GOVERNMENT OF INDIA
MINISTRY OF POWER

On behalf of:
Federal Ministry for Economic Affairs and Climate Action

on the basis of a decision by the German Bundestag

Energy Efficiency in the Iron and Steel Sector

Study by:

CII

Initiative by:

igef Indo-German Energy Forum

Imprint

Commissioned on behalf of
Bureau of Energy Efficiency (BEE), Ministry of Power (MoP), Govt. of India
The Federal Ministry for Economic Affairs and Climate Action (BMWK), Govt. of Germany

Commissioned by
Indo-German Energy Forum Support Office (IGEF-SO) and
c/o Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
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Version: December 2021
Design and Layout: Aspire Design

Executive Summary

The Indian steel sector has been growing steadily, and in 2019, it was the second largest producer of steel and the largest producer of DRI globally. The Ministry of Steel has spared no effort to enable a hassle-free pathway for the growth of the sector in the next decade, so that it may achieve the target capacity of 300 million tonnes by 2030. Various policy measures and initiatives have been introduced to facilitate the growth of the sector. For instance, the Make in India initiative and the amendments to the Domestically Manufactured Iron & Steel Products Policy (DMI&SP) have created a conducive environment for growth, with a focus on minimizing imports of raw material and maximizing exports of finished steel.

The annual per capita steel consumption of India is around 74 kg, which is just 1/3rd of the global average. There is a transition underway in construction, with steel-intensive construction prevailing globally, and this bodes well for future consumption and production of crude steel. The collaborative branding campaign of the Ministry of Steel, called "Ispati Irada", aims to promote the benefits of steel in various facets of nation building.

Overall, the steel sector is foreseen to reach the milestone of 300 MT capacity by 2030, with various drivers and factors contributing to greenfield expansion projects. With higher production capacities, the demand for good quality domestic scrap will go up. There will be integration of various breakthrough technologies in the 2030s, which will increase the adoption of alternate fuels and innovative processes, and that will in turn reduce the overall GHG emissions from the sector.

Brownfield expansion projects have been announced by many stakeholders, but greenfield expansion projects have not curried favour. Policy frameworks are being designed with a vision to improve industry interest in greenfield expansion, and support in key areas can be expected in the near future.

The steel sector is energy intensive and has a significant share in the country's total carbon emissions. The Ministry of Steel aids the sector with several schemes, such as 'Promotion of R&D in Iron & Steel Sector', wherein financial assistance is provided to R&D projects and to indigenous energy efficient processes and technologies. The Perform, Achieve and Trade (PAT) Scheme has also been playing a key role in accelerating energy efficiency in the sector.

This report aims to detail the outlook for the sector over the next one decade, in terms of energy consumption, GHG emissions, and production growth. It also identifies various avenues to accelerate energy efficiency and to reduce emissions. Brief descriptions of what each chapter of the report entails is presented below:

Chapter 1: Highlights the global steel status in terms of production, including leading steel producers (global), route-wise production, leading private steel producers, and the status of energy consumption and GHG emissions.

Chapter 2: Highlights the Indian steel scenario. Domestic steel production is captured based on the production route, and suggestions on segmentation of the steel sector are included. Details of Indian energy consumption and GHG emissions are covered in this chapter.

Chapter 3: Covers the institutional framework for the sector, and maps the role of important stakeholders, such as ministries, government agencies, steel producers, associations, etc. Detailed information on key stakeholders is provided in Annexure – A.

Chapter 4: Provides an overview of current energy efficiency levels in the steel sector for Blast Furnace – Basic Oxygen Furnace and DRI-EAF/IF route. The chapter covers assessment of the current levels of energy efficiency, and the gap analysis for Best Available Technology. The chapter also includes analysis on BAT performance, steel plant section-wise.

Chapter 5: Covers Baseline Scenario and Best Available Practice & Technology Scenario analysis for growth in production and consumption of steel, and a comparison of these scenarios for impact on energy consumption and GHG emissions.

Chapter 6: Includes assessment of whether the steel sector can play a key role in managing the peak power for the Grid by managing its captive power generation.

Chapter 7: Sheds light on how Hydrogen-based production will be a viable route for steel production in the future. The chapter provides an analysis of the potential for Green steel production in India.

Chapter 8: Provides an overview of scrap usage and the potential challenges to increasing the scrap utilisation in steel production.

Chapter 9: Includes key recommendations for the sector based on the analysis undertaken in the study. The recommendations emphasise on continuing the current efforts for improvement, but also to implement more focused programs to align current energy consumption levels with global benchmarks.

Based on the assessment and analysis in this study, it can be concluded that the sector is driven not only towards a progressive growth but also towards a sustainable growth. Supported by a plethora of initiatives by the Ministry of Steel, the Ministry of Power, and other stakeholders, the Indian steel sector has the potential to accelerate its transition to energy efficient production, in line with global benchmarks. The sector is also looking into futuristic technology integration, such as green hydrogen and other high impact solutions, which will reduce the GHG emissions substantially.

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Abbreviations

AIIFA	All India Induction Furnace Association
AISRA	All India Steel Re-Rollers Association
ASPA	Alloy Steel Producers Association of India
BAPT	Best Available Technologies and Practices
BAT	Best Available Technologies
BF	Blast Furnace
BIR	Bureau of International Recycling
BOF	Basic Oxygen Furnace
CAGR	Compound Annual Growth Rate
CCS	Carbon Capture and Storage
CCUS	Carbon Capture Use and Storage
DC	Designated Consumers
DMI& SP	Domestically Manufactured Iron & Steel Products Policy
DRI	Direct Reduced Iron
EAF	Electric Arc Furnace
ERU	Economic Research Unit
FIMI	Federation of Indian Mineral Industries
Gcal	Giga Calories
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GJ	Giga Joules
IF	Induction Furnace
IFAPA	The Indian Ferro Alloy Producers' Association
IICA	Inland Importers and Consumers Association
INSDAG	Institute for Steel Development and Growth
IRMA	Indian Refractory Makers Association
ISA	Indian Steel Association
ISSDA	Indian Stainless-Steel Development Association
JPC	Joint Plant Committee
kWh-	Kilo Watt Hour
MNRE	Ministry of New and Renewable Energy
MoEFCC	Ministry of Environment, Forest and Climate Change
MT	Million Tonnes
MTPA	Million Tonnes per Annum
NAPCC	National Action Plan on Climate Change
NHEB	National Hydrogen Energy Board
NISST	National Institute of Secondary Steel Technology
NMEEE	National Mission on Enhanced Energy Efficiency
NSI	National Steel Institute
NSP	National Steel Policy
PAT	Perform Achieve and Trade
PMAI	Pellet Manufacturers Association of India
SCC	Steel Consumers' Council
SDF	Steel Development Fund
SEC	Specific Energy Consumption
SIMA	Sponge Iron Manufacturers Association
SMR	Steam Methane Reforming
SMS	Steel Melting Shop
SRMA	Steel Re-rolling Mills Association of India
SWMAI	Steel Wire Manufacturers Association of India
TCS	Tonnes of Crude Steel
USD	United States Dollar
VFD	Variable Frequency Drive

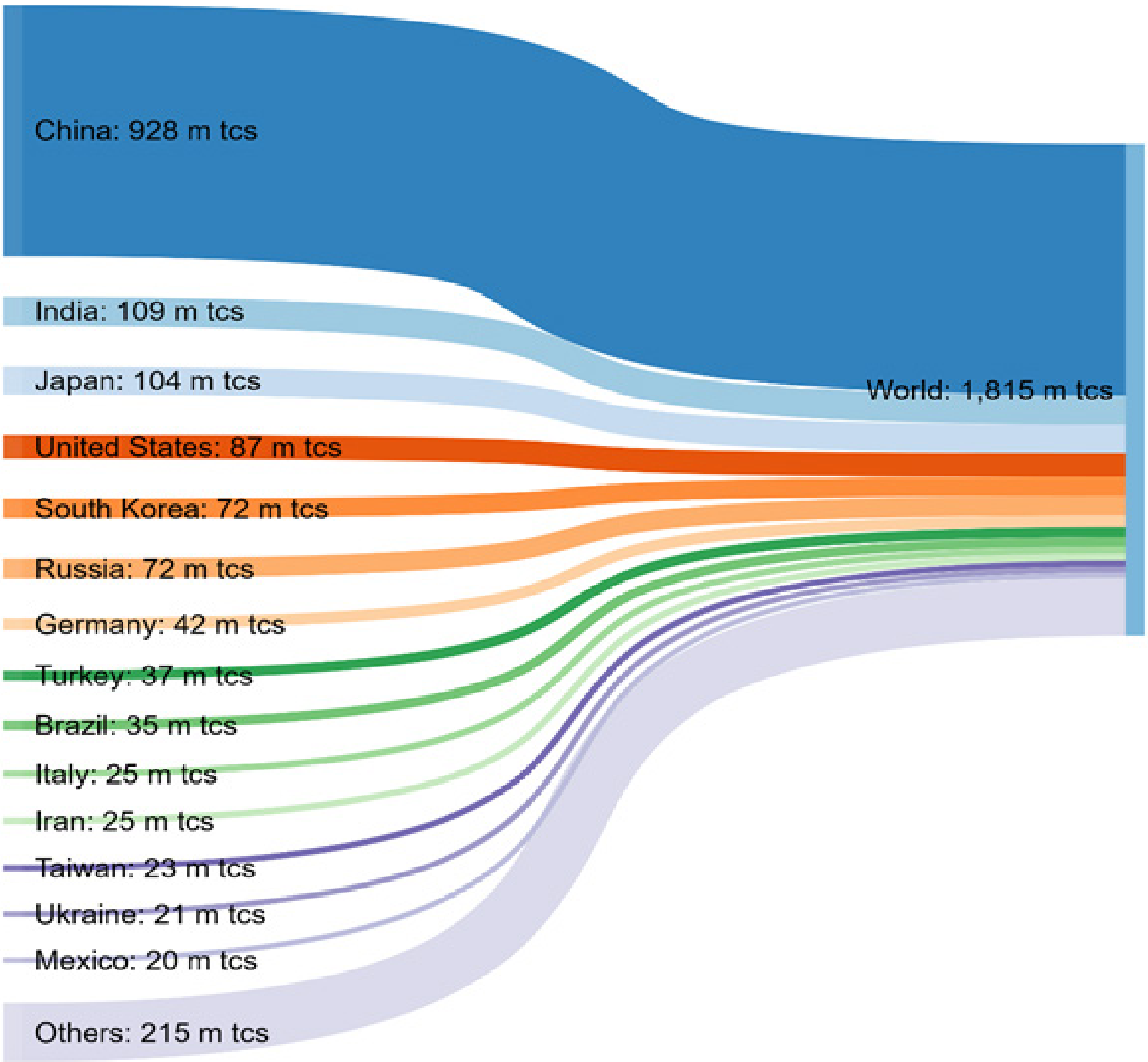
1. Introduction

The Iron & Steel industry drives the economic development of the world. Iron and steel are vital inputs for construction and infrastructure, and enable a wide range of value adding manufacturing activities in various sectors, such as manufacturing, automobile, transport, etc. In 2017, from the economic point of view, the total value contribution of the steel sector was United States Dollar (USD) 2.9 trillion, which is around 3.8% of the world's Gross Domestic Product (GDP) (equivalent to the whole of India's GDP), and supported 96 million jobs [1].

1.1 Global Steel Production

Steel production has grown 2.2 times from 850 million tonnes crude steel (TCS) in 2000 to 1,869 million TCS in 2019. China alone accounts for 53% of global steel production, followed by India and Japan accounting for 5.9% and 5.3% respectively [2]. Figure 1 highlights the global production of steel based on the contribution of countries/regions to overall production. The top five countries account for 71% of global steel production, and the top 10 countries account for 83% of the world's steel production.

Figure 1: World Steel Production – 2018 [2]



During the last two decades, China has been the leading steel producer in the world, and it contributed an 85% increase in steel production globally during the period of 2000-2019. Figure 3 highlights the growth in steel production in the top 10 countries in the last 20 years. During this period, global steel production grew by 4% every year, whereas China and India registered production increase of 10.7% and 7.34% respectively, indicating that the two Asian countries have been driving the steel production and consumption globally.

Figure 2: World Steel Production

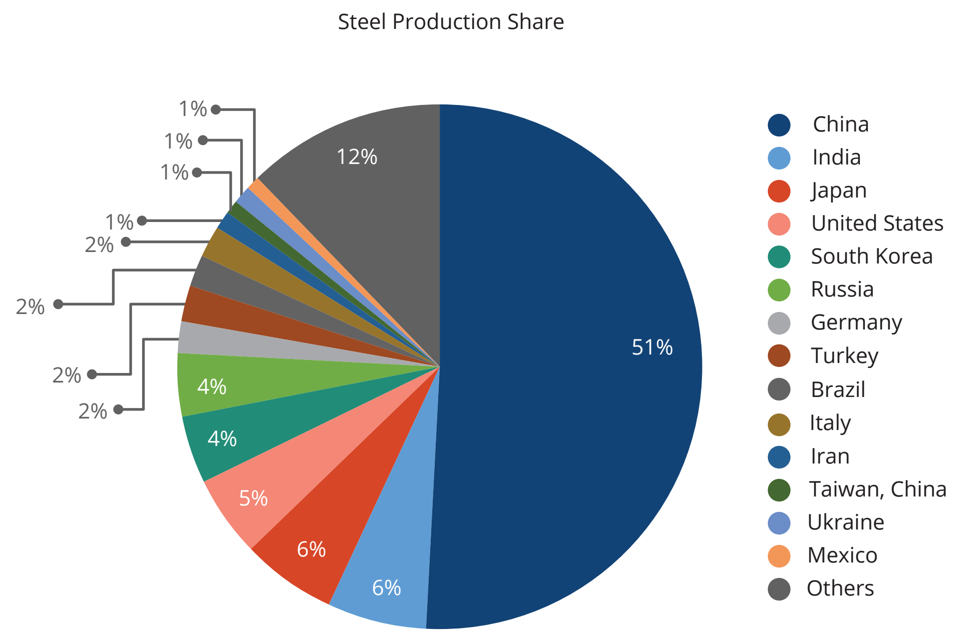
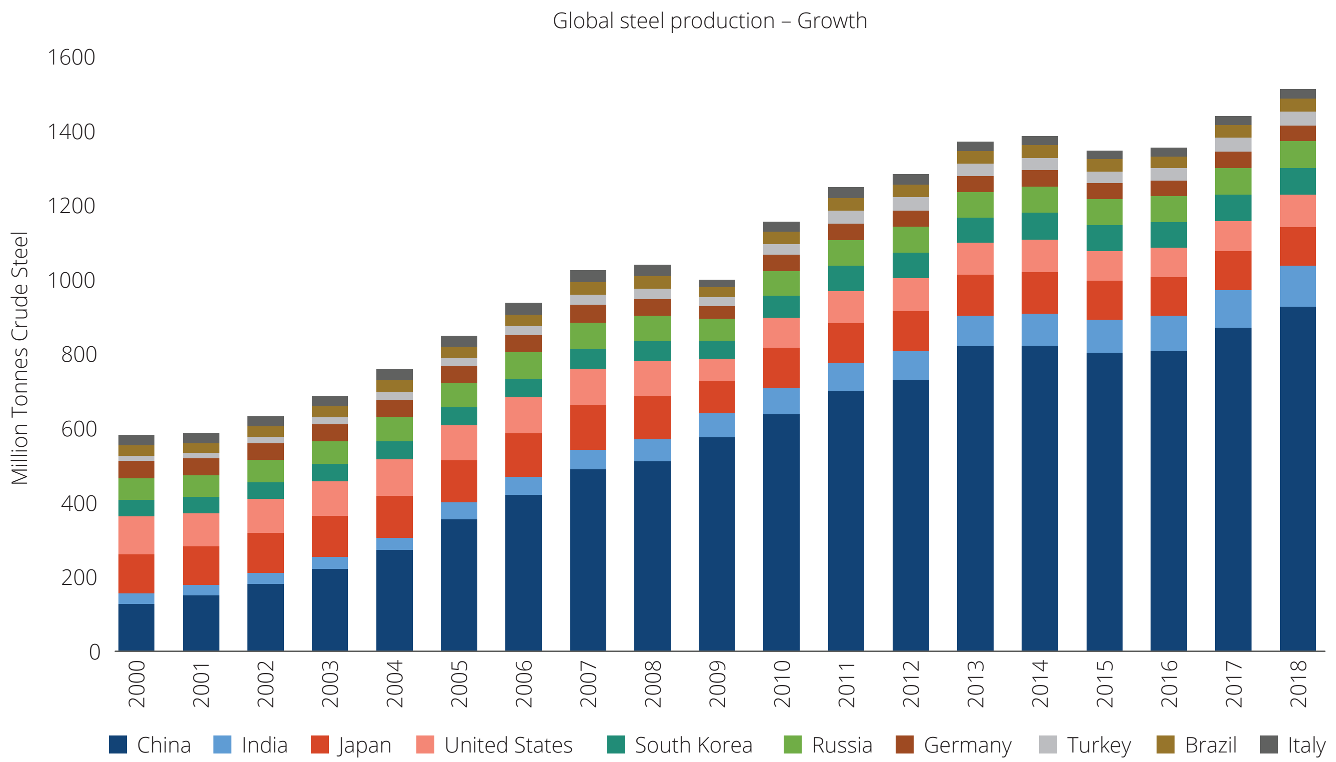


Figure 3: World steel production – Last two decades [2]



1.2 Production Technology

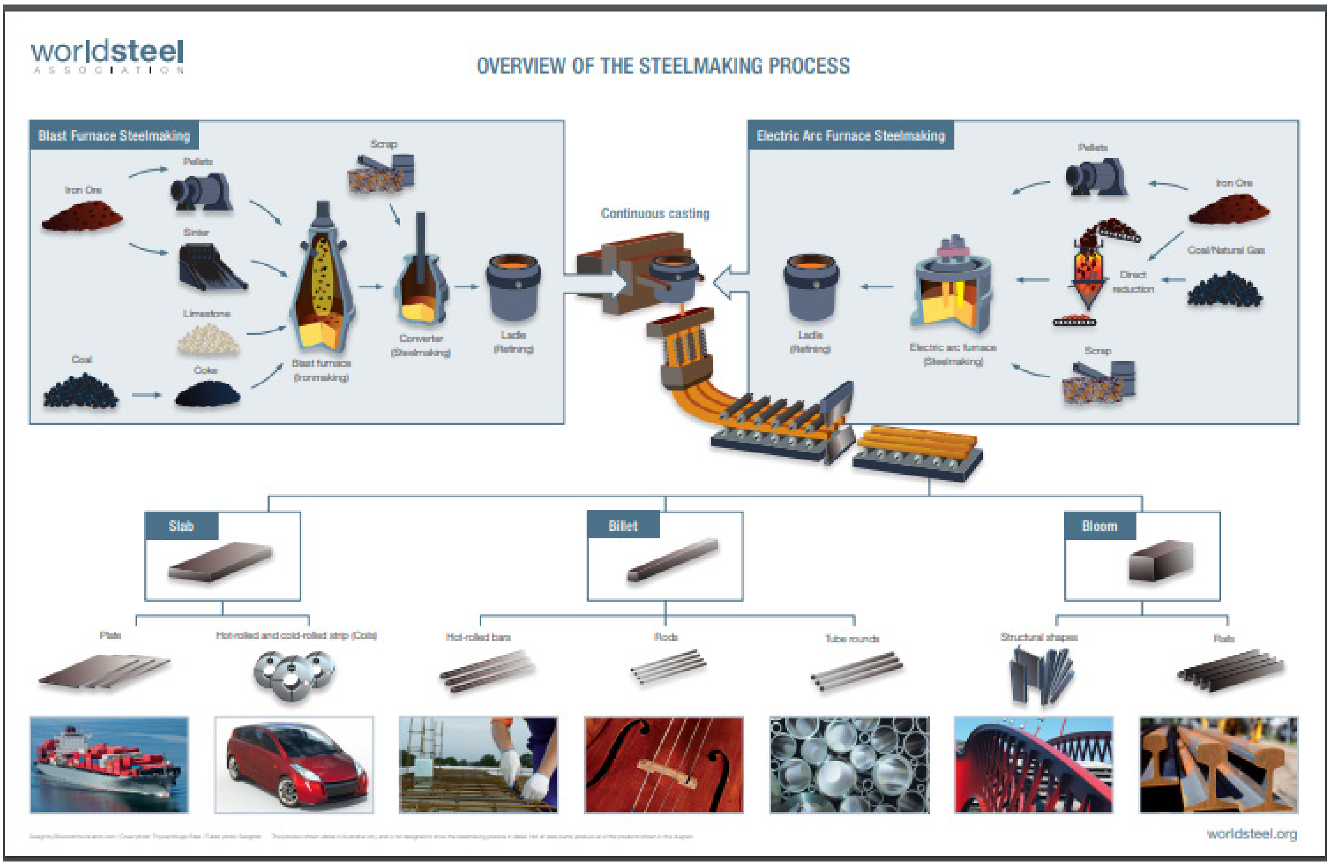
Globally, crude steel is produced using two different routes: Blast Furnace (BF) – Basic Oxygen Furnace (BOF) Converter, and Electric Arc Furnace (EAF). The key difference between the two is the type of raw materials/fuels they consume.

Route-I: The BF-BOF route – Under this route, in the blast furnace, pig iron is extracted from iron ore using coke, and subsequently, the output from blast furnace is refined and converted to steel in the basic oxygen furnace (BOF). Depending on the requirement, scrap is added to this process, primarily to regulate the temperature. Under this route – globally on average, 1,370 kg of iron ore, 780 kg of metallurgical coal, 270 kg of limestone, and 125 kg of recycled steel are used to produce 1,000 kg of crude steel. [3]

Route II: The Electric Furnace Route – Under this route, there are two sub routes: EF – scrap-based steel production, and Direct Reduced Iron (DRI) – EAF route. Under the EF – scrap-based route, electricity is used to melt steel scrap, and additives such as alloys are added to adjust to the desired chemical composition. Under the DRI-EF route, the Direct Reduced Iron (DRI), also known as Sponge Iron, is produced from direct reduction of iron (in the form of lump, pellets or fines) by a reducing gas produced from natural gas or coal. Further to this, the output of DRI is charged (hot or cold) to EF for steel making. Under this route – globally on average, 710 kg of recycled steel, 586 kg of iron ore, 150 kg of coal, 88 kg of limestone and 2.3 GJ of electricity are used to produce 1,000 kg of crude steel. [3]

For both the routes, the downstream process is similar, where the output is further converted into value added products through casting and rolling mills.

Figure 4: **Steel Production Process**



Source: World Steel Association

Figure 5: Global crude steel production – route

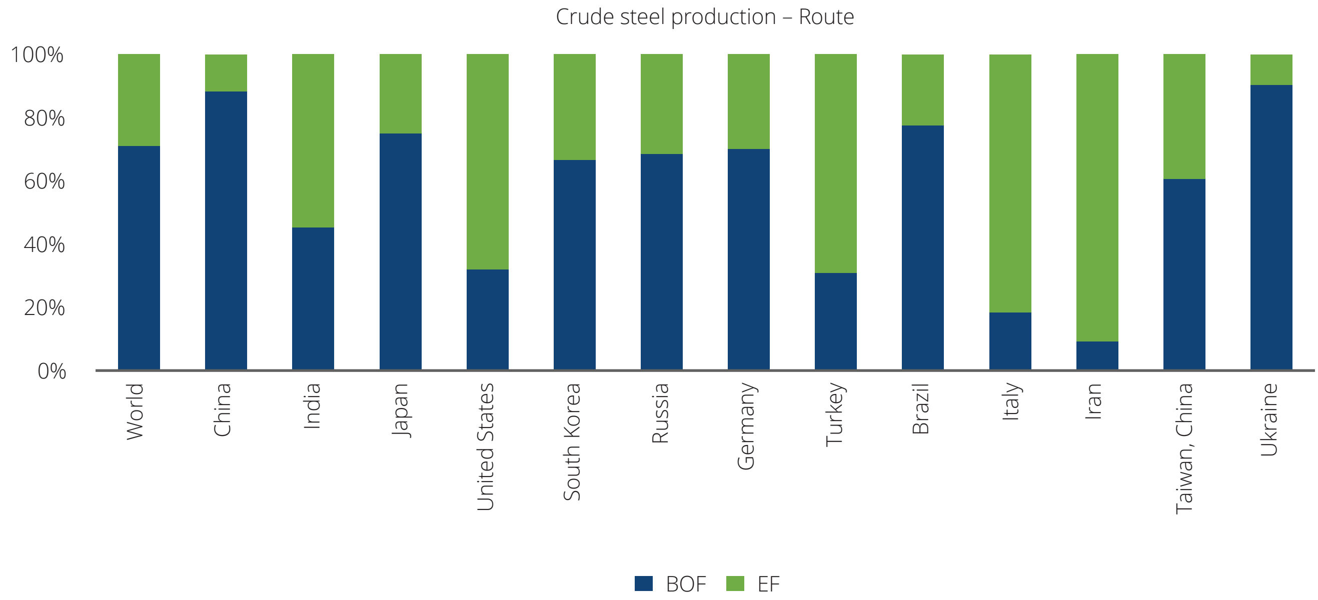
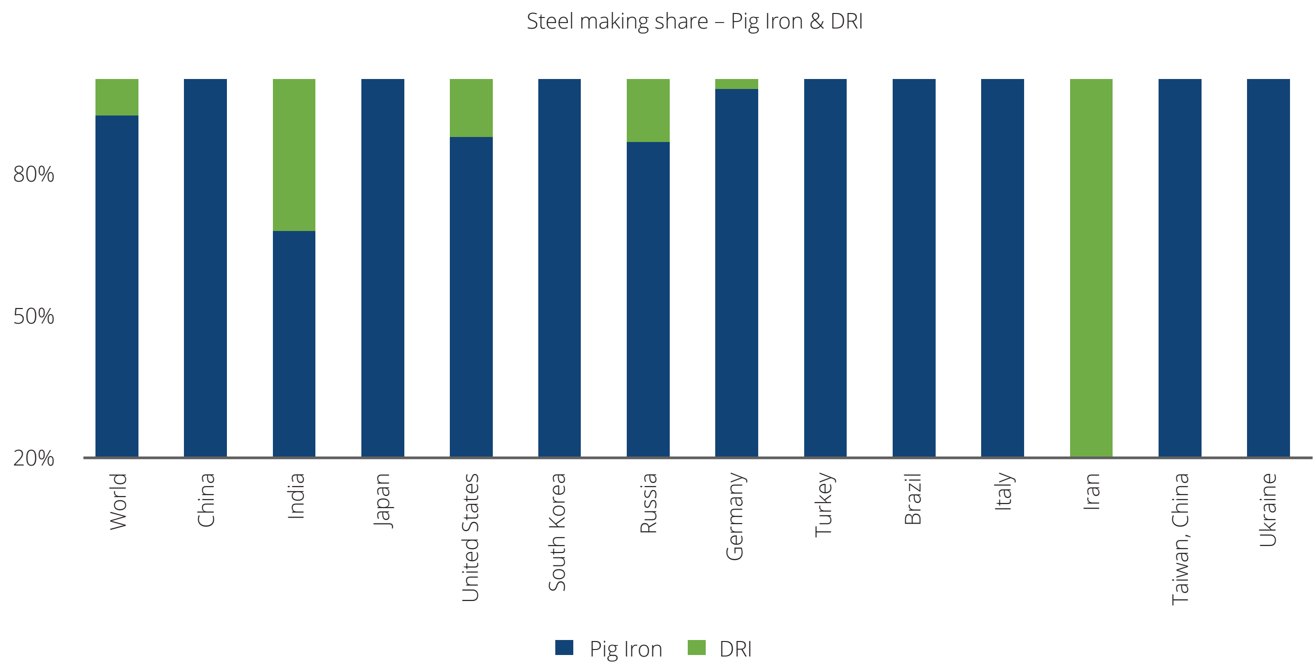


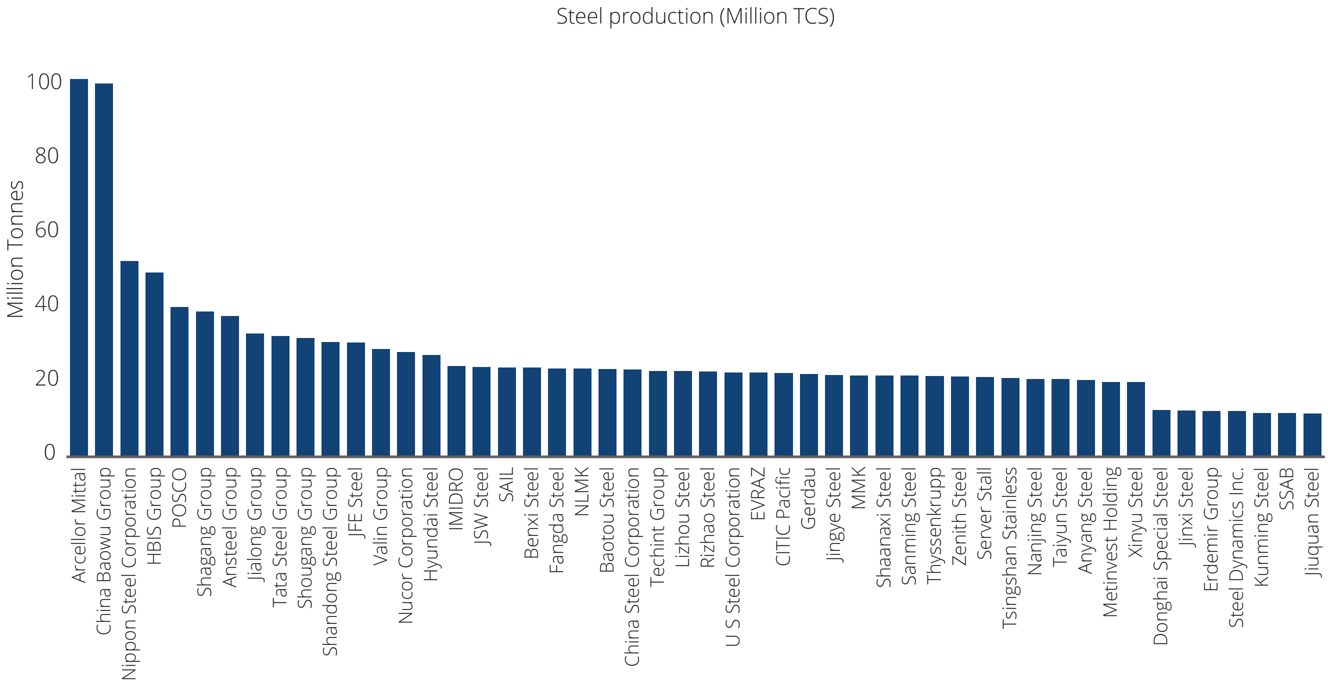
Figure 6: Steel making share – Pig Iron & DRI



Globally, more than 70% of crude steel is produced using the BF-BOF route, and around 30% crude steel is produced through the scrap/DRI based EAF route. The following graph shows the share of BF-BOF and EAF routes for crude steel production [3]:

Pig iron, DRI, and scrap are major inputs for steel making. The following graph highlights the production of pig iron and DRI among tip producers. In most of counitries, the share of pig iron is high. In India, there has been an increase in DRI production over the last few years, and India is currently the largest producer of DRI in the world, followed by Iran.

