at 34% (2016).

Context of Jharkhand

Jharkhand has a prominent place on the country's mineral map. No other area in the world has the kind of extensive mineralization that Jharkhand is blessed with in such proximity. Energy, ferrous, non-ferrous, fertiliser, industrial, refractory, atomic, strategic, precious, and semi-precious mineral groups have prospective resources in the state.

With 26% of the total reserves of iron ore (hematite), Jharkhand is second among all the Indian states. One of the richest mining regions in the world, Jharkhand's main industries are mining and mineral extraction due to abundant mineral deposits.

Steel Production Capacity in Jharkhand



Jharkhand is rich in mineral resources, including coal (25% of India's reserves), iron ore (26% of India's reserves), copper ore (18.5% of India's reserves), uranium, mica, bauxite, granite, limestone, silver, graphite, magnetite, and dolomite. Coking coal, uranium, and pyrite are only produced in Jharkhand, a state in India. Jharkhand is second among the states in terms of iron ore (hematite) reserves, accounting for 25.7% of the total.

Coking coal is a major cost factor in steel production to the tune of 42%.

India is currently the world's second largest steel producer.

Jharkhand is home to 40% of India's mineral reserves.

Jharkhand has the second largest iron ore reserves of the country.

Jharkhand is an industrialised state that is home to a wide range of industries, including coal, steel, cement, fertiliser and chemicals.

In addition to being the fourth-largest producer of coal (16.72%) and coking coal (99%), Jharkhand is also one of the biggest producers of steel. Furthermore, it has the biggest amounts of coal bed methane (27.8%).

Significance of Steel in Decarbonisation

Making steel is highly carbon intensive. On average, 1.8 metric tonnes of CO2 are emitted during the manufacture of one metric tonne of steel, which accounts for 8% of all worldwide CO2 emissions. Steel factories are an excellent option for decarbonisation because the steel industry is now one of the top three sources of carbon dioxide emissions, with emissions occurring only in a few places.

India's National Steel Policy-2017 outlined the goal of tripling output capacity by 2030. It sets out the direction of growth as well as climate change targets for the sector. Over the coming decades, India will dramatically increase its steel production to meet rising domestic and global demand. With a compound annual growth rate (CAGR) of 3.7%, domestic crude steel output increased nationally during a five-year period, from 137.97 MT in 2017–18 to 154.06 MT in 2021–22. However, domestic crude steel production in Jharkhand accounts for about 14% of the total production nationally. There is significant growth potential given India's low per capita steel consumption of 77.2 kg in 2022–2023 compared to the global average of 233 kg in that same period1[1]. By 2030, it is projected that the CO2 emissions from the manufacturing of crude steel will be increased by almost 2.5 times under the status quo[2].

Iron and steel production requires a lot of energy and resources, yet it is essential for economic progress. Significant energy, environmental, resource, and economic ramifications will result from India's steel market's rapid expansion. The energy consumption of the iron and steel industry is currently the highest of any industrial sector .Therefore ,energy-efficient and cutting-edge technological advances must be developed and implemented in the steel manufacturing industry.

Low Carbon Technology for Steel Production

In comparison to other nations, India's steel industry is relatively diverse, having a wide range of facilities of various sizes in the primary and secondary steelmaking sectors. The Blast Furnace - Basic Oxygen Furnace (BF-BOF), coal-based Direct Reduction (DR), gas-based DR, electric induction furnace (EiF), and electric arc furnace (EAF) are among the other modern technologies in use. The majority of new capacity is built using BOF technology, which is dominating an increasing portion of the steel production industry. EAF and EiF account for nearly equal shares of the remaining market.

New technologies will be needed, especially for the replacement of traditional primary production processes with low emissions alternatives, to accomplish deep decarbonisation of the iron and steel sector. Several innovative low-emission methods are being developed to make steel from iron ore. They can be divided roughly into three groups:

Production of 1 ton of steel emits around 1 ton of CO2 on an average.

India's crude steel production capacity is expected to rise to 300 million tonnes by 2030.

India's per-capita steel usage (77.2 kg) is one-third of the global average (233 kg).

India's per-capita steel consumption has gone up by 50% in the last 8 years.