Figure 7: Global steel producers – Top 50



1.3 Leading Steel Producers – World

More than 50% of global steel production comes from just 50 companies, and in 2019, the top 50 producers made 1,060 million TCS [2]. Some of the leading steel producers are Arcelor Mittal, China Baowu Group, Nippon Steel Corporation, POSCO, Tata Steel, etc. The following graph highlights the top 50 steel producers in the world.

The leading producers from India in the top 50 are Tata Steel, JSW Limited, and Steel Authority of India Limited.

1.4 Energy Use in Steel Making

Steel manufacturing process is energy- and material-intensive. Coal is used as a reducing agent and to meet energy demand in various processes. Energy constitutes a major portion of steel production cost: about 20-40% [4], and energy consumption varies depending on the production route, raw material, fuel and technology.

Globally in 2018, the energy consumption of the steel sector was 33.57 EJ. The following table highlights energy/fuel consumption across steel manufacturing processes:

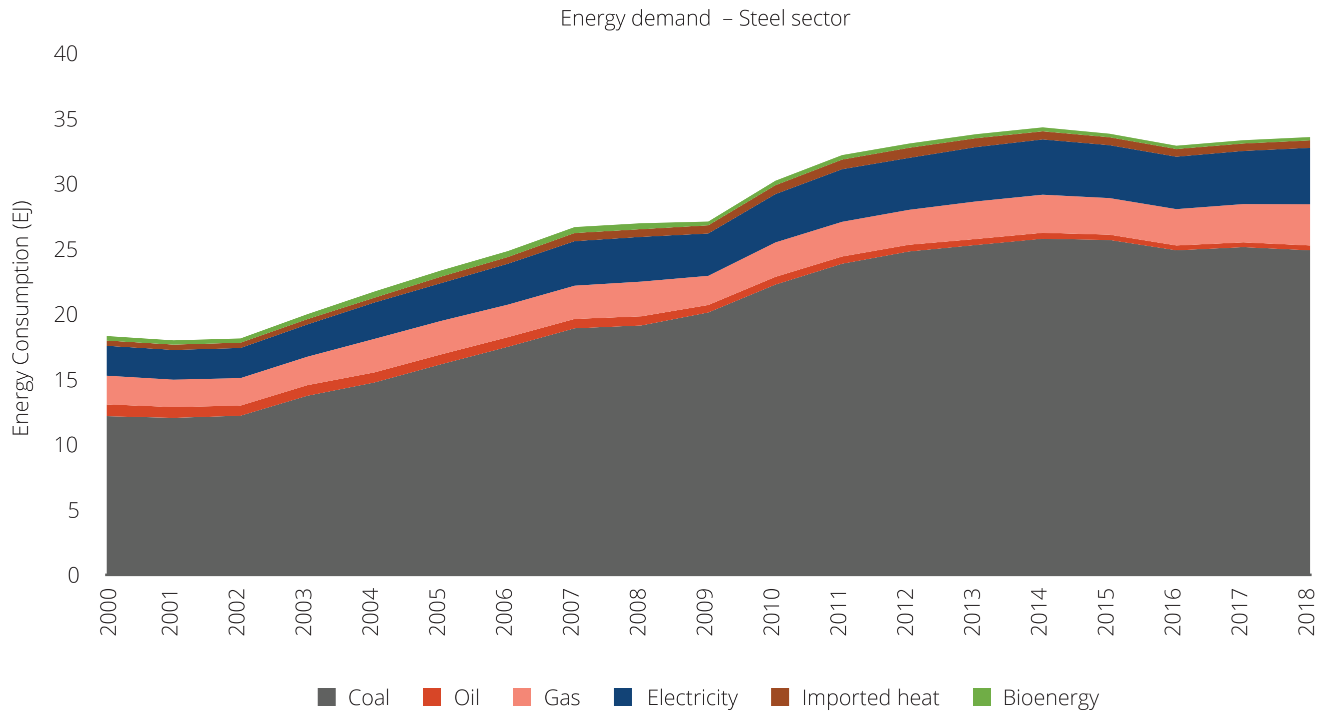
Among all the fuels/energy sources, coal is the major one, followed by electricity, gas, and oil. The following graph highlights the share of different fuels in the overall energy usage for steel making during 2000-2018 [5].

Owing to the increase in demand for steel in the last two decades, the energy consumption of the steel sector

Table 1: Energy use in steel making

Fuel (Energy)	Use	% Share of overall use (2018)
Coal	Coke production, Blast Furnace, sinter, DRI	74.1%
Electricity	Electric Furnace, rolling mills and other uses in steel plant (induction motors, etc.)	12.9%
Natural Gas	Furnaces, Blast Furnace, DRI	9.4%
Oil	Blast Furnace, DRI, etc.	1.1%
Others	Process	2.5%

Figure 8: **Energy consumption with various fuel sources**



has grown 3.2% annually, while steel production has witnessed annual growth of 4%.

Energy Intensity

As highlighted in the previous section, steel making is an energy-intensive process, and improving energy efficiency is must for achieving cost savings and emission reduction. Considering the energy cost, energy efficiency is an important focus area for the steel sector. Owing to various energy efficiency and technology upgradation projects, globally, the steel sector's energy intensity has improved by 60% since 1960 (50 GJ/T) [4]. The following graph highlights the energy intensity improvement for crude steel production during the period of 2000-2018 [5]. During this period, the energy intensity improved at a rate of 0.78% annually.

Considering the best practices/technologies, the following are the possible energy intensities across various steel making routes:

Figure 9: **Energy intensity in steel production**

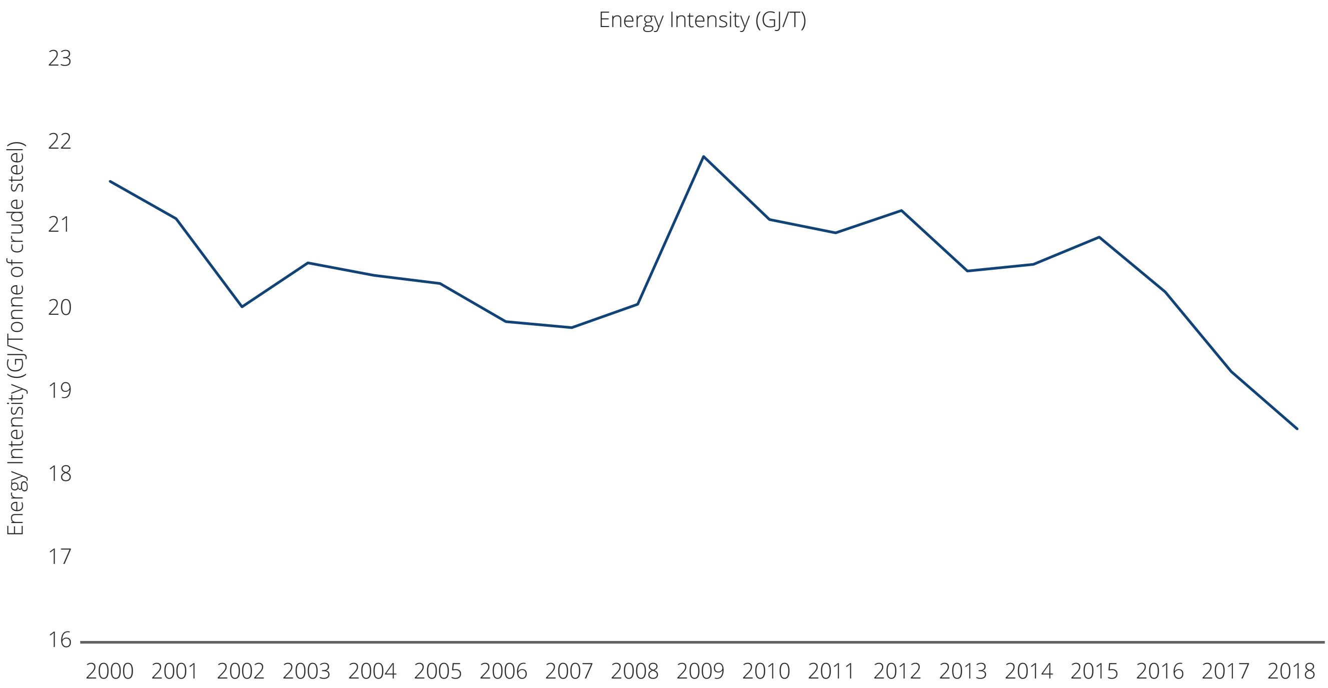


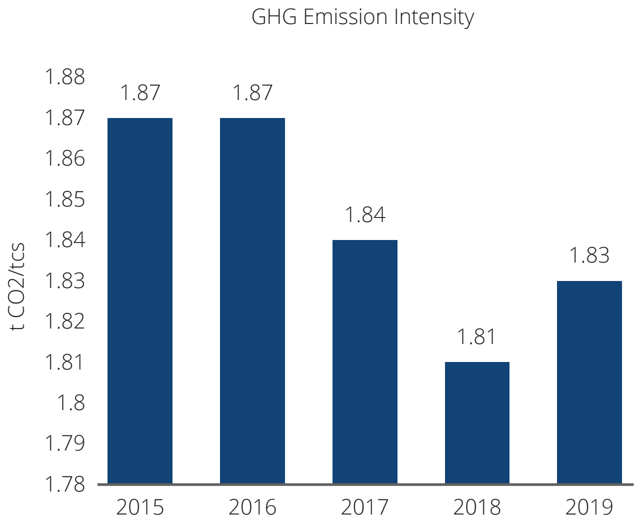
Table 2: **Energy intensity – Best practices for different steel routes**

S. No.	World's Best Practices – Energy Intensities	GJ/tonnes steel
1	Blast furnace – Basic Oxygen Furnace	14.8
2	Smelt reduction – Basic Oxygen Furnace	17.8
3	Direct Reduced Iron – Electric Arc Furnace	16.9
4	Scrap – Electric Arc Furnace	2.6

GHG Emissions

The Iron & Steel sector is among the most GHG- and energy-intensive sectors, and globally, it is the largest contributor of CO_2 emissions. The GHG emissions in the steel sector are primarily due to energy related emissions and process emissions (reduction of Iron ore with coke). Average around 1.85 T CO_2 is emitted due to steel production and the sector directly accounted for 2.6 billion tonnes of CO_2 emissions in 2019, which is around 7% of global emissions. The global average GHG intensity for steel production has been improving from 2015 and following figure highlights the trend of GHG emission intensity for steel production in the last few years [2].

Figure 10: **GHG Emission Intensity – Steel Production (2016-2018)**



2. Indian Steel Overview & Segmentation

Key Highlights

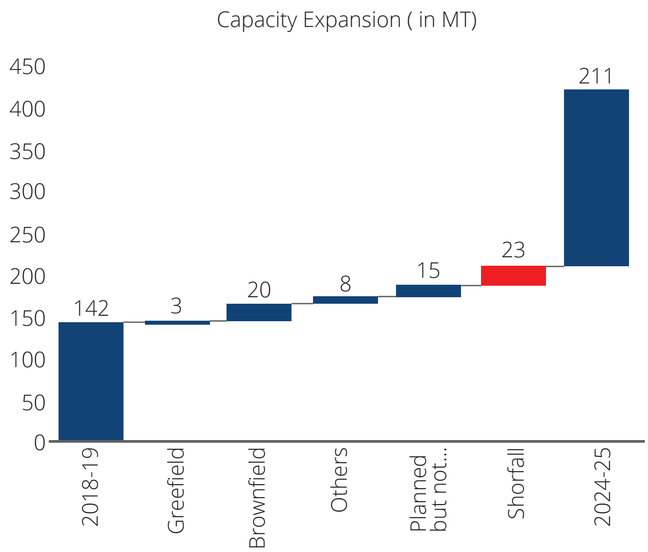
- CAGR of 3.87% in the Indian steel sector from 2016.
- NSP 2017 anticipates 300 MT production capacity by 2030, indicating a required CAGR of 7% for the next decade.
- The present growth rate of the sector will lead to 215 MT production capacity by 2030.
- The capacity addition in the sector for the next decade lays conducive paths for brownfield expansion, in addition to greenfield expansion.
- The Ministry of Steel has included four key elements in the policy framework to increase the interest among the key players for greenfield expansions.
- Ispati Irada and Make in India campaign could be major driving factors for the growth of steel sector per capita consumption of s

2.1 Overview of Indian Steel Sector

In 2016, the Indian steel production capacity was 122 MT, and by 2019, the production capacity reached 142 MT, indicating a CAGR of 3.87%. The progressive growth in the sector made India the 2nd largest producer of steel in the world, with an actual production of 109.14 MT. The steel sector contributes to nearly 2% of the country's GDP and employs more than 600,000 people. The finished steel is consumed by many sectors contributing to the GDP. Steel is hence considered to have strong direct and indirect contribution to GDP growth.

In 2017, the Ministry of Steel released the National Steel Policy, which anticipated a 300 MT production capacity by 2030, requiring a CAGR of 7% for the next decade. At the current CAGR of 3.87%, the production capacity would reach 215 MT by 2030. Aggressive growth is needed in the sector for the upcoming decade [6].The capacity addition outlook is mostly through the brownfield route (expansion).

Figure 11: Capacity Expansion by 2024-25



Source: Ministry of Steel

The annual steel consumption in India is 74 kg per capita; the global average is 224.5 kg per capita. Steel consumption in India is 1/3rd of the global average, and has potential to increase substantially, more so in the construction sector. Steel sector's growth would help in laying the pathway for a $5 trillion economy by 2025. Make in India and Ispati Irada campaigns, and amendments to the Domestically Manufactured Iron & Steel Products Policy (DMI& SP), can be the driving forces for the growth anticipated by 2030. [7]

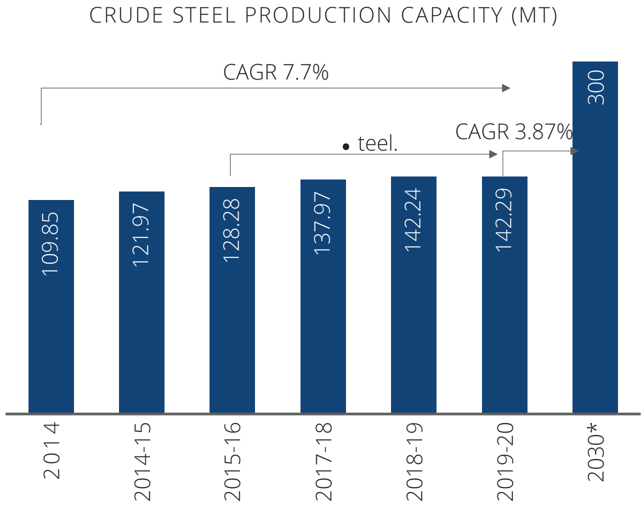
The trend of rising production capacity in the Indian steel sector is depicted in Figure 12:

2.2 Key Steel Producers

The major steel producers in India are concentrated in the eastern coast and some parts of South India. The distribution of the major steel industries in India is depicted in Figure 13.

The key steel producers – SAIL, RINL, TSL GROUP, AM/NS, JSWL and JSPL – contribute 63% of the overall capacity of the sector [8]. During 2019-20, the overall capacity utilisation was 77%, i.e., 1% lower than 2018-19. The capacity utilisation of SAIL, RINL, TSL GROUP, AM/NS, JSWL and JSPL was 83% during 2019-20, i.e., 1% lower than 2018-19 [8].

Figure 12: Crude Steel Production Capacity of Indian Steel Sector



Source: Ministry of Steel

**Anticipated Capacity*

Figure 13: Distribution of steel industries in India

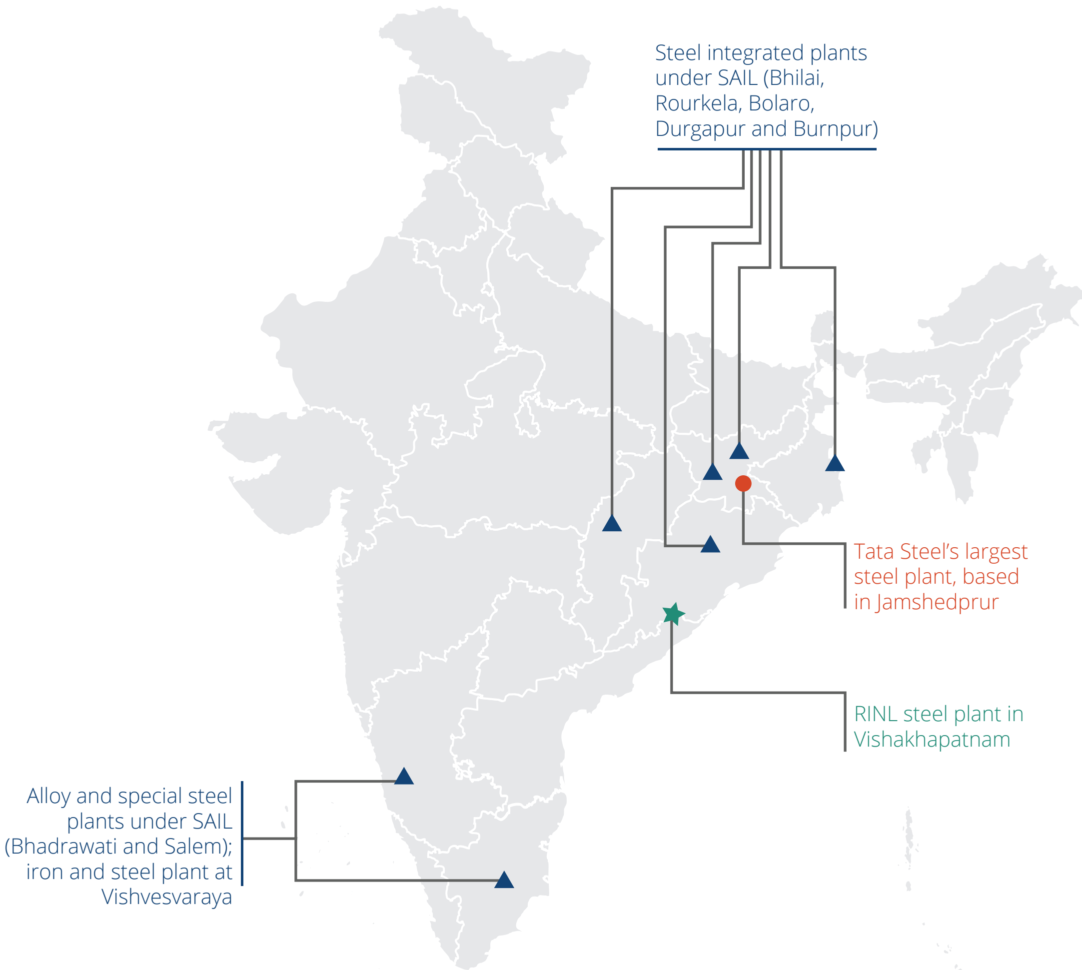


Table 3: **Declaration of Expansion Plan by key stakeholders by FY 2024-25**

Company	Expansion Plan (MTPA)	Timelines
Tata Steel (Jamshedpur)	1	FY 20
Tata Steel (Kalinga Nagar)	5	FY 23
Tata Steel BSL (Dhenkanal)	2.7	FY 24
JSW Steel (Vijaynagar)	1	FY 21
JSW Steel (Dolvi)	5.7	FY 21
JSW Steel (Vijaynagar)	5	FY 23
Electrosteel	1	FY 21
Electrosteel	4.5	FY 24
Bhusan Steel & Power	2	FY 24
Rungta Steel	1.5	FY 24
Essar Steel	2.5	FY 24
Neelachal Ispat	4	FY 24

Source: Ministry of Steel

As mentioned earlier, the expansion plan declaration clearly indicates more brownfield projects. The major expansion plans declared by key players in the sector amount to 35 MTPA by 2024-25, subject to demand in the next five years, with a shortfall of 20-25 MTPA for being in line with NSP 2017. The Ministry of Steel highlights the need for more greenfield projects to offset the shortfall arising in terms of capacity expansion. The Ministry has come up with a policy framework with four key elements to increase the interest levels of the key stakeholders to set up greenfield expansions. These four elements are: possession of unencumbered land, availability of iron ore at competitive market rates, time-bound granting of clearances, and facilitation of logistics linkages. [7]

2.3 Segmentation in the Indian Steel Sector

The Indian steel sector can be categorised broadly based on the following:

1. Production
2. Steel Making Process
3. Energy consumption and emissions

2.3.1 Segregation in terms of production

The simplest way of categorizing the Indian steel sector is based on the production capacity. The broad categorization can be into Large, Medium and Small producers. The different criteria for the categorization are listed below:

1. Large Producers are those with annual capacity of more than 2 MTPA
   A. There are 12 large producers of steel in India, of which three follow the EAF route and nine follow the BOF route.
2. Medium Producers are those with annual capacity between 0.06 MTPA and 2 MTPA
   B. There are 285 units with this capacity range in India. The production process is mostly DRI based.
3. Small Producers are those with annual capacity less than 0.06 MTPA
   C. There are 897 units with this capacity in India. Only 39 units are EAF based, while 858 units are IAF based. [8]

2.3.2 Segregation in terms of steel making process

The Indian steel sector seems to be in a perfect balance in terms of BOF route & DRI route utilization. The share of BOF in the last few years has been close to 45% in terms of the overall steel produced in the country and the share of EAF/IF has been around 55% for the last few years. In India the share of EAF/IF is on higher side as compared to global average where BF-BPF route production is dominant. The share of EAF-IF initially grew due but subsequently slowed down due to cheaper imports and sluggish demand impacted expansion in the EAF/IF route and subsequently the sponge Iron as it is a major input for EAF/IF steel manufacturing process. The trends are depicted in the sections below.

The steel making process involves two main routes:

1. Blast furnace/basic oxygen furnace (BF-BOF)
2. Electric Arc Furnace (EAF)/Induction Furnace (IF)

Figure 14: **Share of production based on different route in India for 2015-2020**

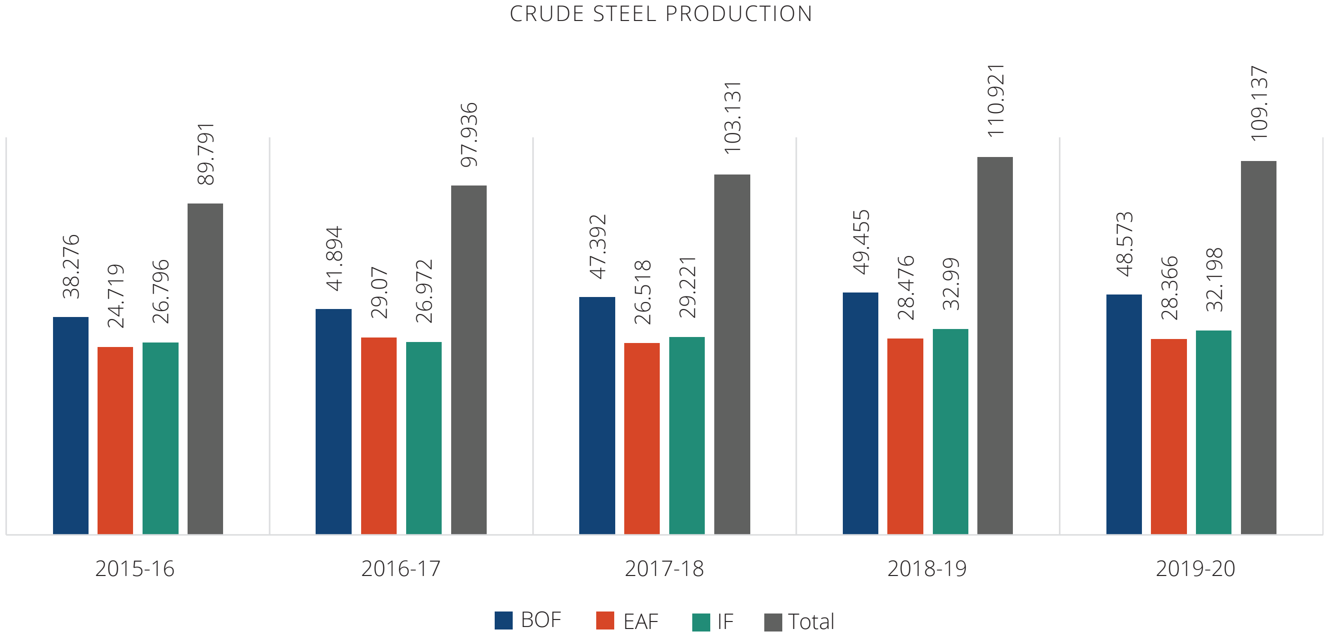
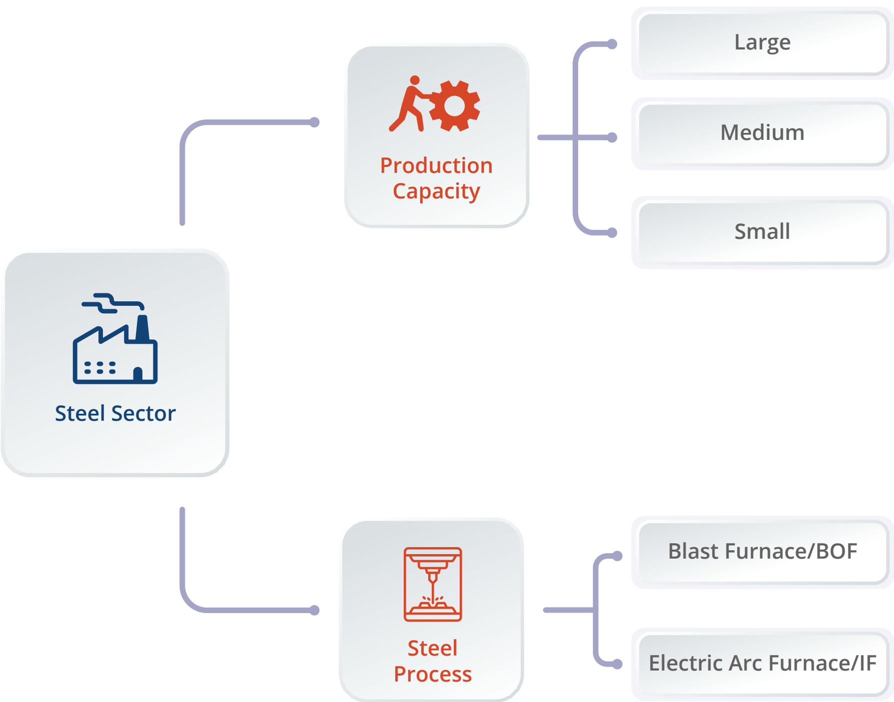


Figure 15: **Steel Sector Segmentation**



2.3.3 Blast Furnace Route

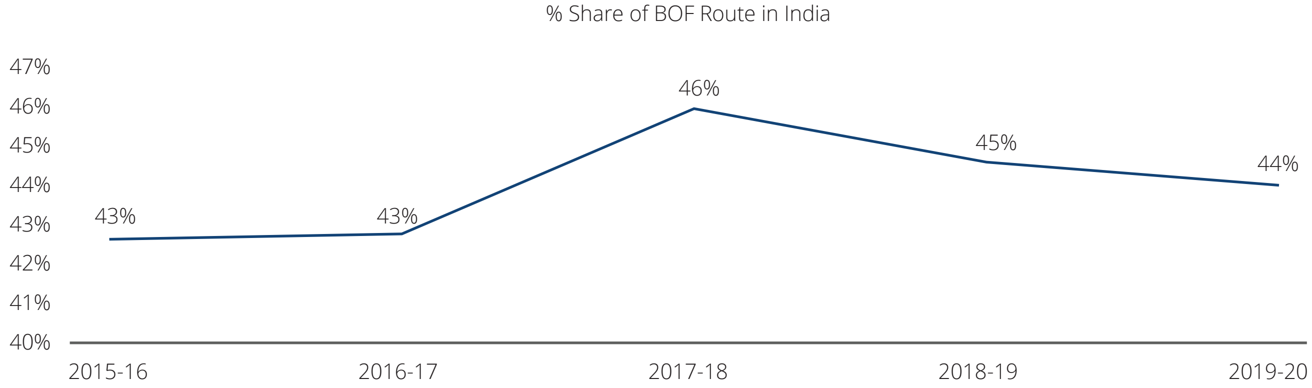
About 72% of global steel is being produced using the BF-BOF route. There is a total of 17 units producing steel through the BOF route with an annual capacity of 57.3 million tonnes in 2019 [9]. The BOF route process contributes to around 44.5% of steel produced in India [9]. The main raw materials for producing 1,000 kg of crude steel in the BF-BOF process are approximately 1,370 kg of iron ore, 780 kg of coal, 270 kg of limestone, and 125 kg of steel scrap. A basic oxygen furnace can be charged as much as 30% scrap [10]. The major challenge with the BOF route is the limitation in its scrap utilization. The circular economy and resource efficiency playing a major role in the next decade would call for more scrap utilization, and thereby, the growth of BOF route in the next decade seems nominal, with certain planned brownfield expansions.

The share of BOF route in the Indian steel sector over a period of five years is highlighted in the Table 4

Table 4: **Share of BOF route steel production in India**

Particulars	2015-16	2016-17	2017-18	2018-19	2019-20
Crude Steel Capacity MT	121.97	89.79	137.97	142.33	142.29
Crude Steel Production MT	89.79	97.94	103.13	110.92	109.22
Crude Steel Production through BOF MT	38.28	41.89	47.39	49.46	48.06

Figure 16: **% share of BOF route in India for 2015-2020**



2.3.4 Electric Arc Furnace/Induction Furnace Route

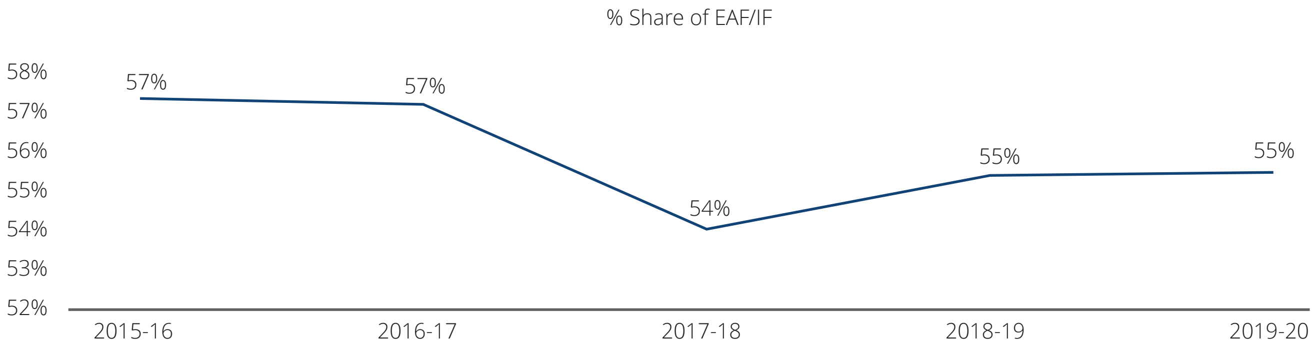
About 28% of global steel is being produced using the EAF route. About 55% of the total steel produced in India is produced in the EAF/IF route, of which 26% is in the EAF route and 29% is in the IF route [11]. The total production through EAF and IF route is around 28.37 MT and 32.19 MT respectively for 2019-20 [8]. The primary raw materials for producing 1,000 kg of crude steel in the EAF route are approximately 710 kg of steel scrap, 586 kg of iron ore, 150 kg of coal, 88 kg of limestone and 2.3 GJ of electricity. An electric furnace can be charged with 100% scrap [10]. The major challenge for the growth of EAF/IF units is the higher cost of electricity and hence the an economy with reduced electricity cost and an increased inclination towards circular economy expecting more scrap utilization would increase the interest among the investors in the near future for more EAF/IF units addition. There are a total of 39 EAF units with a total production capacity of 40.508 MT, and 858 IF working units with a total production capacity of 44.496 MT [8].

The share of EAF/IF route in the Indian steel sector over a period of five years is depicted in the Table 5

Table 5: **Share of EAF/IF route in the Indian steel sector**

Particulars	2015-16	2016-17	2017-18	2018-19	2019-20
BOF	38.276	41.894	47.392	49.455	48.573
EAF	24.719	29.07	26.518	28.476	28.366
IF	26.796	26.972	29.221	32.99	32.198
Total	**89.791**	**97.936**	**103.131**	**110.921**	**109.137**

Figure 17: **% share of EAF & IF route in India for 2015-2020**



In keeping with the Paris Agreement signed by the Hon'ble Prime Minister of India, the constant focus observed in the last few years is to increase renewable power capacity in the country, which is anticipated to be 40% of the overall generation capacity of India. The increase in renewable power will provide a huge impetus to the reduction of power prices in the country and would soon lead key players to look for development of EAF route as the best expansion option.

2.3.5 Segregation in terms of energy consumption/emissions

The steel sector is one of the highest contributor of GHG emissions in the country (Industrial Sector) and in 2014-15 the sector 154 million T CO_2 (direct emissions) which is around 6.6% of India's GHG emissions. [12]. Among the Industrial Sector the Iron & Steel is the largest GHG contributor and it accounted for 27.8% of the Industrial Sector emissions in 2014-15[1]

Energy Efficiency is one of the most important mitigation actions for reducing the GHG emissions. With this objective, the Government of India introduced 8 National Missions under the National Action Plan on Climate Change (NAPCC) in 2009. One of the important missions under NAPCC is National Mission on Enhanced Energy Efficiency (NMEEE) under which the Perform Achieve and Trade (PAT) Scheme was introduced. The PAT scheme was introduced as market-based mechanism to accelerate energy efficiency adoption in the industry. Under the PAT scheme the energy intensive units (Designated Consumers) are given the energy efficiency improvement target which has to be achieved in three-year period and the industries are incentivised based on the performance. The PAT scheme defined 'Designated Consumers' as those units having annual energy consumption above the threshold for the sector defined under the Energy Conservation Act, 2001. Iron Steel units having the annual energy consumption of more 30,000 TOE are included under the PAT scheme. There are 71 DCs in the steel sector as per PAT Cycle-II, with an energy consumption of 40.44 mTOE and these units were given the energy saving target of 2.28 mTOE.

The GHG emission in Indian plants varies in the range of 2.43-3.2 T CO_2/TCS . For the BF-BOF steel plant GHG emission is in range of 2.4-3 t CO2/TCS and for coal based DRI – EAF/IF GHG emissions 3.0-3.2 T CO_2/TCS. The GHG emissions of Indian steel plants are on higher side as compared to international benchmark of 1.8 T CO_2/TCS. [13]

By 2030, the emission is expected to reduce to 2.2-2.4 t/TCS for BF-BOF route and 2.6-2.7 t/TCS for DRI-EAF route by improvement of energy efficiency and adoption of new technologies in phase manner. The reduction potential for EAF route and secondary steel can be higher as the power mix of the country becomes more reliant on non-fossil fuel-based power generation in line with commitment under India's Nationally Determined Contribution under the Paris Agreement,

The segregation of the steel sector in terms of energy consumption or emissions can be done with certain thresholds set with high, medium and low intensity, but would not reflect any different criteria with respect to the segregation based on production capacity. The most favourable segregation of the sector is foreseen based on production capacity.

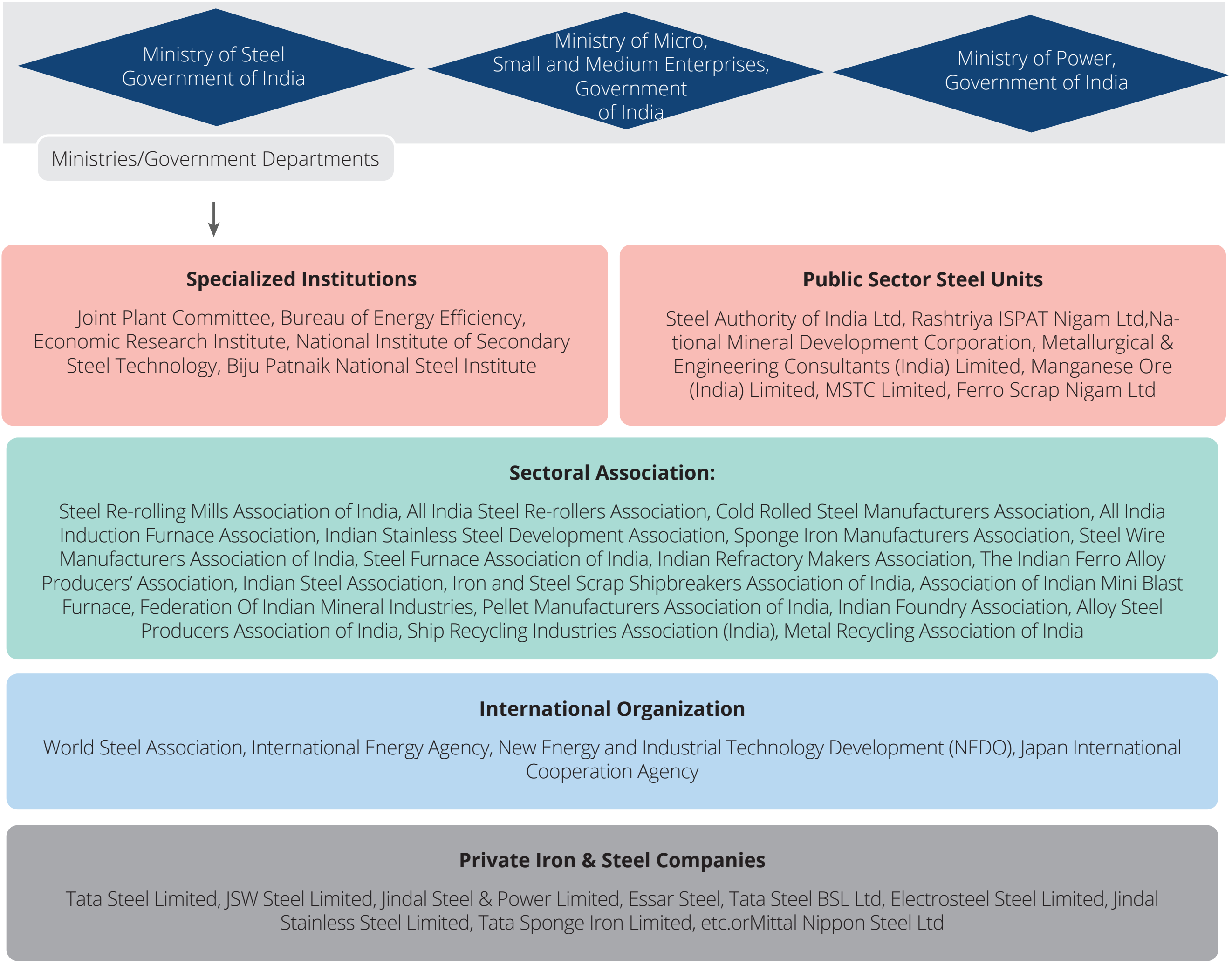
1 Industrial Sector emissions includes – Emissions from fuel combustion in Manufacturing Industries and Construction Sector (351.9 million T CO_2) and Emissions from Industrial Production Process and Use (IPPU) 202.22 million tons of CO_2 (India's Second Biennial Update Report to the United Nations Framework Convention on Climate Change, Ministry of Environment Forestry and Climate Change, Government of India)

3. Steel Associations – Stakeholders & Institutes

3.1 Steel Associations – Stakeholders & Institutes

Several stakeholders and allied institutions of the steel sector are working towards transforming the Indian Steel industry as a global leader acclaimed for its quality, productivity and competitiveness, with a focus on health, safety and environment, along with a thrust on innovation through R&D, all while adopting an inclusive and collective approach. They also act as the platform for the Indian Iron & Steel industry to facilitate the redressal of issues, concerns and challenges common to its members, by advocacy efforts engaging the Government and other stakeholders within and outside India, in compliance with all applicable laws and regulations. The key stakeholders in the Indian iron and steel sector are indicated in Figure 18:

Figure 18: **Institutional Framework – Iron & Steel Sector**



Ministry of Steel, Government of India

The Ministry of Steel is responsible for planning and development of Iron and Steel industry, development of essential inputs such as iron-ore, limestone, dolomite, manganese ore, chromites, ferro-alloys, sponge iron etc. and other related functions

The main functions of the Ministry of Steel are:

- Coordination of the data from various sources for the growth of the iron and steel industry (including re-rolling mills, alloy steel and ferro alloy industries, refractories) both in public and private sectors
- Formulation of policies in respect of production, pricing, distribution, import and export of iron & steel and ferro alloys
- Planning and development of and assistance to the entire iron and steel industry in the country
- Development of input industries relating to iron ore, manganese ore, refractories, etc required mainly by the steel industry

Relevant Departments, State Governments

Relevant Departments in the various states of India are responsible for the development of the iron and steel sector in the respective states. Typically, most states have a "Department of Mines & Geology", which concerns itself with iron ore and related minerals; Odisha has a "Steel and Mines Department". The manufacturing of steel and related products typically comes under the "Department of Industries".

3.2 Councils & Committees

Ministry of Steel has formulated several councils & committees for co-ordination and planning of the growth and development of Iron and Steel Industry in the country. Various function of these council & committee are collecting of data on the Indian Iron & Steel industry, analysis of data and conducting specific studies/analysis, management of funds related to steel sector development, providing training, service with centre of research & development, advice and assistance to the Central Government on matters relating to supply, availability, quality and the market trends of iron and steel.

The following are the list of boards , councils , committees and other bodies

- Joint Plant Committee (JPC)
- Economic Research Unit (ERU)
- Steel Development Fund (SDF)
- Biju Patnaik National Steel Institute (BPNSI)
- National Steel Institute of Secondary Steel Technology (NISST)
- Institute for Steel Development and Growth (INSDAG)
- Steel Consumers' Council (SCC)

3.3 Steel Associations and Allied Institutions

The various iron and steel-related associations in India represent the concerns of the industry as well as provides suggestions on amendments to policies and regulations pertaining to mining and/or auction procedure of steel making raw materials to the Ministries. Many of them also engage with steel associations of other countries on matters of mutual interest. These associations also work to create a safer working environment for those working in the steel industry, as well as to reduce the environmental impacts of the sector. In addition, they also play a role in ensuring India's position in the global steel arena, including playing a role to regulate increases in tariffs by other countries and the threat of dumping.

The major associations working in Indian Steel Sector

- Indian Steel Association
- All India Steel Re-rollers Association
- Steel Re-rolling Mills Association of India
- Cold Rolled Steel Manufacturers Association
- Indian Stainless-Steel Development Association
- Sponge Iron Manufacturers Association
- Steel Wire Manufacturers Association of India
- The Indian Ferro Alloy Producers' Association
- Pellet Manufacturers Association of India
- Alloy Steel Producers Association of India
- All India Induction Furnace Association
- Steel Furnace Association of India
- Federation of Indian Mineral Industries
- Indian Refractory Makers Association

3.4 Steel Recycling Associations

Steel is a permanent material that can be infinitely recycled and is 100% recyclable without loss of quality. There are various associations that support steel recycling activities in India . These associations support the interests of the recycling industry on a national scale. They provide a forum for members to share their knowledge and experience, and also promote recycling among other industrial sectors and policy makers. Following are the list of associations involved in recycling activities in steel sector

- Metal Recycling Association of India
- Bureau of International Recycling (BIR)
- Inland Importers and Consumers Association (IICA)

3.5 Institutions

A number of R&D and training institutions provide trained manpower to secondary steel sector by conducting short term and long term courses, improving awareness about latest available technologies, providing various industrial services, testing facilities, etc. These institutions also extend consultancy services to the industry in terms of solving technological problems, improving energy efficiency and reducing pollution levels.

The following are a few such institutions in India:

- National Institute of Secondary Steel Technology(NISST)
- Biju Patnaik National Steel Institute (NSI)
- Institute for Steel Development and Growth(INSDAG)

More details about the above stakeholders are provided in the annexure.

4. Energy Efficiency in Iron & Stewel Sector

Key Highlights

- Indian Steel Sector Efficiency levels are lower as compared to other steel plant in Japan, Europe, etc.
- PAT scheme has played an important role in accelerating energy efficiency In Indian Steel Sector (large) and the performance of the steel sector during the PAT Cycle I and Cycle II has been
- The Indian steel sector has uniform share distribution in terms of BOF & EAF route of production
- The average SEC of BF-BOF route is observed to be 6.6 Gcal/TCS against the BAT figures of 4 Gc

4.1 Introduction

The Iron & Steel sector in India has a higher energy intensity as compared to the most energy efficient plants in the world. The higher energy intensity is due to many aspects, such as outdated technology, availability and quality of resources (coal, coke, iron ore scrap, etc.), but the units can aim to improve their energy intensity by adopting widely applicable technologies such as waste heat recovery, application of VFD, pressure recovery turbine, and the best available technologies. These are not yet widely adopted in the Indian plants.

Under the NMEEE, PAT scheme has played an important role in accelerating the energy efficiency levels in the Indian Steel Plants. During the PAT Cycle I (2012-2015) the Iron & Steel Sector achieved the energy savings of 2.1 million TOE and this resulted in reduction of 6.51 million T CO_2, the sector exceeded the energy saving target 41% (target energy saving was 1.48 million TOE) [13]. After the PAT Cycle I, during the PAT Cycle II also the steel sector performed well achieved the energy savings of 2.70 million TOE against the target of 2.28 million TOE. This resulted in reduction of overall emissions 11.3 million T CO_2 [14]. The Iron & Steel Sector was among the major contributor for overall energy savings under the PAT Cycle III contributing around 21% of overall energy savings achieved (The highest contributor is Thermal Power Plant sector, followed by Steel sector), The following table provide summary of the sector performance for the PAT Cycle I and PAT Cycle II

Table 6: Summary of Iron & Steel Sector Achievement – PAT Cycle I & PAT Cycle II

PAT Cycle	Number of Iron & Steel Units	Energy Consumption (million TOE)	Target Energy Savings (million TOE)	Energy Savings Achieved (million TOE)
I (2012-2015)	67	25.32	1.486	2.100
II (2016-2019)	71	40.44	2.283	2.706
Total			3.769	4.80

Table 7: Iron & Steel Sector Summary – Target Energy Savings – PAT Cycle III & PAT Cycle IV

PAT Cycle	Number of Iron & Steel Units	Energy Consumption (million TOE)	Target Energy Savings (million TOE)
III (2017-2020)	29	7.65	0.457
IV (2018-2021)	35	3.23	0.193
Total			3.769

Figure 19: **Comparison Specific Energy Consumption – BF-BOF**

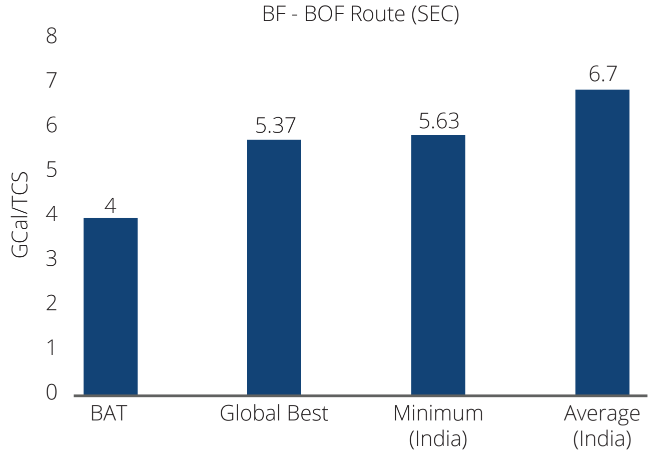
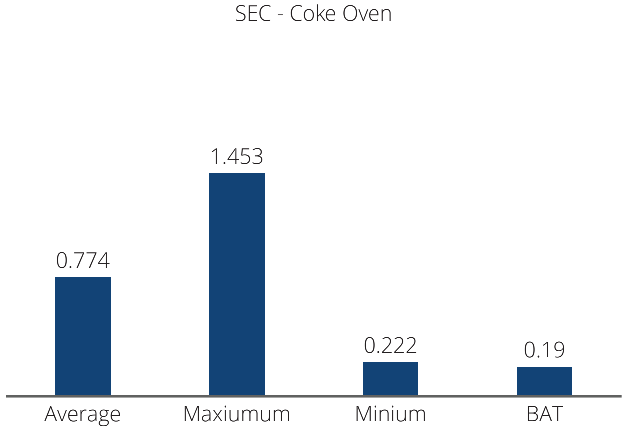


Figure 20: **Specific Energy Consumption – Coke Making**



As the PAT Cycle I & II have similar units, more additional units from the Iron and Steel Sector are included under subsequent PAT Cycle III, IV and V.

In the following section, the current status of energy efficiency is analysed, and in the Scenario section, the energy efficiency scenario in the steel sector till 2040 has been modelled to assess where the Iron & Steel sector will stand in terms of efficiency and emissions. The analysis has been performed based on the average performance data for Iron & Steel sector collated from PAT data analysis. The proforma to capture the Iron & Steel sector performance prepared by BEE for the PAT scheme is very exhaustive and provides all the necessary information to analyse the section wise energy performance of the individual units.

4.2 Current Energy Efficiency Levels

The energy efficiency levels for the iron and steel plants have been analysed for various sections – raw material, iron making and steel making. The analysis has been undertaken for both the Blast Furnace-Basic Oxygen Furnace and Direct Reduced Iron – Electric Arc Furnace/ Induction Furnace route.

4.2.1 BF-BOF Route

More than 45% of the current crude steel production is through BF-BOF route. The analysis of the specific energy consumption for some of the leading plants indicates that the average specific energy consumption is in the range of 6.5-6.7 GCAL/TCS, and the inefficient and most efficient plants have a specific energy consumption of 8.9 GCAL/TCS and 5.9 GCAL/TCS respectively[2]. This indicates that there is good potential for the Indian plants to improve their energy efficiency in the long term by implementing the necessary energy efficiency and technology upgradation in their process and operations. The following graph provides the summary of the specific energy consumption of the leading plants in the country in comparison to the global best and Best Available Technology.

Coke Oven – Energy Consumption

The energy consumption in coke oven is around 12-15% of overall energy consumption in the steel plant. The average energy consumption in coke ovens in India is around 0.774 GCal/TCS [15]. Latest technologies that can be implemented in coke ovens to achieve the BAT specific energy consumption value are: coke dry quenching, waste heat recovery, coal moisture control, programmed heating, etc. The BAT specific energy consumption for coke oven is 0.19 GCal/TCS.

Following is a list of possible energy efficiency measures in coke oven that can be implemented by the Iron & Steel plants in the country. [4]

2 CII Analysis – Based on PAT data

Table 8: **Energy efficiency measures – Coke Oven plants**

S. No.	Focus Areas	Technology	Electricity Savings kWh/t of product	Fuel Savings GJ/t of Product	CO_2 Reduction Kg-CO_2/tonne of Product
1	Coke Making	Coke Dry Quenching (CDQ)	150 kWh/t-coke	1.9/t-coke	210/t-coke
2		Coal Moisture Control (CMC)		0.3/t-coke	27.6/t-coke

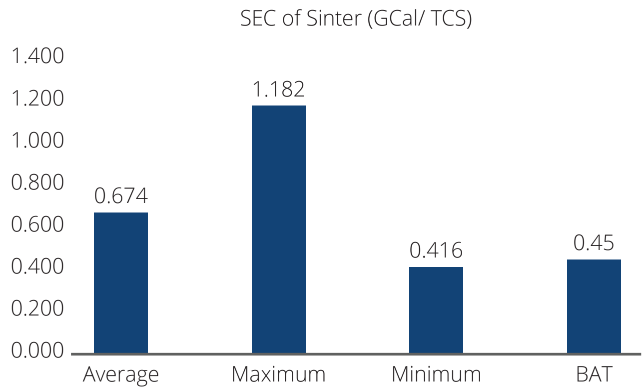
Other Possible Energy Savings Measures in Coke Oven Plants

Under-firing gas calorific value control, programmed heating, steam utilisation from exhausters, coke dry quenching, coal moisture control, application of variable speed drives, combustion gas preheating, high pressure ammonia liquid spray aspiration, O_2 control, Waste Heat Recovery from flue gas (low grade), WHR of Coke Oven by-product gas, Jumbo Coke Reactor, Non-Recovery Coke Oven, etc.

Sinter – Energy Consumption

The Sinter operation accounts for 15% of the energy consumption in steel making. The sinter preparation is important for stable blast furnace operations, and many integrated steel plants in India have sinter plant. The specific energy consumption of the sinter plant in India varies from 0.44 to 1.18 GCal/TCS. The following graphs compare the data of sinter plant in India with the best available technology/practice energy consumption. The analysis indicates that in India, sinter plants have the potential to improve energy efficiency, and some measures that can be explored are waste heat recovery/ strand gas recovery, sinter bed height optimization, energy efficient combustion, etc.

Figure 21: **Specific Energy Consumption - Sinter**



Following is a list of possible energy efficiency measures in sinter plant that can be implemented by the Iron & Steel plants in the country. [4]

Table 9: **Energy Efficiency Measures -Sinter Plants**

S. No.	Technology	Electricity Savings kWh/t of product	Fuel Savings GJ/t of Product	CO_2 Reduction Kg-CO_2/tonne of Product
1	Sinter Plant Heat Recovery (Steam Recovery from Sinter Cooler Waste Heat)	-	0.251/t- sinter	23.9/t-sinter
2	Sinter Plant Heat Recovery (Power generation from sinter cooler waste heat)	22.1 kWh/t-sinter	-	19.9/t-sinter
3	High Efficient (COG) Burner in Ignition Furnace for Sinter Plant		0.011 /t-sinter	0.50 /t-sinter

Possible Energy Savings Measures in Sinter Plants

Sinter Cooler Exhaust Gas WHR, material segregation charging, combustion control, sinter bed depth control, application of Variable Frequency Drives for centrifugal fans, flue gas waste heat recovery, use of solid waste as fuel, high efficiency burner systems, reduction of air leakages, etc.

Blast Furnace – Energy Consumption

The Blast Furnace is a major energy consumer in the plant. It is the main process where iron ore is reduced to iron and is further processed for deriving value-added products. The major energy consumption is in the form of coke/coal, primarily used for reducing the iron ore. The following graph highlights the range of specific energy consumption in Indian blast furnaces.

The best available technology can help further reduce the energy consumption in blast furnace, and average and inefficient plants in India can reach higher energy efficiency levels. Some of the technologies and energy efficient measures possible in blast furnace process are highlighted in the Best Available Technology section of the report.