1 https://www.pib.gov.in/PressReleasePage.aspx?PRID=1896882#:~:text=The%20finished%20steel%20consumption%20was,world%20per%20capita%20steel%20consumption.

2 https://www.cseindia.org/decarbonizing-india-s-iron-and-steel-sector-report-11434

- Direct electrification by the electrolysis of iron ore;
- Carbon Capture, Utilisation, and Storage (CCUS);
- The use of low-carbon hydrogen to replace fossil fuels;

Based on their financial viability ,capacity to cut emissions ,and compatibility with India's current infrastructure and resource profile ,each of these technologies has a different level of applicability to the Indian setting.

Low Emission Steelmaking Technologies

Technology	Emission reduction potential
Carbon Capture, Utilisation, and Storage	
BF-BOF with CCUS	Possibility to reduce CO2 by approximately 60%. Although higher capture rates are possible, costs increase substantially due to multiple CO2 sources.
Coal based DRI with CCUS	There have been no comprehensive studies on applying CCUS technology to coal-based rotary kilns for sponge iron production but similarity to natural gas DRI suggests around 90% reduction may be possible.
Natural gas DRI with CCUS	Currently operating plants have shown that around 90% reduction is possible.
Smelting reduction with CCUS	Smelting reduction processes alone can reduce emissions by approximately 20% versus conventional BF-BOF. The addition of CCUS can potentially reduce emissions by 80% (Tata Steel, 2020)
Hydrogen	
BF with H2 blending	It is expected that H2 would only be able to replace part of the injected coal, resulting in maximum 20% emissions reduction.
H2 DRI	Emissions reduction potential depends on the share of H2 and whether the H2 is from low carbon sources. Assuming 100% green H2, emissions reduction can be >90%, with residual emissions from carbon sources for steelmaking, graphite electrodes and limestone.
H2 plasma reduction	If produced from low carbon electricity, there is the potential for >90% emissions reduction.
Direct electrification	
Electrolysis	If produced from low carbon electricity, there is the potential for >90% emissions reduction.

Source: Achieving Green Steel: Roadmap to a net zero steel sector in India. New Delhi: The Energy and Resources Institute (TERI)

Initiatives Undertaken for Promoting Decarbonisation in Steel Industry

- A Task Force on Sustainable Just Transition has been constituted by the Government of Jharkhand to create roadmaps and action plans for sustainable energy transition with due focus on decarbonisation initiatives for various sectors including industries in the state.
- The Ministry of Steel, Government of India has formed 13 task forces that will determine action points for every facet of producing green steel.
- The 2019 Steel Scrap Recycling Policy increases the supply of scrap produced domestically to cut down on the amount of coal needed to make steel.
- For the purpose of producing and using green hydrogen, the Ministry of New and Renewable Energy (MNRE) has announced the National Green Hydrogen Mission. The steel industry has been included as a key stakeholder in the Mission. The mission involves accelerating the commercial production of green steel.
- The supply of scrap in the steel industry will rise as a result of the Motor Vehicles (Registration and Functions of Vehicles Scrapping Facility) Rules, which go into effect in September 2021.
- The National Solar Mission, initiated by MNRE in January 2010, encourages the use of solar power while simultaneously assisting in the reduction of emissions from the steel industry.
- The National Mission for Enhanced Energy Efficiency's Perform, Achieve, and Trade (PAT) scheme encourages the steel industry to cut back on energy use.
- In its modernisation and growth projects, the steel industry has used the Best Available Technologies (BAT) that are currently available on a global scale.
- Steel mills have adopted the New Energy and Industrial Technology Development Organisation (NEDO) of Japan's Model Projects for Energy Efficiency Improvement.

The steel industry is about to undergo an immense transition. Utilising its own resources and talent, the state of Jharkhand is ideally placed to benefit from many aspects of a sector that is competitive, digital, and decarbonised.

However, there are serious risks involved in not accepting this challenge. Governments, the financial sector, and steel buyers are all moving quickly to clean up their acts, which is causing the global steel sector to change drastically. India's steel industry is currently among the most polluting, so it still has a long way to go while simultaneously increasing production.

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