Following is the list of possible energy efficiency measures in Blast Furnace that can be implemented by the Iron & Steel plants in the country. [4]

Figure 22: Specific Energy Consumption – Blast Furnace

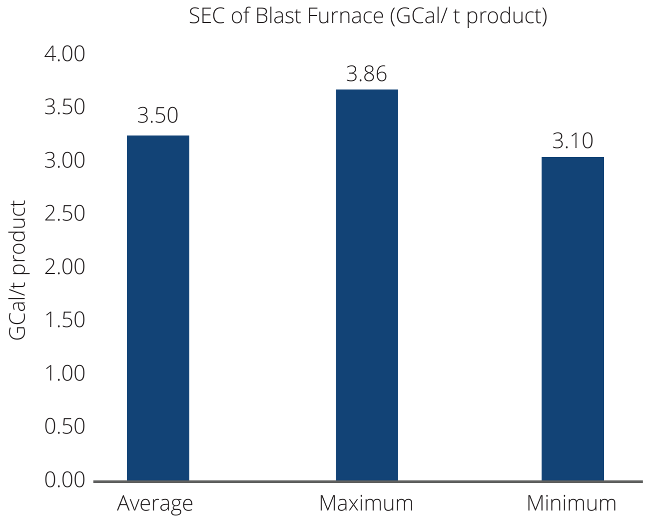


Table 10: Energy Efficiency measures – Blast Furnace plants

S. No.	Technology	Electricity Savings kWh/t of product	Fuel Savings GJ/t of Product	CO_2 Reduction Kg-CO_2/tonne of Product
1	Top Pressure Recovery Turbine (TRT)	50 kWh/t-pig iron		45.0 /t-pig iron
2	Pulverized Coal Injection (PCI) System		1.55 /t-pig iron	147 /t-pig iron
3	Hot Stove Waste Heat Recovery		0.08 /t-pig iron	7.8 /t-pig iron

Possible Energy Savings Measures in Blast Furnace Plants

Blast Furnace Gas Recovery, Pulverised Coal Injection, Top Recovery Turbine, Waste Heat Recovery from Slag, computer aided control, preheating of combustion air, oxygen enrichment, hot blast stove automation, alternative injectants, energy efficient blowers, BF charge distribution control, etc.

Steel Melting & Casting

Following is the comparison of specific energy consumption in (integrated plants) steel melting & casting section of the steel plant:

Following is the list of possible energy efficiency measures in steel making (BF-BOF) that can be implemented by the Iron & Steel plants in the country. [4]

Figure 23: SEC of Steel Melting & Casting Plant

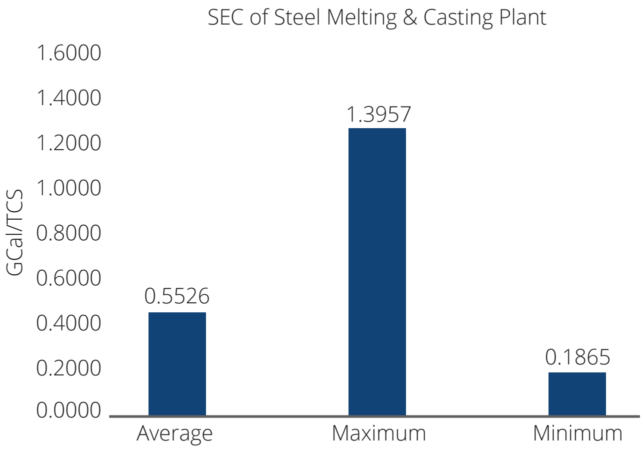


Table 11: **Energy Efficiency measures – Steel Making**

S. No.	Technology	Electricity Savings kWh/t of product	Fuel Savings GJ/t of Product	CO_2 Reduction Kg-CO_2/ tonne of Product
1	Converter Gas Recovery Device		0.84 /t-steel	79.8 /t-steel
2	Converter Gas Sensible Heat Recovery Device		0.126 /t-steel	12.0 /t-steel
3	Ecological and Economical Arc Furnace	150 kWh/t-steel		135 /t-steel
4	Waste Heat Recovery from EAF	87.7 kWh/t-steel		78.9 /t-steel

Possible Energy Savings Measures in Steel Making (BF-BOF)

Waste Heat Recovery from Converter, vessel bottom stirring, thin slab casting, application of variable speed drive, programmed ladle heating, ladle temperature management, heat recovery from BOF slag, application of regenerative burners, scrap utilisation in BOF, etc.

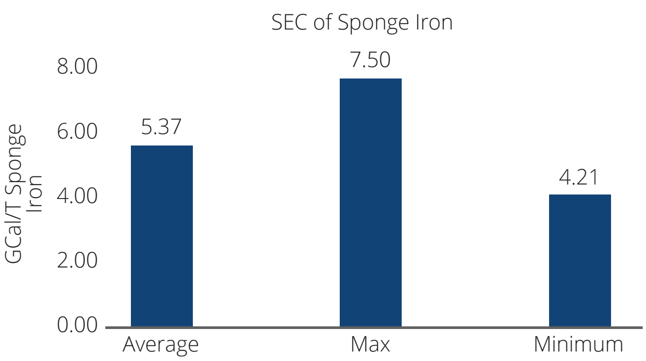
4.2.2 Direct Reduced Iron (Route)

India is one of the largest producers of DRI in the world. The installed capacity of DRI in India in 2019-20 is around 47 million tonnes per annum. The DRI can be produced using coal or gas as fuel. In India, not many steel plants use gas based DRI due to non-availability of gas, and most of the DRI is produced by using coal. The DRI is a relatively energy intensive process and has higher emissions (Greenhouse Gas) compared to BF-BOF route steel production. The following section highlights SEC for Sponge Iron and melting for various steel plants in the country.

Sponge Iron Production

Sponge Iron/DRI is produced in rotary kiln and coal is a major source of energy in the DRI process. Following graph provides an overview of specific energy consumption for sponge Iron production in India:

Figure 24: **Specific Energy Consumption – Sponge Iron production**



Following is the list of possible energy efficiency measures in Sponge Iron that can be implemented by the Iron & Steel plants in the country.

Table 12: **Energy Efficiency measures – Sponge Iron**

Possible Energy Savings Measures in Sponge Iron[3]
Waste Heat Recovery, thermal coating (kiln), application of VFD, raw material preheating, energy efficient motors, optimisation of water spray in cooler, etc.

Steel Melting Shop & Rolling Mill

The following table provides an overview of specific energy consumption in the steel melting shop and rolling mills in India:

Table 13: **Specific Energy Consumption – SMS & Rolling Mill**

Particulars	UOM	Average	Max	Minimum
Overall Specific Energy Consumption (SMS)	GCal/t	1.51	3.14	0.24
Electrical SEC (SMS)	kWh/t	836	1158	-
Specific Energy Consumption (Rolling Mill)	GCal/t	0.39	0.83	0.13

Following is the list of possible energy efficiency measures in Steel Melting Shop and Rolling Mill that can be implemented by the Iron & Steel plants in the country. [4]

3 Manual on Energy Conservation Measures in Sponge Iron Manufacturing Cluster Orissa, Sameeksha

Table 14: Energy Efficiency measures – SMS & Rolling Mills (DR-EAF)

S. No.	Technology	Electricity Savings	Fuel Savings	CO_2 Reduction t-CO_2/year
1	Ultra high power transformer	5.5%		3,690
2	High impedance operation	1.5%		738
3	Aluminium electrode arm	0.7%		517
4	Improved regulation control	3%		2214
5	Oxy-fuel burner	3%		2214
6	Coherent jet	2%		1476

Possible Energy Saving Measures in EAF
Application of Oxy-Fuel Burners, arc control, oxygen blowing, scrap pre-heating, Hot DRI charging, direct current EAF, waste heat recovery, bottom stirring, utilisation of scrap, continuous charging systems, application of VFD for centrifugal equipment, etc.
Possible Energy Saving Measures in Rolling Mills
Air to fuel ratio control (Combustion), air preheating, waste heat recovery, hot charge rolling, regenerative burners, walking beam furnace, WHR from skid system, improved insulation, door sealing in furnace, hot charge direct rolling (HCDR), high emissivity coating, application of variable frequency drive, etc.

4.3 Overall Specific Energy Consumption – Iron & Steel Plant

After the iron making process, the hot metal is further converted into value added products such as rods, billets, sections, etc. In addition to the production process, there are other supporting processes for steel manufacturing, such as oxygen plant, calcining plant, power plant, etc., which provide necessary energy and material for iron and steel manufacturing. The following table provides an overall summary for specific energy consumption for the best technology/practices.

Currently in India, the average specific energy consumption for the BF-BOF route is 6.5.6.7 GCal/TCS [16], and for DRI-EAF/IF it is around 7.02 GCal/TCS[4]. However, based on the analysis of various studies of best practices and technologies, the benchmark SEC through BF-BOF route is 3.94 GCal/TCS, and 4.5 GCal/TCS through coal based DRI-EAF route.

At present in India, the best plant has achieved the specific energy consumption (BF-BOF) of around 5.63 GCal/TCS [17]. The above analysis indicates that there is good potential for the Indian Iron & Steel sector to increase the energy efficiency levels and set long-term goals in achieving in the best possible specific energy consumption levels.

4 PAT Data analysis

Table 15: **Best Practice/Technology Specific Energy Consumption [15]**

All Units (GCal/TCS)				
Category	Process	BF-BOF	DRI-EAF	Scrap – EAF
Material Preparation	Sintering	0.45	0.45	
	Pelletizing		0.14	
	Coking	0.19		
Iron Making	Blast Furnace	2.91		
	DRI		2.80	
Steel Making	Basic Oxygen Furnace	-0.10		
	Electric Arc Furnace		0.62	0.57
	Refining	0.02		
Casting and Rolling	Continuous Casting	0.01	0.01	0.01
	Hot Rolling (bar)	0.44	0.44	0.44
Sub-Total		3.94	4.47	1.04
Cold Rolling & Finishing	Cold Rolling	0.1		
	Finishing	0.26		
Total – Option A		4.30	4.47	1.03
Casting Rolling	With Thin Slab Casting	0.05	0.05	0.05
Total Option B		3.53	4.06	0.62

5. Achieving World Class Energy Efficiency in Iron & Steel Sector

5.1 Iron & Steel – Journey toward world class efficiency levels

As India embarks on a journey toward becoming a USD 5 trillion economy, the steel demand will grow at a much larger pace. The steel consumption will grow owing to the demand in infrastructure, mobility, real estate and manufacturing, and to meet this demand, the Government is taking many steps. Two such initiatives are introduction of Policy on Promotion of Greenfield Investments in the Steel Sector in India, and Mission Purvodaya, which aims at accelerated development of eastern India through development and promotion of Integrated Steel Hub. The aim of these initiatives is to facilitate investments in greenfield and brownfield expansion of steel plants so that India could achieve 300 million tonnes capacity for steel manufacturing, and thus be able to meet the growing steel demand. As the Government of India aims to reduce GHG emissions intensity of the country by 33-35% from 2005 levels by 2030, the role of Iron & Steel sector is crucial to achieve this target, as well as to be in line with the Paris Agreement of limiting the global temperature rise within 2 ºC.

This scenario analysis for the Indian Iron & Steel sector has been undertaken to understand the possible energy efficiency improvements by the sector to achieve the world class levels in energy efficiency. The following is the broad methodology adopted for scenario analysis:

Figure 25: Steps – Modelling

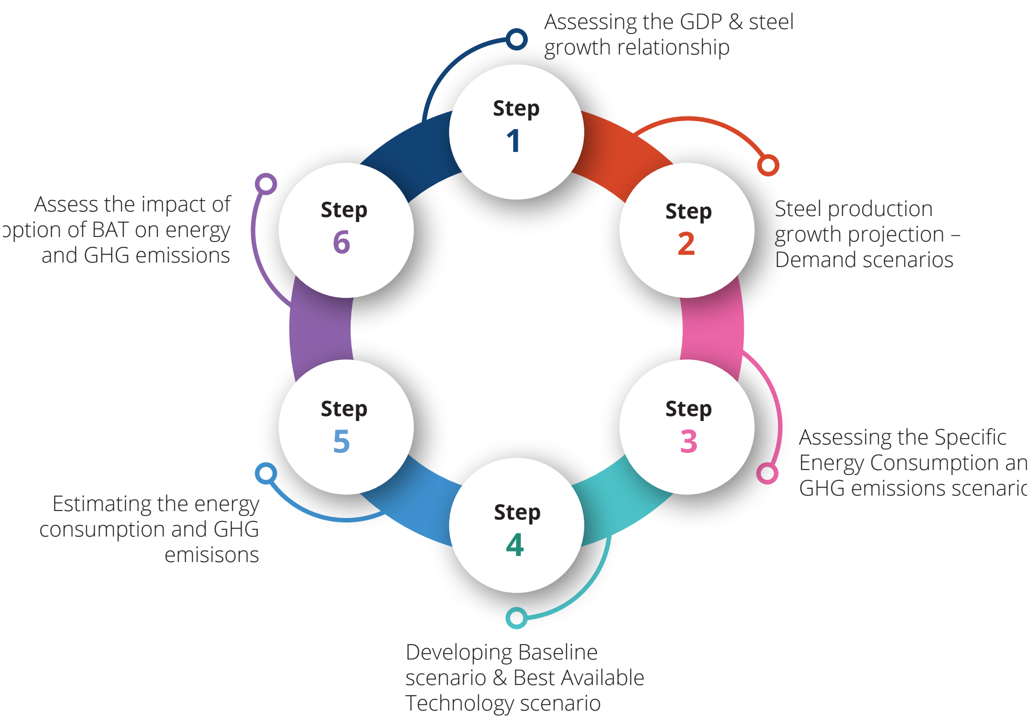
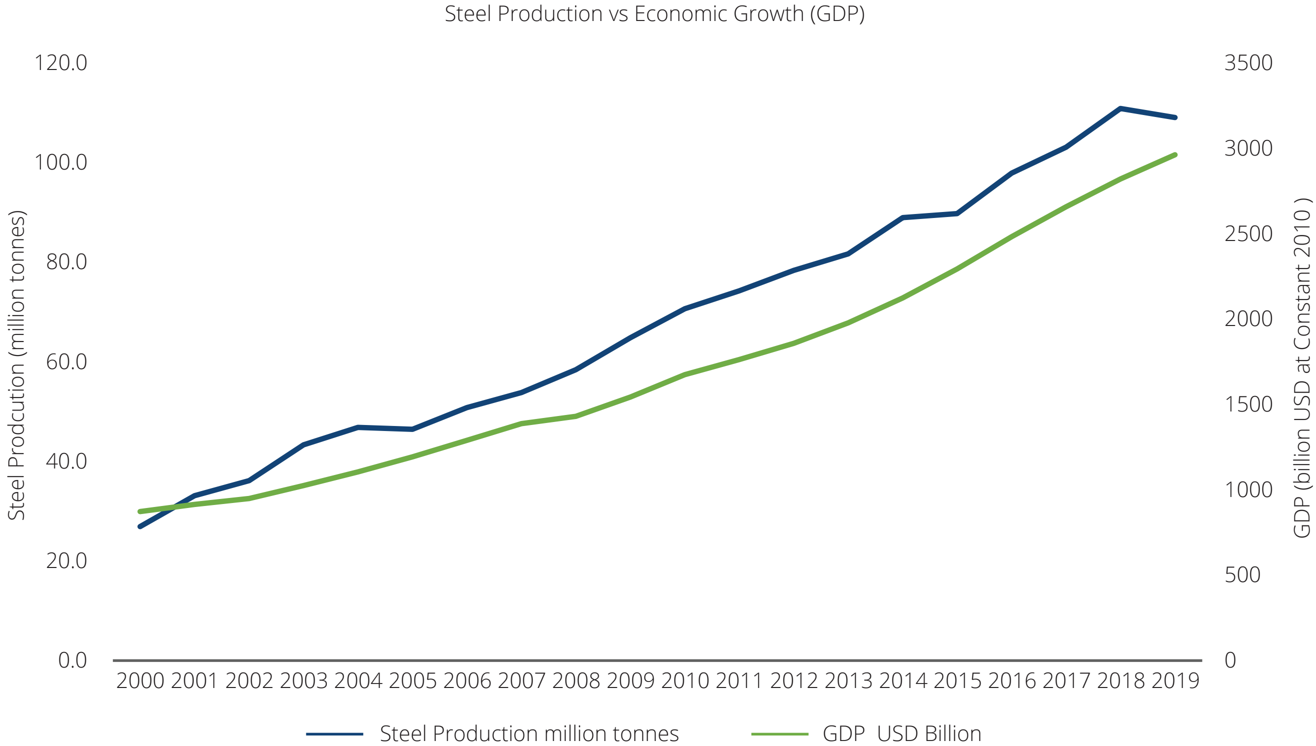


Figure 26: **Historical growth – Steel production & economic growth (GDP)**



5.2 Scenario Analysis

Production Growth

For undertaking analysis, the first step is to assess the production of steel for the upcoming years. For this, the historical analysis of India's Gross Domestic Product and steel production was undertaken. The analysis was done to estimate the steel-to-GDP elasticity, to use the same to develop the future production projections.

During the period of 2000-2019, the steel production [19] witnessed an average growth of 7.80% and the economy registered an average growth of 6.7% annually [20]. The elasticity of steel production and GDP was calculated for the last 20 years, and an average elasticity of 1.17 was estimated for further projection and scenario development.

To develop the production estimated, three scenarios for economic growth were considered – High Demand, Medium Demand and Low Demand. For each scenario, the GDP rate was assumed for two periods: till 2030, and beyond 2030. The following table provides the summary of growth rates under three different scenarios:

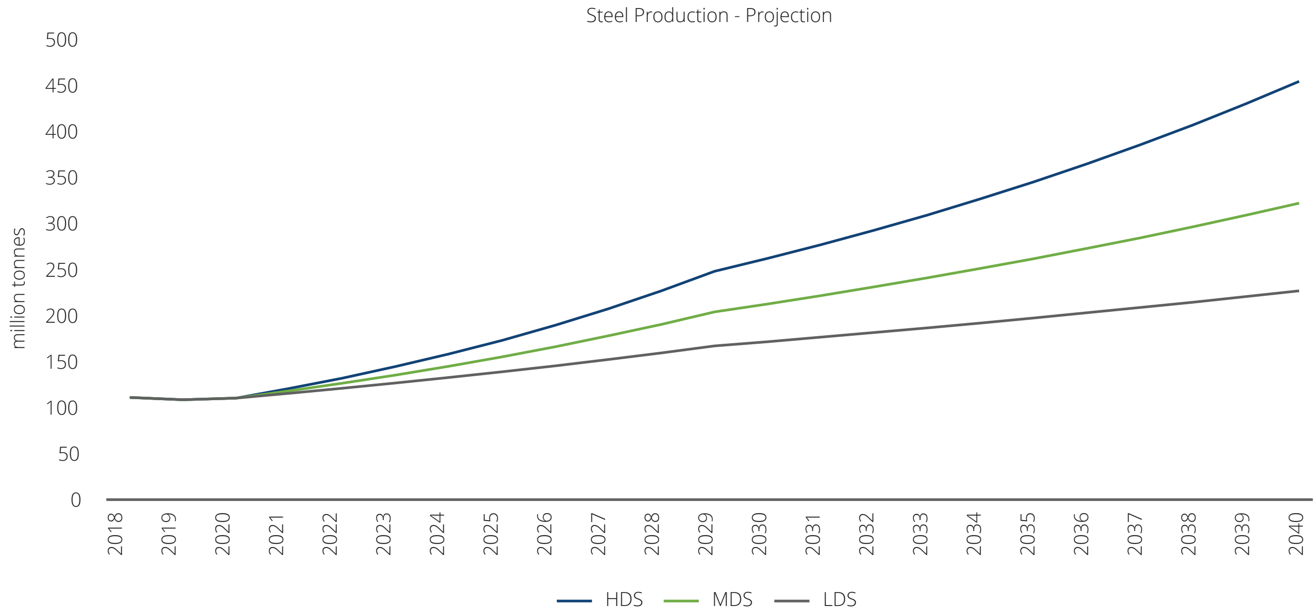
Based on the growth rates under different scenarios, the steel production was estimated. Under the HDS the steel production is estimated to be 264 million tonnes, and for MDS and LDS the national steel production is estimated to be 214 million tonnes and 172 million tonnes respectively.

The MDS scenario projecting the steel production of 214 million tonnes by 2030 and 321 million tonnes by 2040 seems to be possible as the steel sector in the past

Table 16: **Steel & economic growth projections 2030 & beyond**

Period	Particulars	High Demand Scenario (HDS)	Medium Demand Scenario (MDS)	Low Demand Scenario (LDS)
Till 2030	GDP Growth	8.00%	6.00%	4.00%
	Steel Growth	9.43%	7.07%	4.71%
2030-2040	GDP Growth	5.60%	4.20%	2.80%
	Steel Growth	6.60%	4.95%	3.30%

Figure 27: **Steel Production Projection**

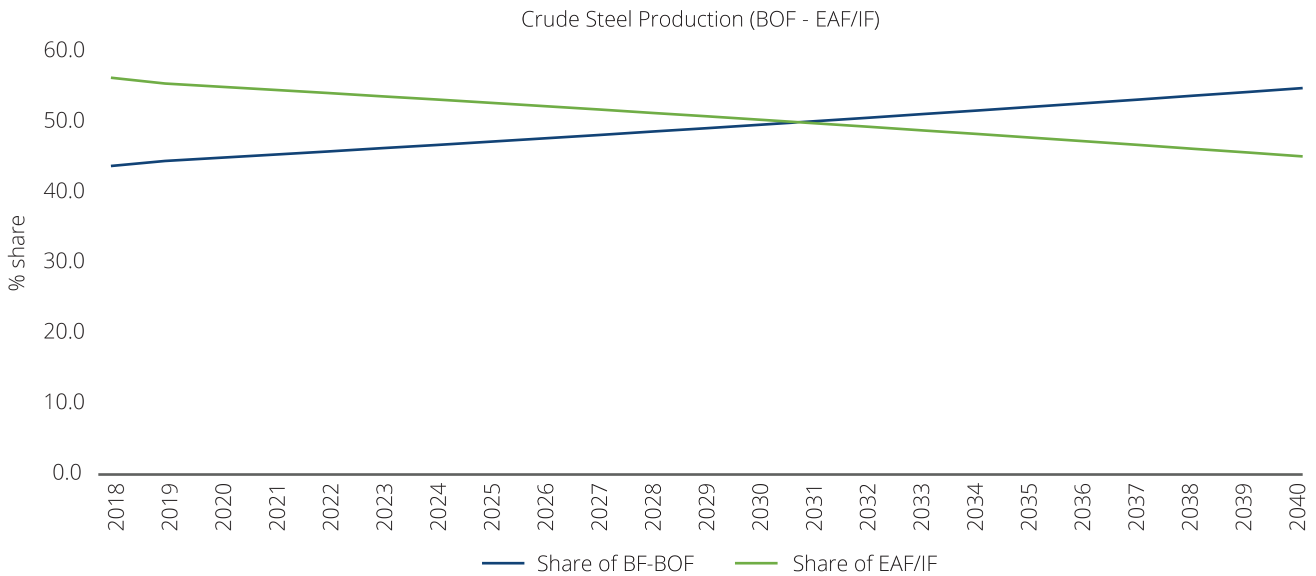


20 years has witnessed a similar growth, and owing to COVID-19 disruptions to the global economy, the steel demand is expected to see a fall in 2020-21[5]. Various studies have also estimated production to be less than 225-250 million tonnes by 2030, and thus the MDS scenario production is considered for further analysis.

Production Mix

The various routes of producing the steel are BF-BOF and DRI-EAF/IF. At present, 55% of the steel production is through EAF/IF route where DRI and Scrap are used as inputs to the process. As highlighted in the previous chapter, there are large numbers of medium to small units having EAF/IF route for crude steel production in India, while the BF-BOF route is favoured by larger units. Globally, the BF-BOF route has a higher share for steel production and considering various expansion plans in place by various steel companies, it is expected that India will also have a higher share of BOF-based steel production in line with the global trend. The production mix with 60% share of BF-BOF by 2030 is suggested by Ministry of Steel also for estimating Steel sector's contribution in achieving India's Nationally Determined Contribution. However, with Government of India's push towards resource efficiency and introduction of scrap recycling policy for various consumers, the scrap availability in India will go up and more uptake in DRI -EAF is also a possibility. Considering the above, for the current analysis, it is assumed that India's share of

Figure 28: **Share of BF-BOF and EAF-IF**



5 Moody's News Article - India's steel demand is likely to fall by 10pc in the April 2020 to March 2021 (July 2020). However, in the scenario development the steel production for 2020 is assumed to 110 million tonnes, 0.5% increase over 2019-20 production.

BF-BOF will increase to 50% and 55% by 2030 and 2040 respectively.

As India already has large steel assets, scrap utilization is expected to increase in the coming years. This will result in energy as well as resource benefits, as material preparation and iron making steps are avoided, and directly the scrap can be fed during steel making process in furnaces. This will result in substantial energy and GHG reductions, and for the analysis, it is assumed that the current scrap utilization is with DRI-EAF/IF process.

Energy Efficiency

Energy efficiency is an important lever for the Iron & Steel sector to achieve lower energy and resource consumption. The current level of energy consumption indicates that the Indian steel sector has a potential to improve 35-40%, if the best available technologies are adopted. However, it is a challenge for the sector to implement such measures immediately due to vintage of plant, raw material quality, fuel quality, capacity utilization, etc. In the long term, it is expected that the companies will implement the measures as they become more cost effective, technologies become more accessible and the brownfield and greenfield expansion makes companies upgrade their existing technologies and processes with more energy efficient ones.

The following table provides an overview of the current energy consumption and the benchmark energy consumption that is possible by implementation of best practices and best available technologies.

Table 17: Specific Energy Consumption – BF-BOF and DRI-EAF/IF

Route	Average	BAT	Best Plant in India
BF-BOF	6.6	3.94	5.63 [17]
DRI-EAF/IF	7.07	5.00	–

5.3 Results

For the development of the specific energy consumption analysis, two scenarios are considered – Baseline scenario and Best Available Practice & Technology scenario. The following table highlights the assumption for the scenarios:

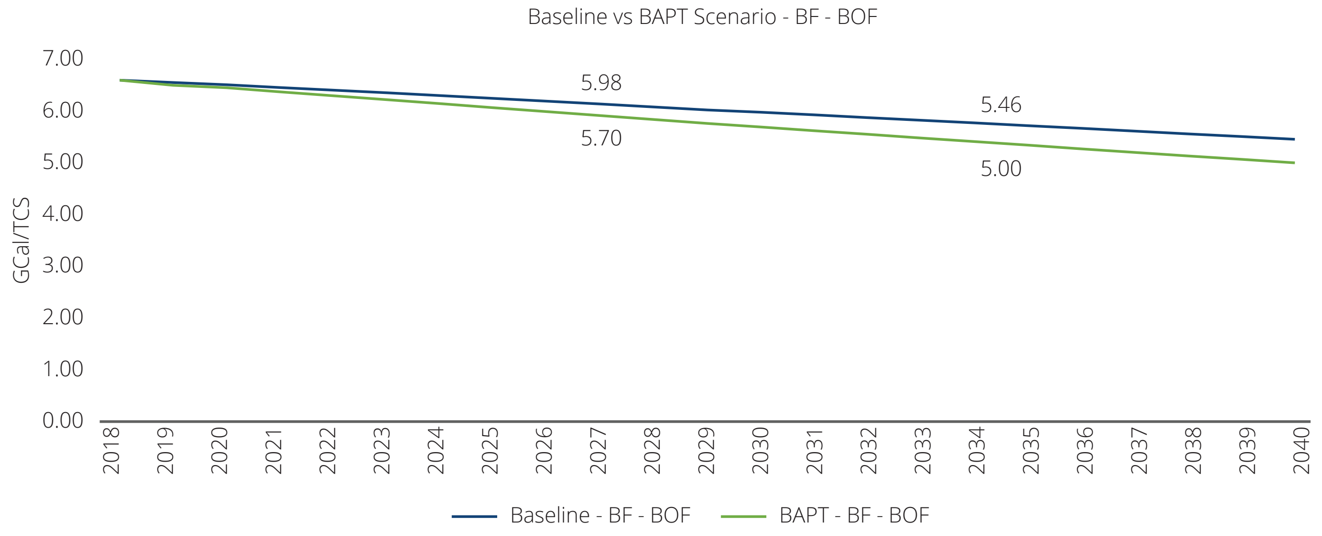
The following graph highlights the specific energy consumption improvements for the BF-BOF and DRI-EAF/IF steel production under the Baseline and BAPT scenarios.

By the adoption and implementation of best practices and technology the BOF-BF Steel plants would be able to achieve the energy consumption level of 5.46 GCal/tcs.

Table 18: Assumption – Energy Efficiency Scenario

Scenario	Remarks
Baseline Scenario	Under the baseline scenario, it is assumed that the sector will continue to improve the energy efficiency. For the historical energy efficiency, improvement rate (2010-2018) for leading plants (accounting for 30% of the country's steel production) is considered at 0.65% annually. And in addition to the above it is also assumed that the new capacity addition will have higher energy efficiency than the average performance of the sector. The baseline scenarios performance achievement is possible by implementation of current technologies and practices by an energy efficient plant in the country.
Best Available Practice & Technology (BAPT)	For the BAPT scenario it is assumed that the Indian Steel sector would be able to achieve the benchmark energy consumption level by 2050. Under this it is assumed that new capacity additions will be able to achieve the benchmark energy performance by 2050 gradually. And the older plants will implement new technologies and practices and upgrade their existing process. This is possible by implementation of current technologies and practices and the best available practices and technologies for steel production.

Figure 29: **Specific Energy Consumption – Baseline vs BAPT Scenario – BF-BOF**



This will lead to additional 10% gains on specific energy consumption by 2040 as compared to baseline scenario.

By the adoption and implementation of best practices and technology the DRI-EAF/IF Steel plants would be able to achieve the energy consumption level of 5.68 GCal/tcs. This will lead to additional 6.27% gains on specific energy consumption by 2040 as compared to baseline scenario

Energy Consumption & GHG Emissions

Based on the Specific energy consumption for the different steel route production and projected share, the energy consumption for the sector is estimated. For assessing the project energy consumption, the steel production under medium demand scenario is considered.

Based on the analysis the energy consumption of the Iron & Steel sector is estimated to be 76.2 million toe in 2018. Based on the steel production and energy efficiency projection scenario, the adoption of best practices and technologies can result in reduction of sectoral energy consumption by 7.5% as compared to baseline scenario by 2040 (13.7 million toe).

Figure 30: **Specific Energy Consumption – Baseline vs BAPT Scenario – DRI-EAF/IF**

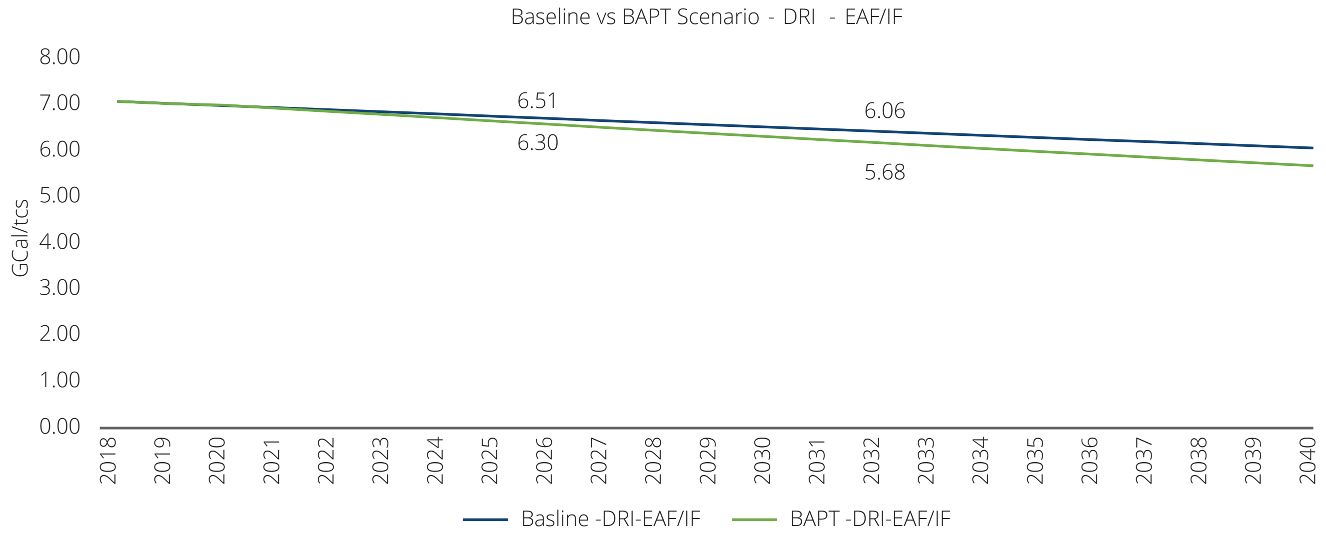


Figure 31: **Energy Consumption – Baseline vs BAPT Scenario**

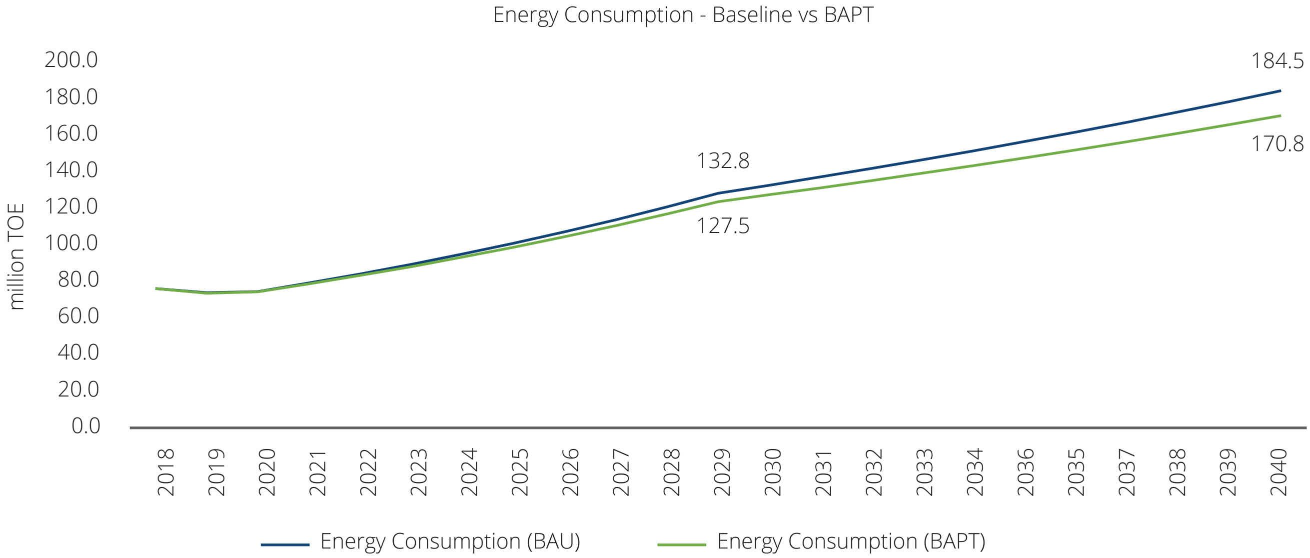
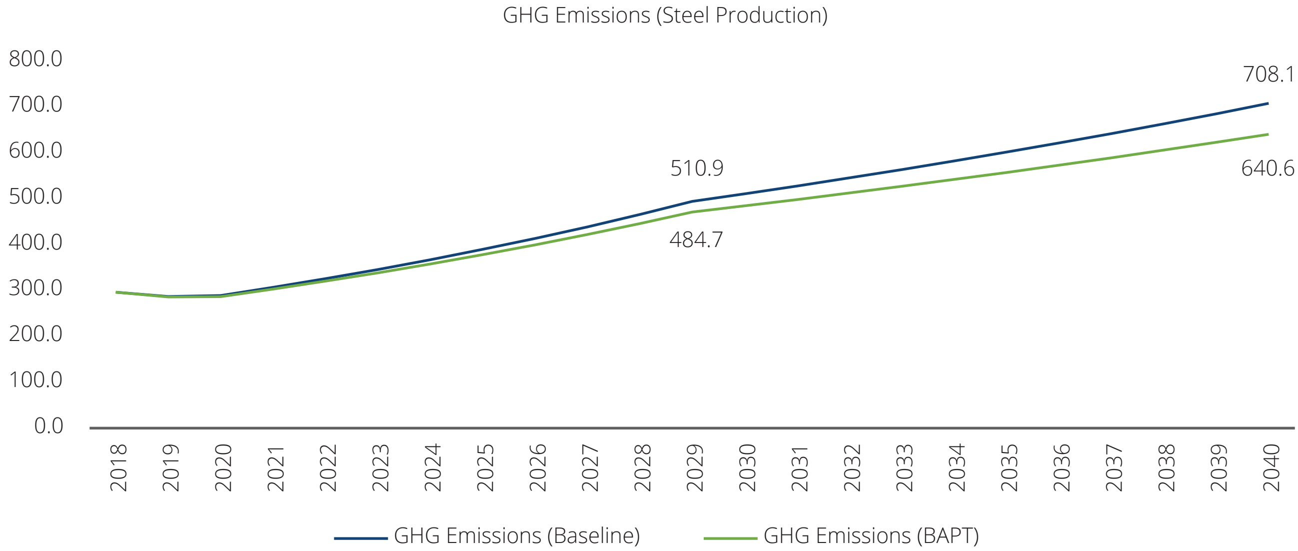


Figure 32: **GHG Emissions – Steel Sector**



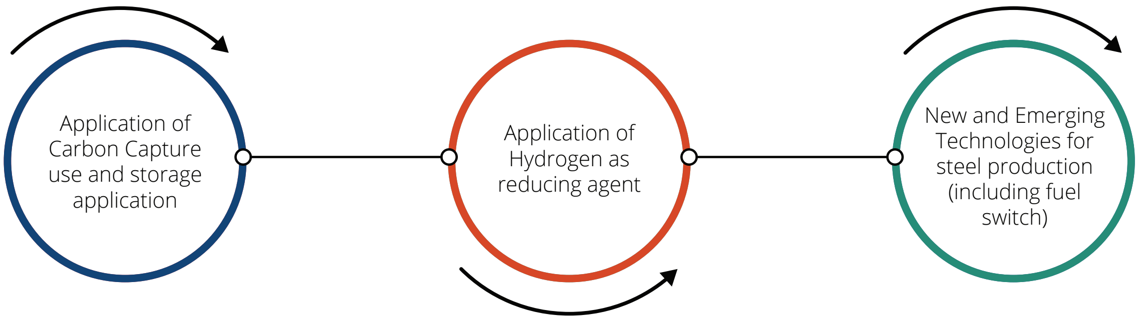
The energy efficiency in the steel sector also yields GHG reductions in the steel sector as improvement in directly leads to reduction of fossil fuel consumption and electricity which are major sources of emissions in the steel production process. The current GHG emissions for BF-BOF varies in the range of 2.4 -2.6 T CO_2/TCS for BF-BOF and 2.8 -2.9 T CO_2/TCS for DRI-EAF/IF, which is almost 1.5 times the international benchmark of 1.8 t CO_2/ TCS [16].

Based on the estimates, the GHG emissions from the Iron & Steel sector was 296.3 million t CO_2 in 2018. Based on the steel production and energy efficiency projection scenario, the adoption of best practices and technologies can bring down the sectoral GHG emissions by 9.5% as compared to baseline scenario by 2040 (67.4 million T CO_2).

Adoption of Novel Technologies for Steel Production

In addition to the best available technologies, there is also potential application of novel clean technologies in manufacturing of the steel that can yield significant benefits for GHG reduction. The novel technologies can be classified under three groups as follows:

Figure 33: Categorisation - Novel Technologies for Steel Production



The implementation of novel clean technologies for steel production can result in reduction of energy consumption as well as reduction of CO_2 emissions from iron and steel process, thus driving deep decarbonisation in the sector. However, many of these technologies are not yet commercialised and are still under research and development, so the adoption of such technologies would be considered in the long term (beyond 2040).

Following is the list of novel technology options for driving energy efficiency improvement and GHG reduction in the sector:

Table 19: Novel technologies for Iron & Steel sector[6]

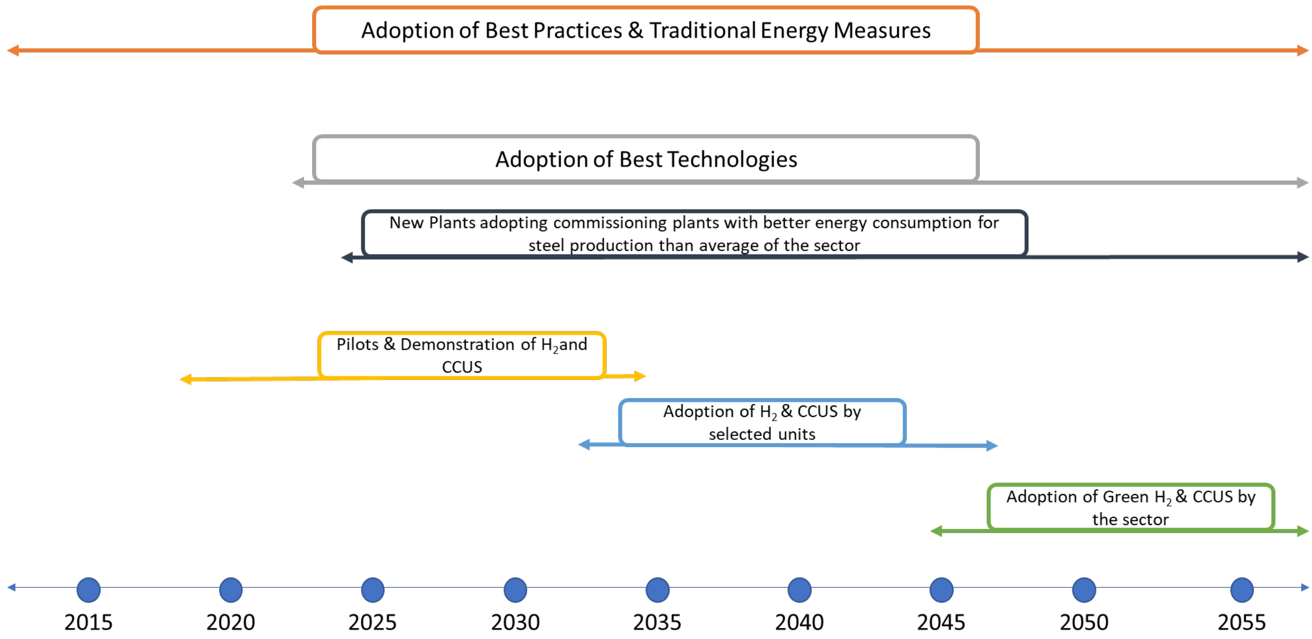
S. No.	Technology	Area of Application	Technology Readiness Level	Area	Impact
1	Single Chamber System	Coke Oven	TRL 4	Technology Upgradation	Thermal Energy efficiency improvement 38-70%
2	CO_2 Ultimate Reduction in Steelmaking Process by Innovative Technology for Cool Earth 50	Coke Oven	TRL 5	Carbon Capture and Storage	30% emission reduction
3	SCOPE 21 - Next Generation Coke Making Technology	Coke Oven	TRL 6	Technology Upgradation	Coke Energy consumption can be reduced by 21%
4	Utilisation of Alternate Fuel (Waste, Charcoal)	Sinter	TRL 6	Fuel Switch	5-10% savings
5	Top Pressure Recovery Turbine	Blast Furnace	TRL 9	Technology Upgradation	Electrical Savings
6	Plastic Waste Injection	Blast Furnace	TRL 8	Fuel Switch	For every ton of plastic waste used, coke use can be reduced by 750 kg
7	Biomass use	Blast Furnace	TRL 5	Fuel Switch	Pulverised Coal Injection can be replaced with biomass
8	Top Gas Recycling	Blast Furnace	TRL 6	Technology Upgradation	15% CO_2 reduction
9	Slag Waste Heat Recovery	Blast Furnace	TRL 6	Technology Upgradation	0.08 GCal/TCS saving possible
10	Hydrogen Application in Blast Furnace[7]	Blast Furnace	TRL 6	Hydrogen use	GHG Reduction (20% during the pilot stage)
11	Automated Steel Cleanliness Analysis Tool	Basic Oxygen Furnace	TRL 5	Technology Upgradation	0.25% energy savings

6 Disclaimer: Not all the technologies are covered.
7 https://www.thyssenkrupp.com/en/newsroom/press-releases/pressdetailpage/green-hydrogen-for-steel-production--rwe-and-thyssenkrupp-plan-partnership-82841

S. No.	Technology	Area of Application	Technology Readiness Level	Area	Impact
12	In-Situ Real-Time Measurement of Melt Constituents	Basic Oxygen Furnace	TRL 6	Technology Upgradation	
13	Recycling of BOF steelmaking slag	Basic Oxygen Furnace	TRL 6	Technology Upgradation	
14	Continuous Casting	Steel making	TRL 8	Technology Upgradation	
15	Thin Slab Casting	Steel Making	TRL 8	Technology Upgradation	Energy Savings 0.5-1 GCal/TCS
16	Castrip ® Process	Steel Making	TRL 8	Technology Upgradation	Energy Savings 0.47 GCal/ TCS
17	Thermochemical Recuperation for High Temperature Furnaces	Rolling	TRL 5	Technology Upgradation	Fuel consumption reduction by 25%
18	Model Based Closed-Loop Oxygen Control	Rolling	TRL 6	Technology Upgradation	2-2.5% energy savings
19	Preventing Scale Formation in Rolling	Rolling	TRL 6	Technology Upgradation	Material loss reduction and energy improvement
20	Oscillating Combustion	Rolling	TRL 6	Technology Upgradation	Efficiency improvement by 5%
21	Midrex Process (Natural Gas)	DRI	TRL 8	Technology Upgradation	1/3rd of emission of BF-BOF route
22	Midrex Process (Natrual Gas + Hydrogen)	DRI	TRL 8	Technology Upgradation	
23	Midrex H2[8]	DRI	TRL 6	Hydrogen Application	Zero Emissions
24	HYLSA Process	DRI	TRL 8	Technology Upgradation	0.77 to 0.92 t-CO2/t-steel (100% NG based) [9]
25	Ultra Low CO_2 Steel Making	DRI	TRL 5	Technology Upgradation	Less energy than NG-DRI
26	HIsarna process	DRI	TRL 6	Technology Upgradation	20% savings in primary energy consumption 20% reduction of CO_2 emissions [10]
27	HIsarna process	DRI	TRL 5	Carbon Capture	80% reduction of CO_2 emissions
28	Waste Heat Recovery from EAF	EAF	TRL 5	Technology Upgradation	Approximately 130 kWh/t melted steel can be recovered
29	ECOARC Furnaces (Shaft type EAF)	EAF	TRL 6	Technology Upgradation	This furnace consumes 200 kWh/tonne (at specific oxygen injection rate)
30	Chemical Absorption Technology for Carbon Capture	Iron Making	TRL 5	Carbon Capture and Storage	Carbon Capture

8 https://www.midrex.com/technology/midrex-process/midrex-h2/
9 http://www.iipinetwork.org/wp-content/letd/content/hyl-iii-process.html
10 https://www.steel-360.com/technology-next/hisarna-process-for-ironmaking

Figure 34: Adoption of energy efficiency and novel technologies by the sector



As many of the technologies are in either pilot or initial stages of the development, the implementation of the technologies will be in the long term and is expected to be adopted by the plants once the technology is proven to work and to be cost-effective. Already, many of the steel plants in the country are upgrading their technology and are under expansion stage. The following figure provides a summary of various measures that are expected to be adopted by the plants in India:

The implementation of novel clean technologies – Hydrogen based steel production and Carbon Capture and Storage can further bring the emissions down for the sector; this reduction would be over and above the BAPT. The Green Steel Production and its benefits are discussed in detail in another chapter in this report.

6. Role of Demand Shift

6.1 Role of Demand Shift in India's Energy Transition

India's gross installed power capacity is around 349 GW, but peak load met over FY 2018-19 at a grid level has been about 175 GW [11]. At the national level, India's peak electricity demand usually occurs in the evening, between 6 pm and 9 pm. Meeting this demand requires relatively firm supply which variable renewable energy (RE) cannot supply in the absence of storage.

Over the past five years, the evening peak demand has continuously risen. Table 37 below shows the year-on-year increase in the evening peak demand met. The evening peak demand over the past five years has been increasing at an average of 5.28% per annum (CAGR). Table 38 indicates energy requirement and peak demand deficit for the year 2018-19 . Deficit of energy requirement and peak demand is 0.5% & 0.7% respectively.

Table 20: Year on year increase of evening peak demand met

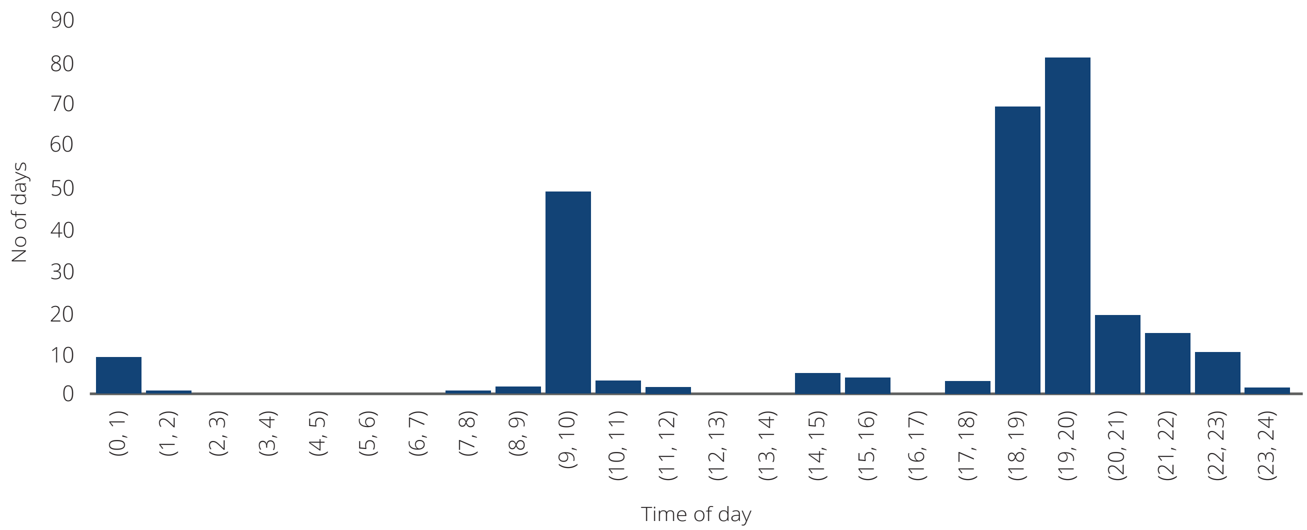
Year	Highest evening peak demand	YOY Growth
13-14	128,251	-
14-15	138,215	7.21%
15-16	147,655	6.39%
16-17	156,058	5.38%
17-18	160,407	2.71%
18-19	174,682	8.89%

Figure 52 below represents frequency of true daily peak demand. Here, we observe that most of the true daily peaks occur in the evenings between 6 pm-8 pm. Although solar installed capacity is supposed to increase to 100 GW by 2022, without a viable storage option, the contribution of solar towards this peak will be effectively zero. In the future, a higher installed solar capacity could lead to higher ramping of power consumption in the evenings.[12]

Table 21: all India energy scenario 2019-20

Energy			Peak		
Energy Requirement	Energy Supplied	Energy not supplied	Peak Demand	Peak met	Demand not Met
1,291,010 MU	1,284,444 MU	6,566 MU(0.5%)	1,83,804 MW	182,533 MW	1,271 MW

Figure 35: Frequency of true daily peak demand (01 May 2018 – 12 Feb 2019)



11 Brookings India , "Understanding India's Power Capacity," Brookings India , 2019
12 Central Electricity Authority , " Load Generation Balance Report 20-21 , " Central Electricity Authority , 2020

As per projections, demand is expected to grow by over 10 GW/year[13]. Compliance with new pollution emissions norms for coal power plants over the next few years is expected to impact available capacity, and huge power deficits are anticipated in the next 2-3 years. Going forward, India needs power storage, and demand-shifting as a tool to balance demand and supply, combined with more flexible and time-of-day reflective pricing for electricity supply.

Demand/load shifting is the shifting of electricity consumption from one time period to another; for example, postponing an industrial process to another time. By shifting the load to another time, the returns generated through energy cost savings may be greater than the loss of production. Load shifting can be achieved by rescheduling processes and turning off unnecessary equipment and machinery. Load shifting does not result in a reduction in net quantity of energy used.

6.2 Power Demand in Steel Sector

In the steel industry, electrical energy is one of the major components that largely support the electric furnace, machinery operations, drives, fans, lighting and other process supported systems. Among Indian steel plants, 24% and 31% utilise electrical furnace (such as arc furnaces) and induction furnace routes respectively. Electrical furnaces melt the charged materials to produce specialised steel using electrical energy. A variety of steels is manufactured through electrical furnaces. For such plants, availability of electricity has to remain relatively stable. Electricity is also generally used for the operation of rolling mill motor systems, in electric arc furnaces for melting of scrap and in rolling mills.

In order to understand the load profile of large steel producers, analysis of capacity utilisation of steel production and plant load factor of captive power plant was carried out by collecting feedback from steel producers. Below table shows the average power available for export from a large steel producer in India.

Based on the feedback received from eleven large steel producers, the average capacity utilisation of these large plants is 77%, which means that the plant is not utilising the theoretical fullest capacity for ~2000 hrs in a year. Average annual peak hour restriction from grid is calculated to be ~1500 Hrs (average 4 hrs per day). By shifting the non-essential load from steel plant operation during the peak hours, steel plants can export the surplus power to grid. For the large steel producers alone, possible load shifting works out to be 1.7 GWh of plant load. This load shifting can be done in very short duration of 15 minutes with proper planning and automation control in place.

Similarly, most of the captive power plants in the steel sector are not utilised to their fullest capacity. From above Table 38 , average Plant Load Factor (PLF) of the captive power plant of big steel producers is 79%. This works out to be 1,160 MW of additional generation possible from captive power plants that can be exported to the grid to support the peak requirement.

In total, large producer of steel can export ~3 GW of power to the grid and support peak hour demand in the electrical system. This could meet the deficit power required for the country during the peak hours which was 1.3 GW in the year 2019-20, and, potentially, reduce peak power purchase costs for an additional ~1.5 GW

Table 22: average power available for export from large steel producer in India

Number of large Integrated Steel Plant (ISP)	**11**
Production Capacity (MT of crude steel)	53,687,000 MT
Actual Production (MT of crude steel)	41,484,848 MT
Capacity Utilisation	77%
Annual power consumption of large Integrated Steel Plant (MWh)	32,042,469 MWh
Required peak load for operation of plant (MW)	4,734 MW
Possible load reduction during peak hours (available to export)	**1,650 MW**
Captive Power Plant capacity	5,511 MW
Overall Generation (MWh)	38,117,129 MWh
PLF of Captive Power plant	79%
Potential load that captive power plant can export by increasing PLF	**1,160 MW**
Total power available for export to grid	**2,810 MW**

13 Brookings India , "Understanding India's Power Capacity," Brookings India , 2019

6.3 Desired intervention for demand shifting - Incentive on power tariff based on Time of Use (ToU)

During peak hours, utilities have to purchase power at very high cost, much higher than the price paid by consumers. To reduce peak power demand, there are broadly two options: reduce power demand during peak hours, reduce overall power demand. One way of reducing peak power demand is through the implementation of Time of Use (ToU) tariff.

Time of Use (or TOU) tariff is a tariff structure in which different rates are applicable for use of electricity at different time of the day. It essentially means that the cost of using one unit of electricity will be different in the morning, noon, evening and night.

The extent to which TOU tariffs can be fully implemented depends on the consumer that is being served, i.e., the practicality of implementation and the consumer's ability to respond to the pricing structure. Typically, every plant has a certain amount of margin built into the controls to allow for failure or maintenance. With the right technology in place, this margin can also be used for controlled load shifting. This is worked out based on the best possible returns, to ensure the cost of shifting the electricity consumption is always exceeded by the financial returns, whether in savings or revenues.

Any TOU tariff introduced on its own to promote efficiency will not be successful if it does not take into consideration the customer's perspective. The pricing structure might have to be complex to result in the the required economically efficient behaviour. Further, if a consumer cannot respond to the pricing structure, the pricing structure again may not achieve its desired purpose. This typically happens where the customer's usage is very low and therefore the customer has no ability to shift or reduce load, or where the customer does not have peak power consumption.

Most of the State Electricity Regulatory Commissions (SERCs) have implemented TOU tariffs, generally for large industrial and commercial category consumers in the country. The status of TOU implementation across various states is tabulated below:

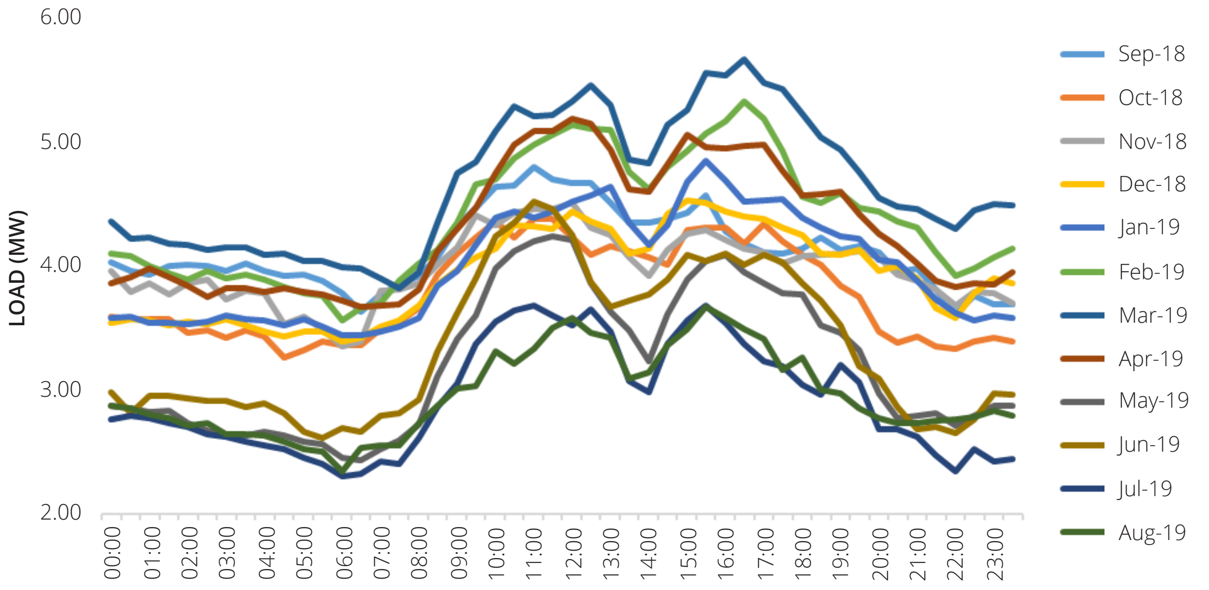
6.4 Case Study : Demand curve of industrial feeder

Andhra Pradesh Eastern Power Development Corporation Limited (APEPDCL) has the Time of Use (ToU) tariff structure for industrial consumers covering voltage levels of 11 kV, 33 kV and 132 kV and above. Present charges for industrial consumer with the voltage level of 11 kV is Rs 7.65 /unit during non-peak hours; during peak hours i.e. between 6 pm to 10 pm, the energy charge is Rs 8.65/unit for all the non-domestic/commercial consumers. For this reason, many industrial consumers have taken measures to shift the load to non-peak hours . In the load curve of Industrial feeder of APEPDCL (Figure 52), we can observe decrease in demand from 6 pm onwards. Thus, there is a clear case to note that industry does, indeed, utilise ToU tariff to reduce their power cost.

Table 23: status of TOU implementation across various states

State	TOU implementation	State	TOU implementation
Assam	Yes	Uttarakhand	Yes
Bihar	Yes	Uttar Pradesh	Yes
Chhattisgarh	Yes	West Bengal	Yes
Gujarat	Yes	Andhra Pradesh	Yes
Himachal Pradesh	Yes	Delhi	No
Jharkhand	Yes	Haryana	No
Karnataka	Yes	Jammu & Kashmir	No
Kerala	Yes	Punjab	No
Madhya Pradesh	Yes	Rajasthan	No
Maharashtra	Yes	Manipur	No
Orissa	Yes	Meghalaya	No
Tamil Nadu	Yes	Arunachal Pradesh	No
Tripura	Yes		

Figure 36: **Load Curve of Industrial Sector**



6.5 Recommendations for encouraging demand shift in the iron and steel industry

A plant with captive power plant can shift the load by enhancing the capacity utilization during off-peak hours and export the surplus power to the grid. This will result in additional revenue on account of both: reduction of TOU surcharges and revenue due to export of power during peak hours. This can be worked out based on the best possible returns, to ensure that the cost of shifting the electricity consumption is always exceeded by the production revenues. Presently, steel producers have limitations to export captive power to grid.

Most of the captive power plant including waste heat power generation of steel plants are not been able to generate at full capacity and inject the excess power to the State transmission system due to current regulatory framework. For a typical large captive power plant (above 25 MW), electricity generation cost is generally below INR 5.0/kWh depending on the type of fuel and location of the plant.[14] On the other hand electricity tariffs across key industrial states go as high as ~INR 8.0/kWh, which proves strong economics for captive power plant to increase their revenue and state grid can meet the peak demand and shortage of energy requirement.

14 Centre for Energy Finance ,"Captive Power Generation", Centre for Energy Finance , Aug 2019

7. Hydrogen based Green Steel making in India

Key takeaways from the chapter

- Benefits of green steel making
- Global & Indian major pilot green steel making projects
- Current status and future potential of Hydrogen applications in India
- Key barriers in Hydrogen utilization in India

Recommendations for hydrogen-based app

7.1 Introduction

Energy constitutes a significant portion of the cost of steel production. Coal, coke, electricity and natural gas are the major conventional fuels used to process iron ore to produce steel. As explained earlier, the production process for manufacturing steel is energy-intensive and requires a large amount of fossil fuels.

As noted earlier, globally, emission intensity is currently 1.9 tCO_2/t-crude steel. However, this varies from plant to plant, depending on process type, efficiency, raw materials and fuels used. The highest emitting & energy intensive process is BF-BOF, with the DRI-EAF route emitting less direct carbon. Though in the near future, steel production through DRI-EAF is expected to increase, steel production from BF-BOF will continue for the foreseeable future. Since the DR-EAF process also uses significant amounts of electricity, indirect emissions may be high if the power generation is from conventional fossil fuels. Hence, for the steel industry to significantly reduce emissions, substantial changes to primary/ secondary processes are necessary. This potentially opens the way for new innovative technologies i.e. hydrogen-based production processes.

7.2 Making of green steel using hydrogen

Hydrogen can act as feedstock and fuel source in steel making. It works as a reducing agent and can be used instead of coke where reduction of iron oxides happens. Here, hydrogen reacts with iron oxide in a fashion similar to carbon monoxide, but instead of producing carbon dioxide, the only by-product is water vapour. When hydrogen is used in the process, the steel making process can become completely or substantially emission-free, creating 'green steel.'

Most of the world's present hydrogen production process consists of "grey hydrogen," which is produced from conventional fuel sources, which forms both hydrogen and carbon dioxide. On the other hand, the term "blue hydrogen" refers to hydrogen that meets the low-carbon threshold but is generated using non-renewable energy sources (e.g. nuclear). "Green Hydrogen" is hydrogen that not only meets the low-carbon threshold but is generated using renewable energy sources such as solar or wind.

There are generally two ways of using (green) hydrogen in steel production. First, it can be used as an alternative injection material to pulverized coal injection (PCI) improve the performance of conventional blast furnaces. However, while the injection of (green) hydrogen into blast furnaces can reduce carbon emissions by up to 20 percent, this does not offer carbon-neutral steel production because regular coking coal is still a necessary reductant agent in the blast furnace.

Second, hydrogen can be used as an alternative reductant to produce DRI that can be further processed into steel using an EAF. This DRI/EAF route is a proven production process that is Pl. do mention IF with DRI as it is the most used process in India with DRI rather than EAF.
At all places in the report wherever applicable currently applied using natural gas as a reductant. Based on the use of green hydrogen as well as renewable electricity from wind, solar, or water, a DRI/EAF setup enables nearly carbon-neutral steel production.

7.3 Benefits of manufacturing green steel

Green steel manufacturing has lower impacts on the environment. Steel making using hydrogen can reduce CO_2 related emissions significantly. The main advantage comes from the reduced use of conventional energy and raw materials, leading to lower emissions of carbon dioxide (CO_2), sulphur oxides (SOx), nitrogen oxides (NOx), and dust.

There are other several benefits of using hydrogen in steel making:

1. Reduces imports of coking coal, coke
2. Increases energy security
3. Hydrogen can be integrated with onsite renewable energy generation

In the DR-EAF process, hydrogen can act as the reductant, replacing natural gas and reducing emissions to as little as 0.05tCO_2 /t steel. There is also some potential to maintain existing BF-BOF plants and partially replace coke with hydrogen. This technology could reduce blast furnace CO_2 emissions by 10-21% and has been piloted in Japan under the COURSE50 program.

7.4 Global scenario – pilot hydrogen-based major green steel making processes

Several countries, including Sweden, Germany, Austria, Japan, UK, and the US are supporting comprehensive research, technology development and demonstration programmes for electricity generation and producing fuel cells for automobiles.

Sweden

Three Swedish companies – steel manufacturer SSAB, mining company LKAB, and energy company Vattenfall – have been exploring the use of hydrogen in steel production. This joint endeavour is known as HYBRIT. To make the process fully fossil-free, the hydrogen used will be generated from renewable electricity. HYBRIT estimates that using decarbonized hydrogen in place of coke could reduce Sweden's total carbon dioxide emissions by 10 percent. A HYBRIT Development AB pilot plant began construction in summer 2018 at the SSAB site in Luleå, Sweden. The pilot phase is expected to last until 2024, followed by a demonstration phase from 2025 to 2035.

Germany

Multinational steel producer ArcelorMittal has taken steps to reduce its carbon emissions by installing a production plant to use hydrogen for iron ore reduction. It is planning to test a hydrogen procedure at its Hamburg steel production plant. Though testing will be done with hydrogen derived from traditional sources, the company plans to transition to decarbonized hydrogen as it becomes more widely available. ArcelorMittal estimates a demonstration scale of around 110,000 tonnes of hydrogen-based iron ore reduction.

German company thyssenkrupp Steel has been also looking to decarbonize its production processes with hydrogen and will use hydrogen in the iron-reducing process. thyssenkrupp Steel will be supplied hydrogen gas from FCHEA member Air Liquide. The company estimates that by using hydrogen, they could decrease their carbon emissions by 20 percent, and it has a long-term goal to reduce carbon dioxide emissions from production by at least 80 percent by 2050.

Austria

Primetals Technologies Limited, the joint venture of Siemens VAI Metals Technologies and Mitsubishi Hitachi Metals Machinery, has been developing technology for hydrogen reduction of iron ore. The company is planning a pilot plant for testing to be constructed at the Voestalpin steel plant in Stahl Donawitz, Austria. It is expected to be commissioned in 2020. The plant comes in a modular design and has a rated capacity of 250,000 tons of steel per year.

7.5 Indian scenario – low carbon new pilot steel making processes

Though there is a growing interest in the use of low-carbon hydrogen in steelmaking to replace coal or natural gas, there is a high capital cost involved. The main cost element in this production route is hydrogen, which has to be produced from low-carbon electricity.

The alternative low carbon options are Steam methane reformation (SMR) or Coal gasification with Carbon capture and storage (CCS) technology. While currently there are some plans in place, there is not much actual production of 'green' steel in the market. The low cost and high availability of coal in India makes other technologies unpopular.

There are, however, a few companies exploring new low carbon processes for making steel:

- Tata Steel has piloted a new process for production of steel that reduces energy use and carbon dioxide emissions by a fifth of that in the conventional blast furnace route. The company has tested this "completely new technology for producing steel" in five pilot plants in Europe; the next step is to bring a commercial scale plant to India. The process, called HIsarna, is a combination of Isarna and Hismelt, the

Celtic words for iron and melting vessel, respectively. The technology removes a number of pre-processing steps and requires less stringent conditions for the quality of the raw materials used. The combination of HIsarna with storage could slash significant carbon dioxide emissions, as compared to that in conventional steel production process.

- At JSPL, Angul, the Syngas, produced through the gasification process, contains methane, carbon monoxide, carbon dioxide, hydrogen and water vapour from coal, water and air. This process has lower impact on environment as compared to coal combustion process. Capital expenditure of setting up of the Syngas plant was high and had a gestation period of three years. However, this high investment is offset by the improved energy efficiency of the system, as compared to the conventional model of producing steel, and reduced environment impact in the long run.[15]

The most resource efficient way to decarbonize the iron and steel sector in the long-term would-be using hydrogen production via electrolysis from renewable energy sources.

7.6 Global hydrogen market, by production method

Hydrogen is extracted from fossil fuels and biomass, from water, or from a mix of both. Natural gas is currently the primary source of hydrogen production. The global hydrogen market in 2018 was valued at over $135.5 billion, with an estimated compound annual growth rate (CAGR) of 8 percent until 2023 (Markets and Markets 2018).

In 2019, about 96 percent of global hydrogen production came from fossil fuel sources, with 4 percent from electrolysis, 48 percent from natural gas via steam methane reforming (SMR), and 48 percent from coal gasification, oil, or other chemical processes (such as chlorine production).[16]

7.7 Current applications of Hydrogen in India

Hydrogen is at present in the early stage of penetration in India. Many funding agencies are supporting a broad-based RD&D projects on different aspects of hydrogen economy including hydrogen production, storage and utilization. Currently in India, hydrogen demand is largely focused in the chemical and petrochemical sectors. Most hydrogen in India is produced through reforming methane, resulting in significant carbon dioxide emissions. The chlor-alkali industry also produces hydrogen as a by-product. On a limited basis, electrolysis route is also used for manufacturing hydrogen. However, industrial base for hydrogen energy applications, including fuel cells and power generation through renewable energy sources, is still in the early stages of development. Figure 54 highlights the experience of various sectors in handling Hydrogen in their process/use.[17]

The Indian hydrogen market is projected to grow from an estimated Rs 19464.72 million ($264 million) in 2018 to Rs 53601.71 million ($727 million) by 2030, exhibiting a CAGR of around 9% during the forecast period, on account of growing demand for chemicals, expansion of refineries, and rising adoption of coal gasification and power-to-gas projects. Moreover, development of fuel cell technology for electricity production and growing demand for hydrogen from hydro-processing industry and steel, chemical and petrochemical plants is expected to boost the country's hydrogen market in the coming years.[18]

Figure 37: **experience of Indian industries in handling hydrogen**

Industry/ Experience	Production process feedstock	Use	Transport over long distance
Refineries	Natural gas reforming Naphtha cracking	Hydro- de- sulphurisation	None
Petro-chemical	Dehydrogenation of ethane	Gaseous fuel, Chemical processes	None
Fertilizer	Natural gas reforming	Ammonia production	None
Chlor-alkali	Electrolysis of Brine	Gaseous fuel, Merchant hydrogen	Limited (as compressed H2)
Power plants	Electrolysis	Coolant for generators	None
Space Research Organization	Napththa cracking	Rocket propellant	Exists

15 https://www.jindalsteelpower.com/sustainabilities/green-steel.html
16 Ajayi-Oyakire 2012, citing Ogden 2004; IEA 2015, 10; IRENA 2018, 13; and Siemens 2019, slide 8.
17 Report of the Group of Hydrogen Energy, Planning Commission, July, 2004
18 https://www.techsciresearch.com/report/india-hydrogen-market/1758.html

The National Hydrogen Energy Road Map (NHERM) is a programme in India initiated by the National Hydrogen Energy Board (NHEB) set up under Ministry of New and Renewable Energy (MNRE) for bridging the technological gaps in different areas of hydrogen energy, including its production, storage, transportation and delivery, applications, safety, codes and standards, and capacity building for the period up to 2020. The objectives of the Indian National Hydrogen Energy Programme are as follows[19]:

- Reduce India's dependence on import of petroleum products
- Promote the use of diverse, domestic, and sustainable new and renewable energy resources
- Provide electricity to remote, far-flung, rural and other electricity deficient areas
- Promote the use of hydrogen as a fuel for transport and power generation
- Reduce carbon emissions from energy production and consumption
- Increase reliability and efficiency of electricity generation

The Ministry of New and Renewable Energy (MNRE) has been supporting a broad-based Research Development and Demonstration (R&D) programme on Hydrogen Energy and Fuel. Projects are supported in industrial, academic and research institutions to address challenges in production of hydrogen from renewable energy sources, its safe and efficient storage.

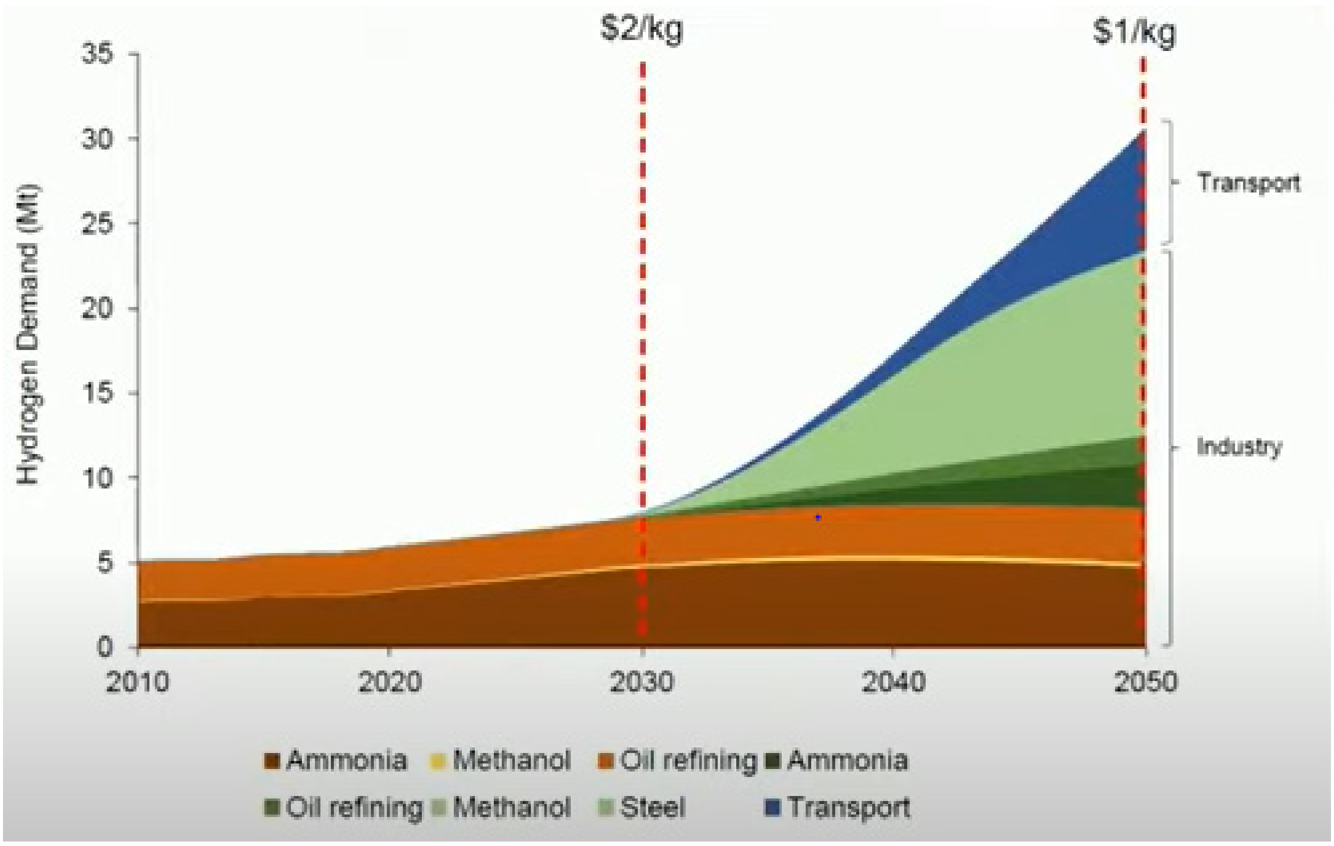
The various funding agencies in India are both the Government agencies and public sector companies. Some of these includes the Ministry of Science and Technology, CSIR Laboratories, Ministry of Petroleum and Natural Gas, Defence Research & Development Organizations, Indian Space Research Organization, Oil & Gas companies, Department of Atomic Energy and automobile sector, oil and gas companies are also involved in the research, development and demonstration programme related to hydrogen.

It is anticipated that the cost of hydrogen will fall in the coming decades, making it more viable for use in the iron and steel (and other) industries.

7.8 Future potential of usage of hydrogen in India

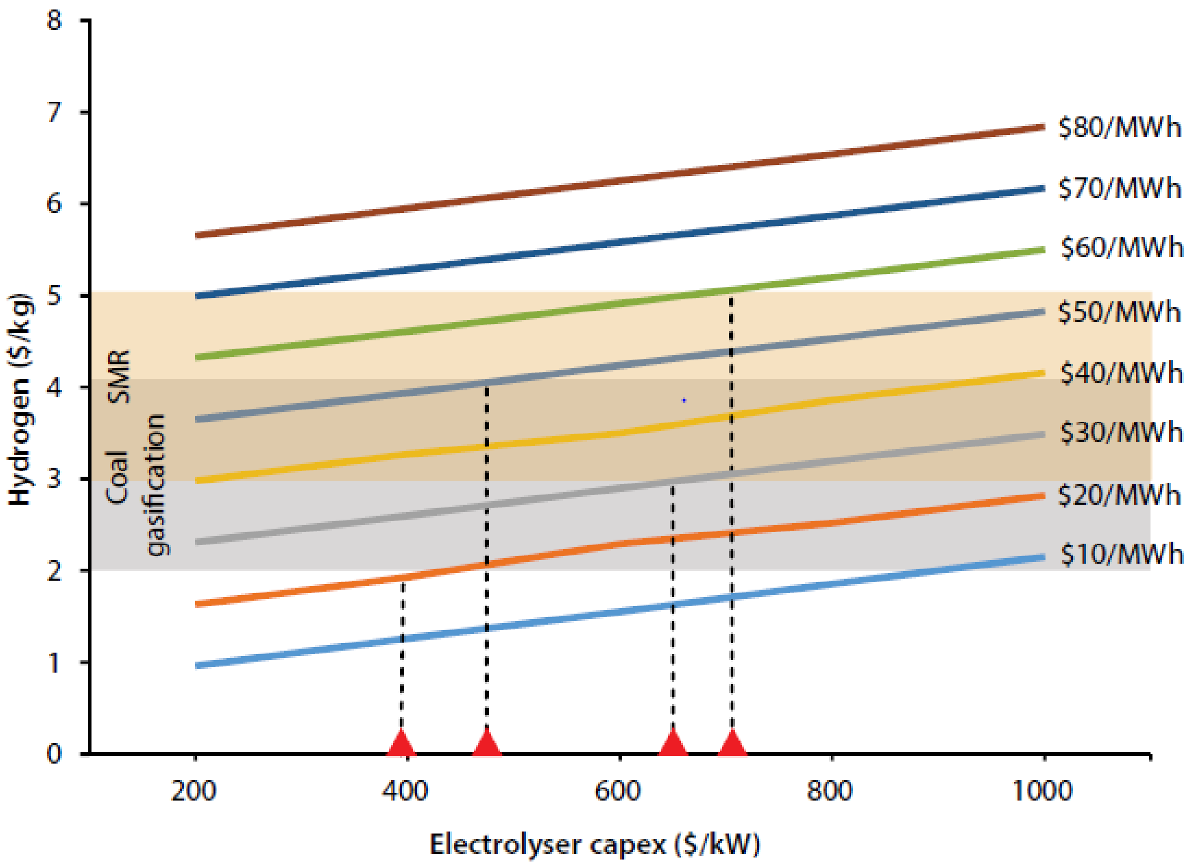
India is focusing on significant power generation from renewable energy resources; electrolysis using renewable energy appears to be a promising route for hydrogen production. By 2030, costs of hydrogen from low carbon sources could start to compete with fossil fuel derived

Figure 38: **Tentative price of Hydrogen production**



19 National Hydrogen Energy Road Map – 2006, (Abridged Version, 2007)

Figure 39: Costs of hydrogen from electrolysis



hydrogen. The Figure 55 highlights the tentative price of hydrogen production:[20]

All hydrogen is produced via electrolysis, using electricity as an input. Therefore, the cost of electricity and electrolyser are critical. The Figure 56 highlights cost of hydrogen from electrolysis.[21]

As mentioned earlier, the steel sector contributes to almost 10% of the emissions in the country, which calls for the sector to switch to alternative fuels. Hydrogen, as explained earlier in this chapter, can be one of the alternative fuels, considering its easy integration in different areas of the steel making. The graph above indicates the market competitiveness for the green hydrogen technology.

Current industrial electricity prices are around Rs 5898.4/ MWh ($80/MWh), the result of high connection costs and the cross-subsidization of agricultural and residential electricity prices. Grid electricity prices for other consumers are closer to Rs 4423.8/MWh ($60/ MWh). At this price the cost of hydrogen production from electrolysis starts to become competitive with steam methane reformation (SMR) at higher gas prices, although it will still be higher than hydrogen produced from coal gasification. The economics that can be inferred from the graph is that Hydrogen as an alternate fuel can be widely accepted for both Coal Gasification route and SMR is around less than Rs 147.46 per kg ($2 per kg). The graph indicates the point of feasibility where we see that the electrolyser capex cost of Rs 29492 ($400) and renewable electricity cost of Rs 1474.6 /MWh ($20/ MWh) would lead to conducive atmosphere for hydrogen to be an alternate fuel for the steel manufacturing.[22]

The cost reduction for electrolysers and renewable electricity can be expected to be more reasonable after 2030, based on its scaling up expected around the world.

7.9 Key barriers in Hydrogen application for steel industry in India

Although there is a growing interest in making green steel, there are still several challenges in the country to introducing a new fuel like hydrogen. There are companies developing hydrogen as a substitute for coal as a reductant in the steel making process but there is not much actual production of 'green' steel in the market. The electrolysis of iron ore is still at an early stage of development. Hence, a smooth transition to green hydrogen-based steelmaking is not likely to happen in India in the very near future.

20 TERI analysis
21 TERI analysis using data from BEIS (2018 and IEA (2019c)
22 Towards a low carbon steel sector- TERI analysis

While the availability of low-carbon fuels like natural gas or CBM will be popular among Indian steel plants, demonstration plants for iron electrolysis are not expected to be built before 2030. Apart from that, several industrial infrastructures are also required for continuous supply of hydrogen to plants.

The other major key barriers for adoption of green steel making process in India are as follows:

- Long lifetimes of present steel making technology
- Commercially availability of technologies – only a few pilot projects
- High investment for hydrogen production
- Cost of renewable energy and electrolyser
- Non-availability of adequate renewable power
- Hydrogen storage and distribution supply chain, i.e., hydrogen hub
- No strict regulations or market instruments
- Electrolysis process is very water intensive, hence there will be requirement of large quantities of fresh water

There is a need to better coordination for hydrogen production & utilization, which is currently being carried out in a disparate manner across different departments and ministries

7.10 Enablers for transition green steel in India

There are many factors which could enable swift transition for producing green steel by Indian steel plants.

- Conventional energy resources are limited, and the prices of fuels are increased substantially
- Mandatory regulations, like the PAT scheme
- Leveraging "Make in India" movement for manufacturing electrolysers
- Demand of hydrogen from other sectors also i.e. transport, refinery, power, etc., which will result in scale and lead to cost reduction
- Increased demand of green steel
- Growing investor and public interest in sustainability
- Invention and scaling up on innovative technologies

7.11 Recommendations for hydrogen-based applications in India

The development of hydrogen energy applications in steel plants will depend on several factors like hydrogen production and logistics costs, availability of adequate renewable energy, market regulations, also demand of hydrogen from other sectors as well.

Key recommendations to scale up hydrogen utilization are as follows:

- Waivers on taxation and duties of electrolyser technology and GST for green hydrogen
- Waivers on electricity duty applied to renewable energy used for green hydrogen production, if any
- Policies and regulation for –
  - Hydrogen blend in natural gas
  - CO_2 emission pricing/Carbon tax
  - Target setting and reporting guidelines for companies
- Setting up manufacturing in India, establishing technology transfer partnerships
- Providing grants for R&D, pilot projects and upskilling of manpower for hydrogen production
- Proactive engagement of Government and large corporations with international agencies to set up demonstration plants and accelerate technology adoption
- Integration of carbon capture and storage or utilization with existing fossil-fuel powered BF-BOF and DR plants
- Water recycling system are to be required to meet the demand of water for electrolysis process

8. Scrap Utilization in India

Key takeaways from the chapter

- Benefits of using steel scrap
- Crude steel production & scrap utilization – Global and Indian
- Current challenges in scrap utilization in India
- Steel Scrap Recycling Policy

8.1 Introduction

Steel is a material that can be used, reused and recycled. Once steel is produced, it becomes a permanent resource because it is 100% recyclable without loss of quality and has a potentially endless life cycle. It offers the ability to make products that are greener and cost-effective.

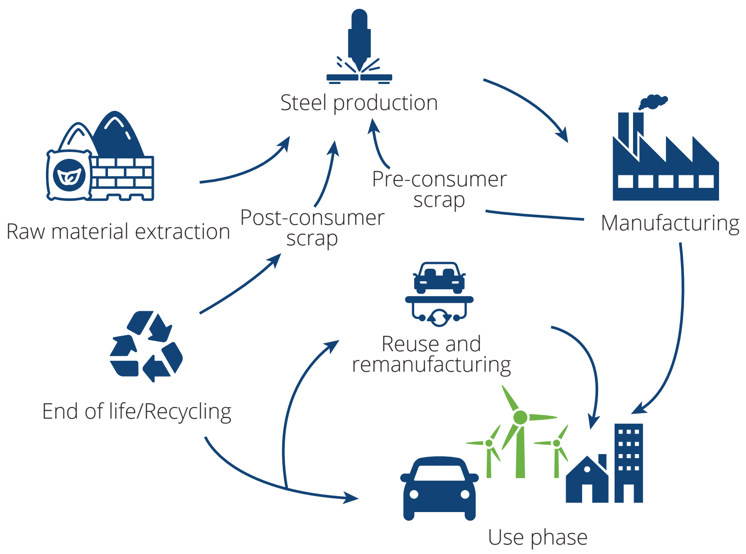
While iron ore remains the primary source for steel making, used or re-used steel in the form of scrap is the secondary raw material for the steel industry. The Indian steel industry is characterized by the presence of many small/medium steel producers who utilize scrap with other inputs in EAF/IF for steel making. While steel production is energy intensive, modern energy management systems and recycling steel scrap have reduced energy intensity of steel production. Scrap-based steel making technologies have been considered among important options to reduce GHG emission intensity. Most of the developed nations are switching over to scrap-based steel production instead of iron ore-based production to make the industry greener. The Figure 40 highlights steel's life cycle.[23]

Today, scrap-DRI based electric route of steel making in India has emerged as one of the key drivers of domestic crude steel production. However, the domestic scrap market is facing challenges in availability, quality, and price fluctuation.

8.2 Benefits of using steel scrap

As steel is 100% recyclable, it can be reprocessed into the same material of the same quality again and again. There is a global trend to increase steel production using scrap as the main raw material, as recycling of scrap helps in

Figure 40: Steel's life cycle



23 World Steel Association

conservation of vital natural resources, besides other numerous benefits. Some of the benefits of utilizing steel scrap are mentioned below:

- Scrap is an important input for electric furnaces. If quality scrap is provided as the charge to the electric furnaces, the furnaces can produce high grade steel.
- It reduces the consumption, expenses, energy, and time needed to mine other valuable resources.
- While recycling does not reduce total steel demand, scrap-based production is considerably less energy and emission intensive than ore-based production.
- High Grade Steel Scrap does not have impurities if processing is done by scrap processing centres and shredders, etc.
- Scrap with less or no impurities makes better Long Products that are commonly used in the construction industry and in common use steel products.
- It contributes to adopting the principle of 'Six Rs', i.e., Reduce, Reuse, Recycle, Recover, Redesign and Remanufacture, to avoid adverse impact on the environment.

8.3 Impact of using scrap in steel making

The use of every ton of scrap can save 1.1 tonne of iron ore, 630 kg of coking coal and 55 kg of limestone. There can be considerable saving in specific energy consumption also, because it will reduce from around 14 MJ/Kg in BF/BOF route to less than 11 MJ/ Kg in EAF/IF route, i.e., savings in energy by 16-17%. It also reduces the water consumption and GHG emission by 40% and 58% respectively.[24]

8.4 Scrap – Classification

Steel scrap is a recyclable material left over from steel manufacture or fabrication or at the end of life of the product. Recycling of scrap is especially important in a green economy because it conserves valuable resources and prevents useful materials from going to landfill as waste. Scrap is classified into the following categories:

- **Home Scrap:** Home scrap is generated at various stages in the process of manufacture of steel in plants and various finished steel products. This is largely consumed within the manufacturing plants. The main source of home scrap includes Integrated Steel Plants, Electric Arc Furnace industry, Induction Furnace industry, Secondary Re-rollers Industry (Flat Products), Secondary Re-rollers Industry (Long Products), and Iron & Steel Foundry industry.
- **New scrap:** New scrap is generated in the downstream processing in manufacturing, fabrication and making of steel products, such as making auto components, white goods, machining, tool and equipment manufacture. The main generators of new scrap include Automobile & Auto Ancillary industry, White Goods/ Household Appliances; Welded Pipes & Tubes, Metal Products, Industrial Plant & Equipment, Fabricated Steel Structures, Construction industry, Bright Bars, Steel Forging Industry, and Iron & Steel Foundries.
- **Obsolete/Old Scrap:** Old scrap is generated from steel products that have come to the end of their useful life (appliances, machinery, buildings, bridges, ships, cans, railway coaches and wagons, etc.). These are collected, processed to certain specifications, and finally sold back to steel plants for re-melting. ELVs also fall under this category.

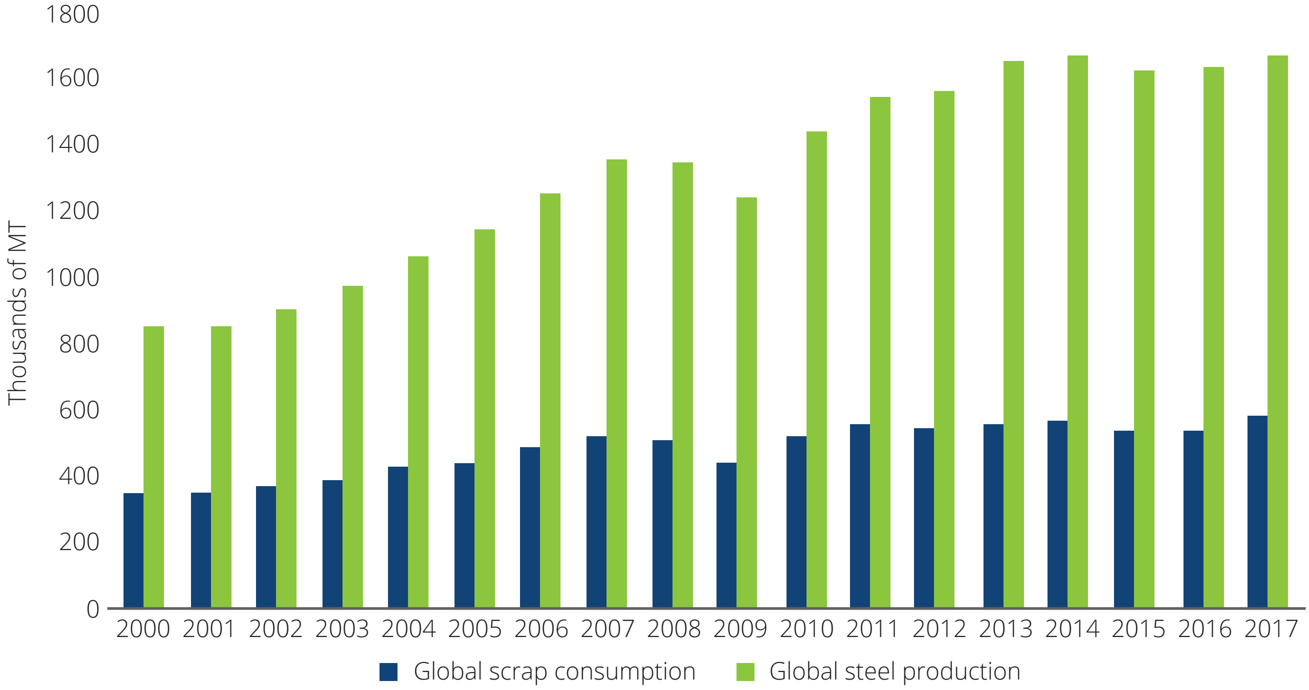
In 2019, approximately 865 (Mt) of iron and steel scrap was available for use globally, comprising about 20% home scrap (165 Mt), 30% prompt scrap (255 Mt) and 50% end-of-life scrap (445 Mt).[25]

8.5 Global steel production and scrap consumption

Countries like Japan, USA, and China have been continuously increasing scrap-based steel production with proportionate reduction from primary route. In 2017, out of 1,688 million tons global steel production, around 475 million tons was produced from secondary route (using scrap).[26] The Figure 58 highlights global steel production and scrap consumption.

24 Steel Scrap Recycling Policy
25 Iron and Steel Technology Roadmap, IEA
26 Steel Scrap Recycling Policy

Figure 41: **Global steel production and scrap consumption**



8.6 Indian steel production and scrap consumption[27]

Steel scrap is important in the Indian steel production scenario. Its higher availability impacts the secondary steel producers. These manufacturers depend fully/partly on scrap and DRI to produce steel. The secondary steel producers in India comprise the EAFs and IFs (electric furnace route) and together they contribute the major chunk of Indian crude steel production. The steel production through the secondary route is expected to increase substantially in the coming years, driven by growing demand of steel, resulting in increase of per capita steel consumption.

Higher volumes of domestic scrap supply will be advantageous to the secondary steel producers, who rely heavily on this raw material. The primary steel producers also use scrap and DRI, but only to the extent of about 15% of their metallic charge in the basic oxygen furnaces (BOFs).

Figure 42 shows present scrap usage pattern in India (last five years):[28]

Currently, 25 MT is supplied by the domestic unorganized scrap industry and 7 MT is obtained from import of scrap. There is potential to reduce this imported quantity. Presently, scrap is being imported mainly from UK, USA, UAE, South Africa and Netherlands. India also imports stainless steel scrap. Current stainless-steel melt shop production is over 3.5 MT and stainless-steel scrap import is around 700,000 T. This is imported from South Korea, Thailand, Turkey, UAE, USA, etc.

Figure 42: **Scrap usage pattern in India**

Particulars	2015-16	2016-17	2017-18	2018-19	2019-20 (P)
Crude Steel Production	89.791	97.936	103.131	110.122	109.215
Equivalent liquid steel!	93.532	102.017	107.428	114.710	113.766
Metaliks for above@	106.286	115.928	122.077	130.352	129.279
Hot Metal available#	47.573	53.944	61.790	67.404	67.021
Sponge iron available*	22.300	28.633	30.199	34.131	36.353
Scrap used$	36.413	33.351	30.088	28.817	25.905
Import of Scrap	6.627	5.360	4.744	6.555	6.566
Internal Scrap	29.786	27.991	25.344	22.262	19.339
Scrap/Metaliks %	34.26	28.77	24.65	22.11	20.04
*! Crude steel/Liquid steel- 96%, @Liquid steel/Metaliks- 88%, # From table 3, *(Production + Import – Export), $ (Metaliks-hot metal-sponge iron).*					

27 Steel Scrap Recycling Policy
28 Performance Review: Iron & Steel 2019-20 by Joint Plant Committee

Figure 43: **Demand-supply scenario of scrap in India**

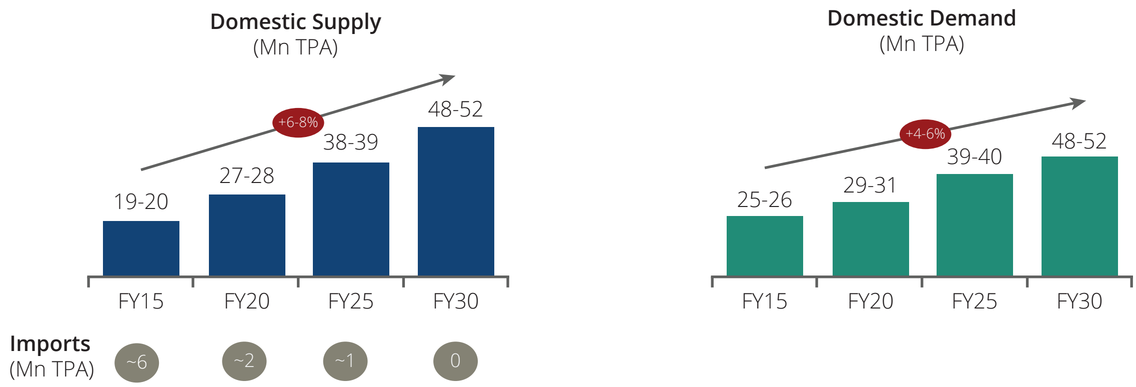


Figure 60 highlights demand-supply scenario of scrap in India. Efficient use of scrap for steel production is crucial for India as 35-40% share has been envisaged from scrap-based steel production in the journey of reaching 300 million TPA by 2030. This shall increase requirement of steel scrap from present levels of around 30 million tonnes to more than 50 million tonnes by 2030.

8.7 Key challenges in utilizing steel scrap in India

The National Steel Policy 2017 (NSP-2017) aims to develop a globally competitive steel industry by creating 300 Million TPA Steel production capacity by 2030, including contribution of 35-40% from EAF/IF route. Thus, the availability of scrap at competitive rates is one of the crucial factors for the growth of the Indian steel industry and to achieve the NSP target. However, scrap usage is low and has come down over the last five years from above 30% to about 20%. Some key challenges are mentioned in the Table 24 **Error! No bookmark name given.**:

8.8 Steel Scrap Recycling Policy

The Ministry of Steel has formulated a Steel Scrap Recycling Policy, which was notified in Gazette of India vide No. 354 dated 07th November 2019. The policy provides a framework to facilitate and promote establishment of metal scrapping centres in India for scientific processing and recycling of ferrous scrap generated from various sources and products. The policy framework provides standard guidelines for collecting, dismantling and shredding activities in an organized, safe and environmentally sound manner. The policy prescribes the guidelines and responsibilities related to dismantling centres and processing centres, the role of aggregators, and the responsibilities of the Government, manufacturers and owners. The Figure 44: Steel Scrap Recycling Policy highlights the steel scrap recycling policy.

Table 24: **Key challenges**

Scrap collection		Scrap Processing		Scrap Consumption	
No formal system	No social status	No industry status	High value loss	High power consumption	High logistics costs
Highly fragmented	Limited statutory compliance	Manual processing	Low concern quality	High dependency on imports	Inconsistent quality
Limited traceability	Contamination	No infrastructure for waste disposal	Unsafe work condition	Low margin	High production

Figure 44: **Steel Scrap Recycling Policy**

Key features of the policy

The policy aims to promote a circular economy in the steel sector, besides promoting formal and scientific collection, dismantling and processing activities for end-of-life products.

It envisages a framework to facilitate and promote establishment of metal scrapping centres in India, which will ensure scientific processing and recycling of ferrous scrap generated from various sources and products.

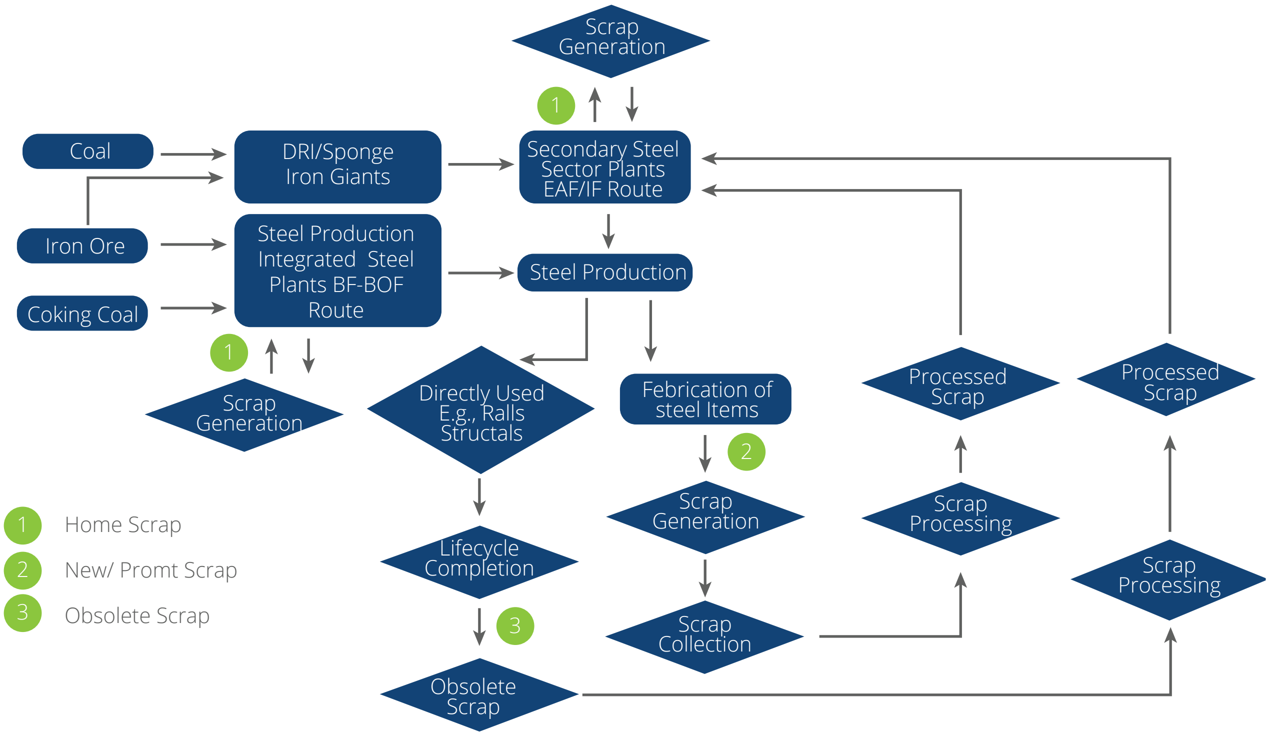
It also aims to decongest the Indian cities from reuse of ferrous scrap, besides creating a mechanism for treating waste streams and residues produced from dismantling and shredding facilities in compliance with Hazardous & Other Wastes (Management & Trans boundary Movement) Rules, 2016, issued by the Ministry of Environment, Forest and Climate Change.

The policy is based on the '6 Rs' principle of Reduce, Reuse, Recycle, Recover, Redesign and Remanufacture through scientific handling, processing and disposal of all types of recyclable scraps, including non-ferrous scraps, through authorized centres/ facilities.

8.9 Steel Recycling Methodology[29]

The methodology of operation as shown in and envisaged for implementation of this Scrap Policy is depicted in Figure 62: **Steel recycling methodology Error! No bookmark name given.:**[30]

Figure 45: **Steel recycling methodology**



29 Annual Report – Ministry of Steel 2019-20
30 Steel Scrap Recycling Policy, Ministry of Steel, Govt of India

8.10 Vehicle Scrapping Policy

There is a need of a Vehicle Scrapping Policy. Although a strategy paper on the need of such policy and guidelines has already been issued by the MoEFCC, a formal policy is yet to be issued. The implementation of such a policy, as and when issued, will result in setting up of more and more shredding facilities and increased availability of shredded scrap for the MSME (secondary) sector. The scrap so generated may require guidelines for classification of scraps, so that high alloy and special scrap can be utilized for producing special materials in a cost-effective manner.

In July 2019, amendments were proposed to the Motor Vehicles Act to allow scrapping of vehicles older than 15 years, with the intent of phasing out old vehicles. Apart from environmental concerns, the policy is also aimed at increasing demand in the market. The policy will reduce the dependency on steel imports as the steel and other metal deposits from the scrapped cars will be cutting down metal imports year by year.

The increased production of vehicles and increased use of consumer durable and white goods in the last two decades and their rapid obsolescence shall generate large quantities of end-of-life products. This shall result in the generation of a continuous flow of large ferrous scrap for recycling in steel production. The collection and/or dismantling centre can either set up by or be associated with a scrap processing centre.

8.11 Recommendations

As steel production in India increases gradually and moves towards the target of 300 Million Tonnes/annum, the requirement of iron-bearing raw material will increase too. The higher usage of steel scrap will benefit the steel makers with lower energy consumption, lower flux consumption, lower CO_2 emission, etc. Natural resources, i.e., iron ore, coal, limestone, etc., are also conserved to the extent that scrap replaces DRI. At the same time, it is economical and allows manufacturing businesses to reduce their production costs. Efficient use of scrap for steel production is crucial for India as 35-40% share has been envisaged from scrap-based steel production in the journey of reaching 300 million TPA by 2030.

Presently in India, steel scrap recycling business is unorganized. Effective coordination is required among all stakeholders, i.e., scrap generators, collectors, traders, processors, original equipment manufacturers and end-users.

- Governments could support increased reuse by:
  - Providing clear guidelines on certification for scrap reuse
  - Supporting voluntary codes and standards on product durability within industrial sectors
  - Raising consumer awareness about the benefits of reuse
  - Formulating health and safety legislation/regulation and environmental norms for the operating centres
- Processed scrap should be free of dirt, rust, non-ferrous metals, foreign material of any kind.
- Scrap pre-heating technology should be adopted by all EAF-based plants to reduce heat requirement.
- Steel manufacturing companies can utilize steel scraps during night time when the power tariff is lower
- Logistics may be one of the main challenges for safe and cost-effective system for inbound unprocessed products/scrap and outbound processed scraps to the melting shops. Thus, scrapping centres (collection-cum-dismantling centres and recycling centres) need to be supported by adequate logistics infrastructure.

Increased reuse of steel products will play one of the most important roles in sustaining a green economy. To minimize dependency on import of scrap and make India self-sufficient in scrap availability, organized and scientific metal scrapping centres should be set up across India. This will also promote resource efficiency in the steel sector. The availability of domestic scrap will give a boost to import substitution initiatives and create huge employment opportunities.

9. Best Available Technology

This chapter lists the best available techniques (BAT) for design, technology and operational performance of the Indian Iron & Steel sector. Table 25 summarizes the best practices in India and the world in the Iron and Steel sector in the following areas:

- Raw material and iron ore agglomeration
- Coke making – By-product recovery and non-recovery
- Iron making – Blast furnace route, Coal DRI route, Gas DRI route
- Steelmaking – Basic Oxygen Furnace route, Electric Arc Furnace route, Electric Induction Furnace route

These technologies are described in detail in the following sections.

Table 25: List of Best available technology

S. No.	Focus Areas	Technology	Electricity Savings kWh/t of product	Fuel Savings GJ/t of Product	CO_2 Reduction Kg-CO_2/tonne of Product
1	Raw Material & Iron Ore Agglomeration	Sinter Plant Heat Recovery (Steam Recovery from Sinter Cooler Waste Heat)	-	0.251/t-sinter	23.9/t-sinter
2		Sinter Plant Heat Recovery (Power generation from sinter cooler waste heat)	22.1 kWh/t-sinter	-	19.9/t-sinter
3		High Efficient (COG) Burner in Ignition Furnace for Sinter Plant		0.011 /t-sinter	0.50 /t-sinter
4	Coke Making	Coke Dry Quenching (CDQ)	150 kWh/t-coke	1.9/t-coke	210/t-coke
5		Coal Moisture Control (CMC)		0.3/t-coke	27.6/t-coke
6	Iron making	Top Pressure Recovery Turbine (TRT)	50 kWh/t-pig iron		45.0 /t-pig iron
7		Pulverized Coal Injection (PCI) System		1.55 /t-pig iron	147 /t-pig iron
8		Hot Stove Waste Heat Recovery		0.08 /t-pig iron	7.8 /t-pig iron
9	Steel Making	Converter Gas Recovery Device		0.84 /t-steel	79.8 /t-steel
10		Converter Gas Sensible Heat Recovery Device		0.126 /t-steel	12.0 /t-steel
11		Ecological and Economical Arc Furnace	150 kWh/t-steel		135 /t-steel
12		Waste Heat Recovery from EAF	87.7 kWh/t-steel		78.9 /t-steel

S. No.	Focus Areas	Technology	Electricity Savings kWh/t of product	Fuel Savings GJ/t of Product	CO_2 Reduction Kg-CO_2/tonne of Product
13	Recycling and Waste Reduction	Rotary Hearth Furnace (RHF) Dust Recycling System		0.21 /t-pig iron	22.8 /t-pig iron
14		Regenerative Burner Total System for reheating furnace		0.17-0.21 /t-billet	16.2-20.0 /t-billet
15	General Application	Cogeneration (Including Gas Turbine Combined Cycle (GTCC))			56.1/t-steel
16		Power Recovery by Installation of Steam Turbine in Steam Pressure Reducing Line	4,308 MWh/y		

9.1 Sinter Plant Heat Recovery – Steam recovery from sinter cooler waste heat

Technology definition

This device recovers the sensible heat in the hot air with a temperature of 250 °C to 450 °C from sinter cooler. Its component comprises Boiler/economizer, pure water feed device, deaerator, and steam drum.

After heat exchange with sintered ores of 500 °C to 700 °C in the cooler, the exhaust gas is introduced to the boiler/economizer to generate steam and is recycled to the cooler. Unit recovery of waste heat is in the order of 60,000 kcal/t-sinter.

The sensitive heat can be recovered by one or more of the following ways:

- Steam generating in a waste heat boiler
- Hot water generating for local heating
- Preheating combustion air in the ignition furnace
- Power generating

Process flow chart

Figure 46: Steam recovery from sinter cooler waste heat

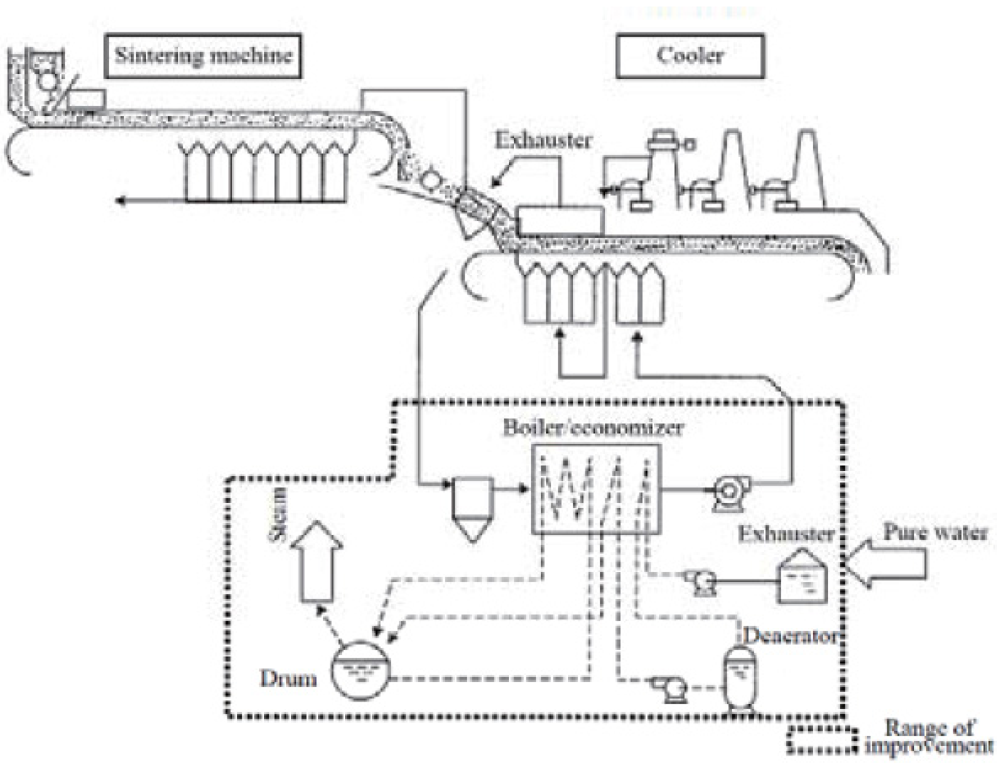


Table 26: **Steam recovery from sinter cooler waste heat**

Investment cost and operating life	Equipment cost: Approx INR 177 Crore Construction cost: Approx INR 30 Crore
Reduction of CO_2 emission	23.86kg-CO_2/t-sinter
Fuel saving	0.251 GJ/t-sinter
Payback time	7.6 years
Cost Saving	INR 15.3 Crore

9.2 Sinter Plant Heat Recovery – Power generation from sinter cooler waste heat

Technology definition

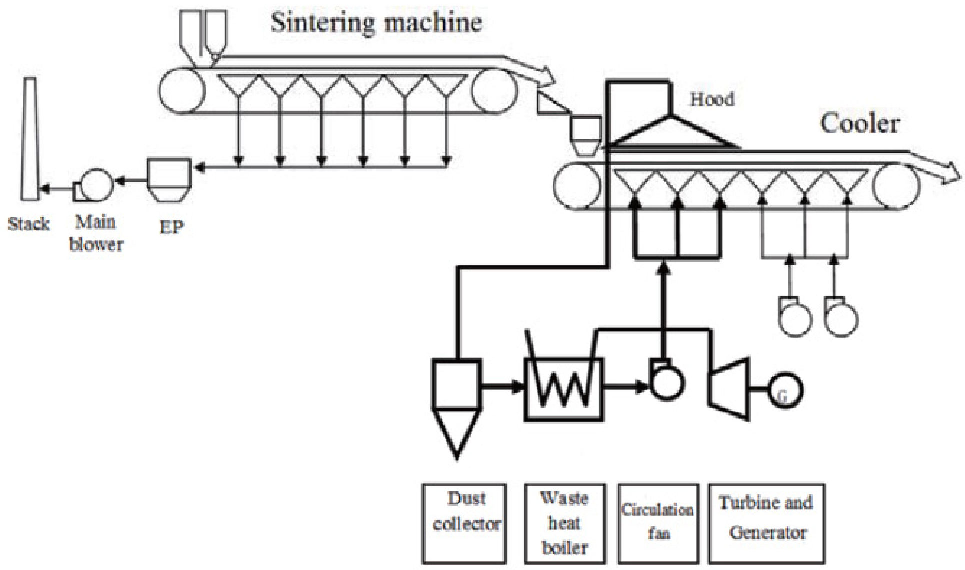
This technology is a waste gas sensible heat recovery system from sinter cooler to generate electric energy. The system is composed of dust collector, waste heat recovery boiler as steam, circulation fan and power generator by steam turbine. Details listed here are obtained from a system configuration of two identical sintering machines, each equipped with waste heat recovery boiler and one unit of electric power generator, to which the steam from two boilers is led.

Table 27: **Power generation from sinter cooler waste heat**

Investment cost and operating life	INR 295 Crores
Reduction of CO_2 emission	19.94 kg-CO_2/t-sinter
Fuel saving	0.235 GJ/t-Sinter
Payback time	5.5 years
Electricity Saving	22.1 KWh/t-Sinter

Process flow chart

Figure 47: **Power generation from sinter cooler waste heat**



9.3 High Efficient (COG) Burner in Ignition Furnace for Sinter Plant

Technology definition

The multi-slit burner is designed to form a successive and uniform frame along a pallet width direction in the ignition furnace. It consists of fuel exhaust nozzles and a slit-like burner tile containing these nozzles. The fuel, coke oven gas, supplied from the fuel exhaust nozzles, reacts with the primary air inside the burner tile, with the secondary air supplied to the periphery area of the frame.

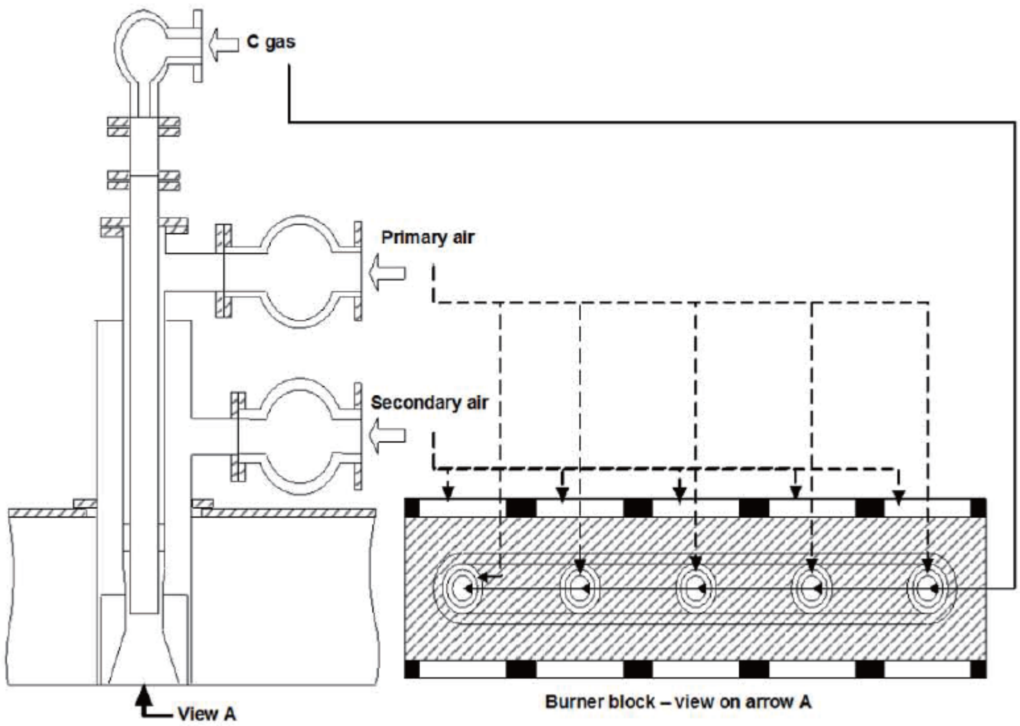
By lining up the burner block, the frame can cover the whole surface of the bed along the width direction. By controlling the primary/secondary air ratio, the length of the frame can be controlled to minimize the energy consumption for ignition.

Table 28: High Efficient (COG) Burner in Ignition Furnace for Sinter Plant

Reduction of CO2 emission	0.46 kg-CO2/t-sinter
Fuel saving	0.010 GJ/t-Sinter

Process flow chart

Figure 48: High Efficient (COG) Burner in Ignition Furnace for Sinter Plant



9.4 Coke Dry Quenching

Technology definition

The heat recovered by inert gas is used to produce steam, which may be used on-site or to generate electricity. Hot coke from the coke oven is cooled in specially designed refractory-lined steel cooling chambers by counters-currently circulating an inert gas media in a closed circuit consisting of:

- Cooling chamber
- Dust collecting bunker
- Waste heat boiler
- Dust cyclones
- Mill fan
- Blowing device (to introduce the cold air from the bottom)
- Circulating ducts
- Capacity

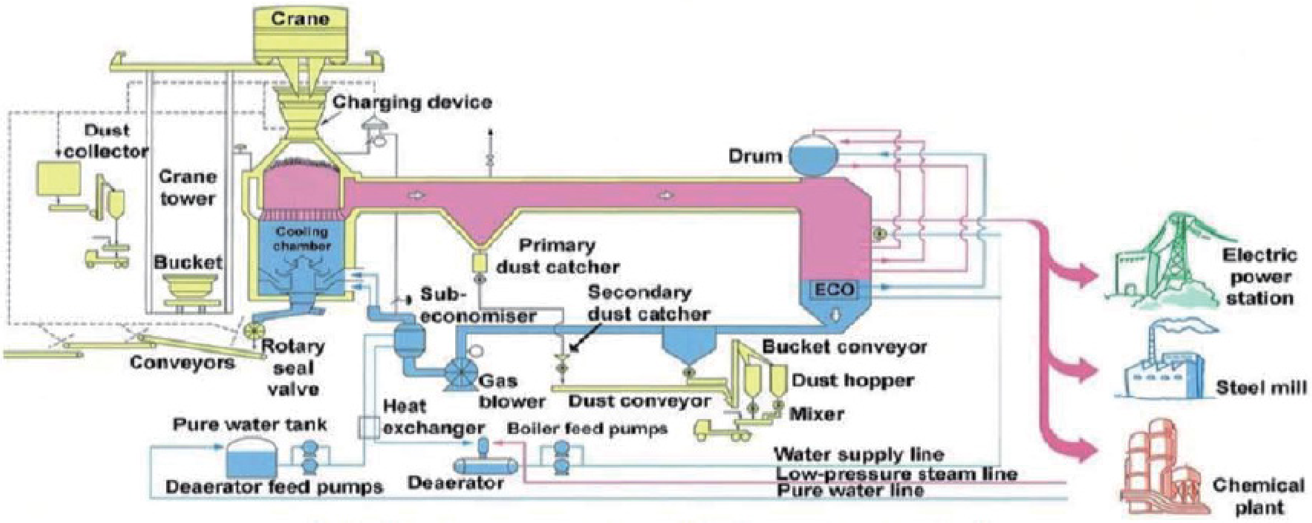
The nominal capacity of a typical CDQ plant is less than 100 t/h/chamber.

Table 29: Coke Dry Quenching

Investment cost and operating life	INR 207 Crores
Reduction of CO_2 emission	97.5 kg-CO_2/t-coke (as fuel) 74.9 kg-CO@/t-coke (as electricity)
Fuel saving	1.2 GJ/t-coke /heat usage
Payback time	4 years
Electricity Saving	1.47 GJ/t-coke/electric usage

Process flow chart

Figure 49: Coke Dry Quenching



9.5 Coke Moisture Control

Technology definition

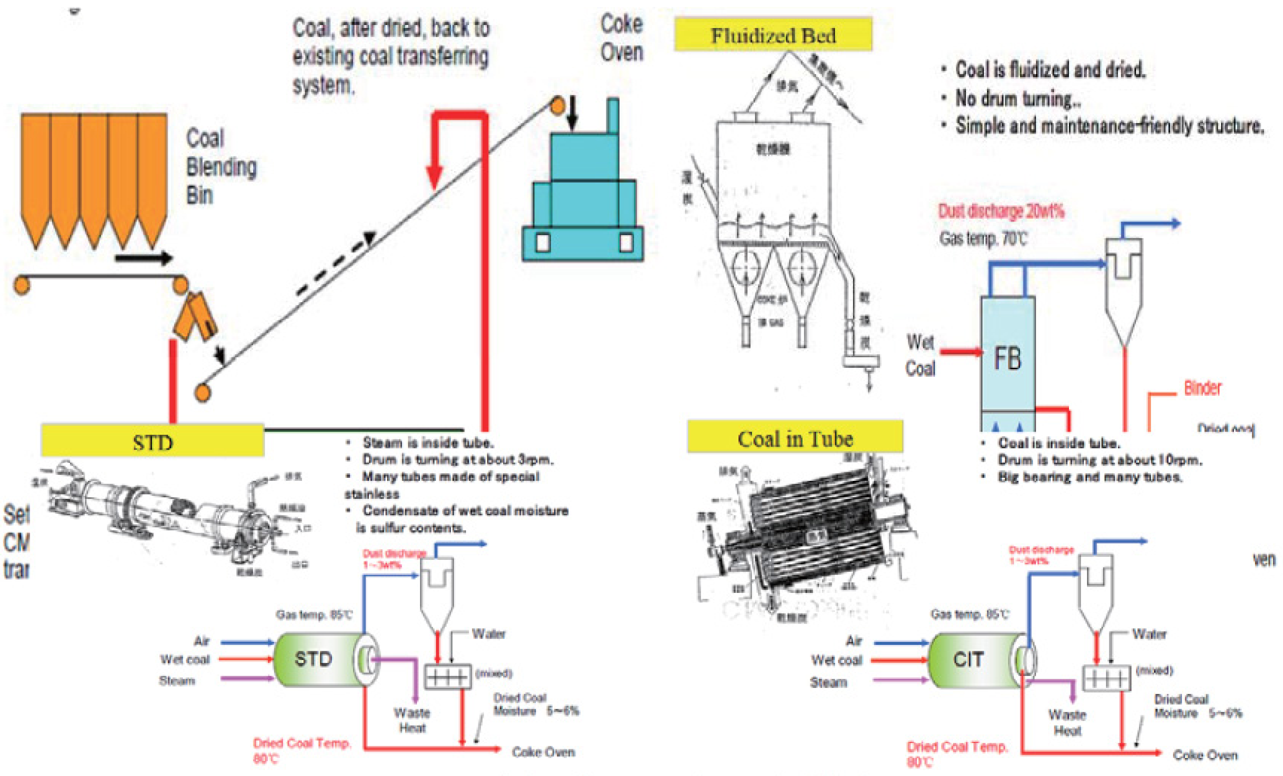
Coal moisture control uses the waste heat from the coke oven gas to dry the coal used for coke making. The moisture control of coal varies, but it is generally around 8-9% for good coking coal. Drying further reduces the coal moisture content 3-5%, which in turn reduces fuel consumption in the coke oven. The coal can be dried using the beat content of the coke oven gas or other waste heat sources, and generally, low-pressure steam is used as the humidity control heat source.

Table 30: Coke Moisture Control

Investment cost and operating life	Equipment cost: INR 118 Crore Construction cost: INR 30 Crore /450,000 t-coke/y
Reduction of CO_2 emission	27.5 kg-CO_2/t-coke
Fuel saving	0.3 GJ/t-coke
Product quality improvement	Coke quality improvement about 1.7%

Process flow chart

Figure 50: Coke Moisture Control



9.6 Top Pressure Recovery Turbine

Technology definition

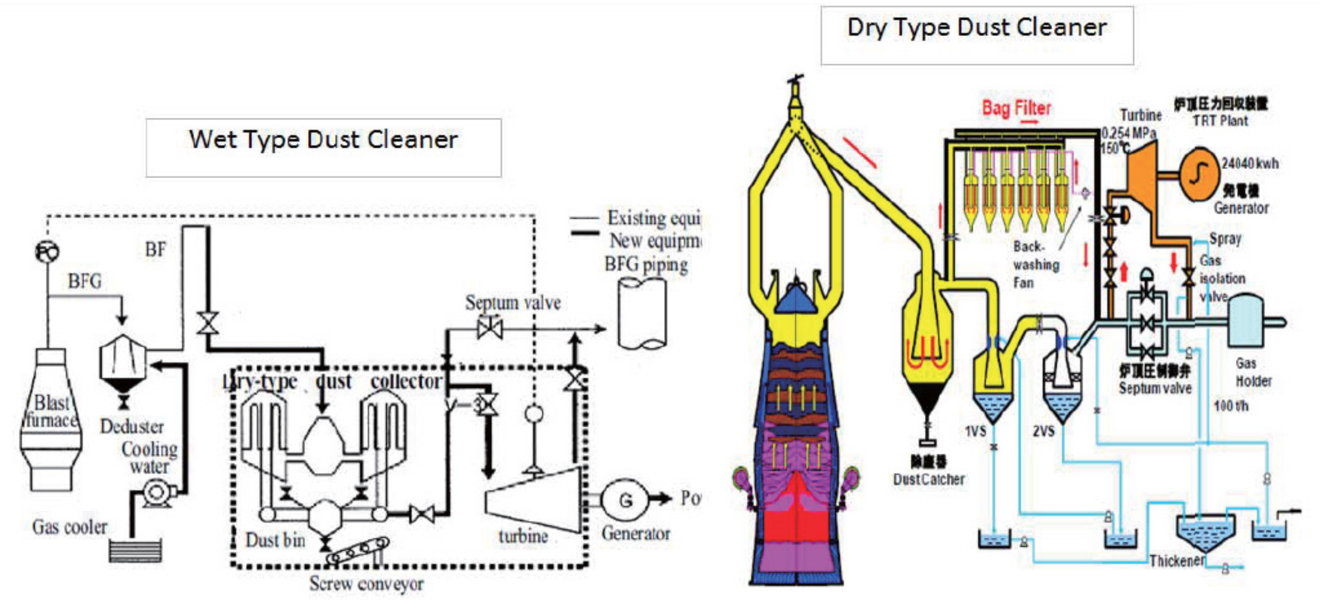
This system generates electric power by employing blast furnace top gas to drive a turbine generator. After the blast furnace gas is used in power generation, it is used as a fuel in iron and steel manufacturing processes. Blast furnace gas (BFG) has a pressure of 0.2-0.236 MPa (2-2.41 kg/cm_2) and temperature of approx 200˚C at the furnace top. This technology is a method of generating power by employing this heat and pressure to drive a turbine generator.

The system comprises dust collecting equipment, a gas turbine, and a generator. Generating methods are classified as (1) wet or (2) dry, depending on the gas purification method. Dust is removed by Venturi scrubbers in the wet method and by a dry-type dust collector in the dry method. When dust is treated by the dry method, the gas temperature drop is small in comparison with the wet method, and as a result, generated output is at maximum 1.6 times greater than it is with the wet method.

Table 31: Top Pressure Recovery Turbine

Investment cost and operating life	Equipment cost: INR 83 Crore (7 MW Generator) Construction cost: INR 24 Crore
Reduction of CO_2 emission	25.0 kg-CO_2/t-Pig Iron
Payback	4 years
Electricity Savings	0.49GJ/t-Pig Iron

Figure 51: Top Pressure Recovery Turbine



9.7 Pulverized Coal Injection (PCI) System

Technology definition

This system comprises a technology and equipment for injecting pulverized coal directly through the blast furnace tuyeres as partial substitute for the coke used in the blast furnace. Because pulverized coal is injected directly, the corresponding amount of coke is unnecessary, making it possible to reduce energy consumption for coke making (coke dry distillation energy).

This equipment comprises (1) coal receiving equipment, (2) pulverizing/drying equipment, (3) pulverized coal injection equipment, and (4) the instrumentation system.

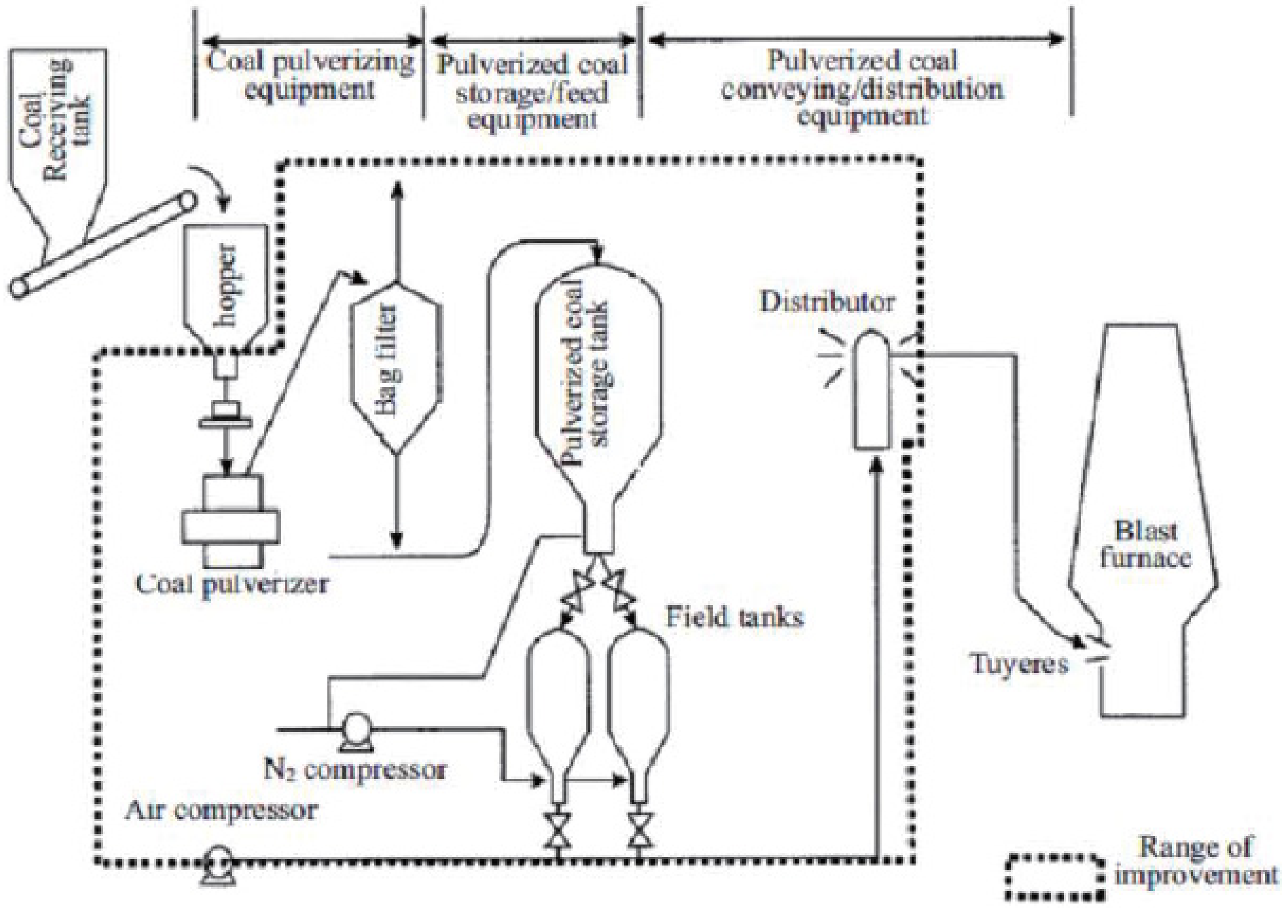
Non-coking coal is used as a partial substitute for coke (i.e., for coking coal). This coal is pulverized to a size of approximately 74 µm, classified using a bag filter, and conveyed to the pulverized coal storage silo. It is then supplied at the timing of injection in accordance with the injection rate. The injection tank is pressured with a compressor, and the pulverized coal is conveyed to the blast furnace tuyeres (charging holes) and injected into the blast furnace using this pressure. However, the type of coal used and the size of the pulverized coal will differ depending on the injection equipment and the blast furnace.

Table 32: Pulverized Coal Injection (PCI) System

Investment cost and operating life	Equipment cost: INR 89 Crore Construction cost: INR 30 Crore, based on blast furnace with 1 million t/y production
Reduction of CO_2 emission	147 kg-CO_2/t-PI
Fuel saving	1.55 GJ/t-pig iron

Process Flow

Figure 52: Pulverized Coal Injection (PCI) System



9.8 Hot Stove Waste Heat Recovery

Technology definition

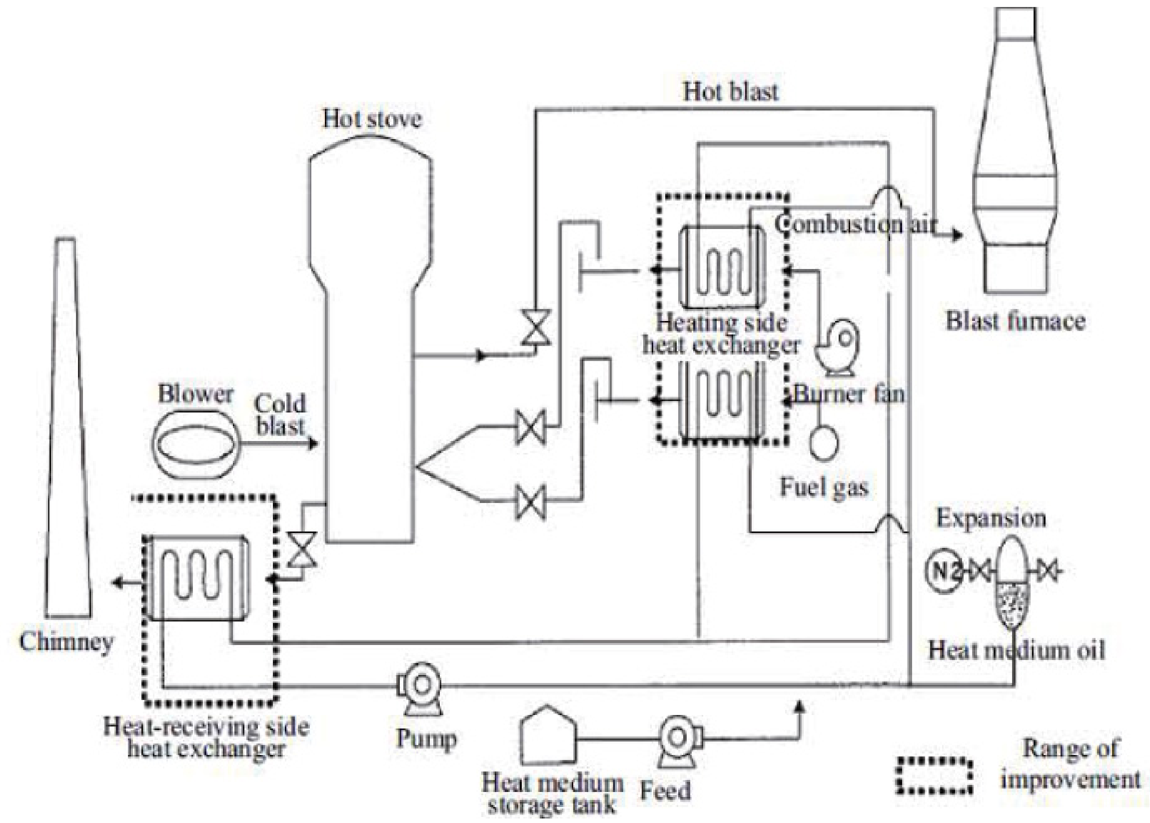
This device recovers the sensible heat of the flue gas generated in heating the hot stoves that supply hot blast to the blast furnace, and uses this heat in preheating fuel and combustion air for the hot stoves. Installation of this device improves the combustion efficiency of the hot stoves, thereby saving energy. This device comprises two heat exchangers. One is a heat receiving heat exchanger that receives the flue gas discharged from the hot stove; the second is a heating side heat exchanger that preheats the combustion air and fuel using the sensible heat of the flue gas received by the heat-receiving side heat exchanger. The preheated combustion air and fuel gas is supplied to the hot stoves. Heat exchange methods are classified as (1) rotary type, (2) plate type, and (3) heat pipe type, depending on the type of heat exchanger. The recovery rate of hot stove flue gas sensible heat with device is 40-50%.

Table 33: Hot Stove Waste Heat Recovery

Investment cost and operating life	Equipment cost: INR 8.9 Crore/ Blast furnace; 1 million t/y. (Plate type; includes civil construction and installation costs)
Reduction of CO_2 emission	7.6-8.1 kg-CO_2/t-hot metal
Fuel saving	Fuel savings vary between 80-85 MJ/t hot metal
Payback	2.8 years

Process flow chart

Figure 53: Hot Stove Waste Heat Recovery



9.9 Converter Gas Recovery Device

Technology definition/specification

Molten steel is produced by the convertor process. This device recovers and uses the high temperature waste gas generated in large quantity during blowing in the convertor (basic oxygen furnace: equipment used to produce crude steel from pig iron, steel scrap, etc.).

Accompanying this process, about 100 Nm³ of high temperature gas (CO) with a heating value of approximately 2,000 kcal/Nm³ is generated.

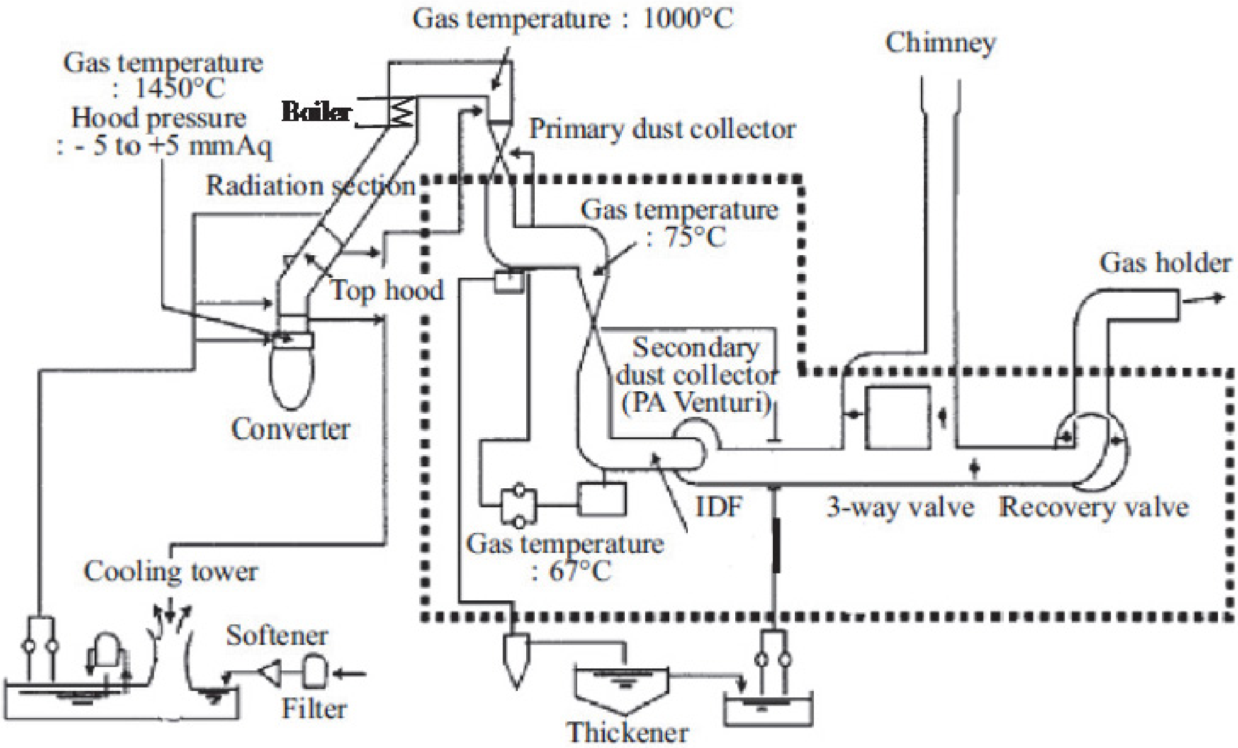
Heat recovery methods are classified as (1) combustion method (boiler method), and 2) non-combustion method (method of recovering gas in an unburned condition: OG method. The advanced type is called the closed OG method). Recently, the closed OG method has become the main stream. The converter gas recovered is mixed with other by-product gases (coke oven gas, blast furnace gas), then used by the heating equipment of the ironworks. Steam is mainly used by the degassing equipment of the steel making factory. Today, gas recovery systems are installed on every BOF in Japan.

Table 34: Converter Gas Recovery Device

Investment cost	Equipment cost: INR 35-65 Crore
Reduction of CO_2 emission	79.8 kg-CO_2/t-Crude Steel
Fuel saving	0.84 gJ/t-Crude Steel
Economic effect	80% of the BOF gas will be recovered, resulting in an annual energy savings of 2,600 TJ/yr, or approximately INR 960/GJ of investment. Payback is about five years, taking into account the savings in the purchase of natural gas and exploitation costs

Process flow chart

Figure 54: Converter Gas Recovery Device



9.10 Converter Gas Sensible Heat Recovery Device

Technology definition

Molten steel is produced by the converter process. This device recovers and uses the high temperature waste gas generated in large quantity in blowing in the converter (basic oxygen furnace: equipment used to produce crude steel from pig iron, steel scrap, etc.). Accompanying this process, about 100 Nm_3 of high temperature gas (CO) with a heating value of approximately 2,000 kcal/Nm_3 is generated.

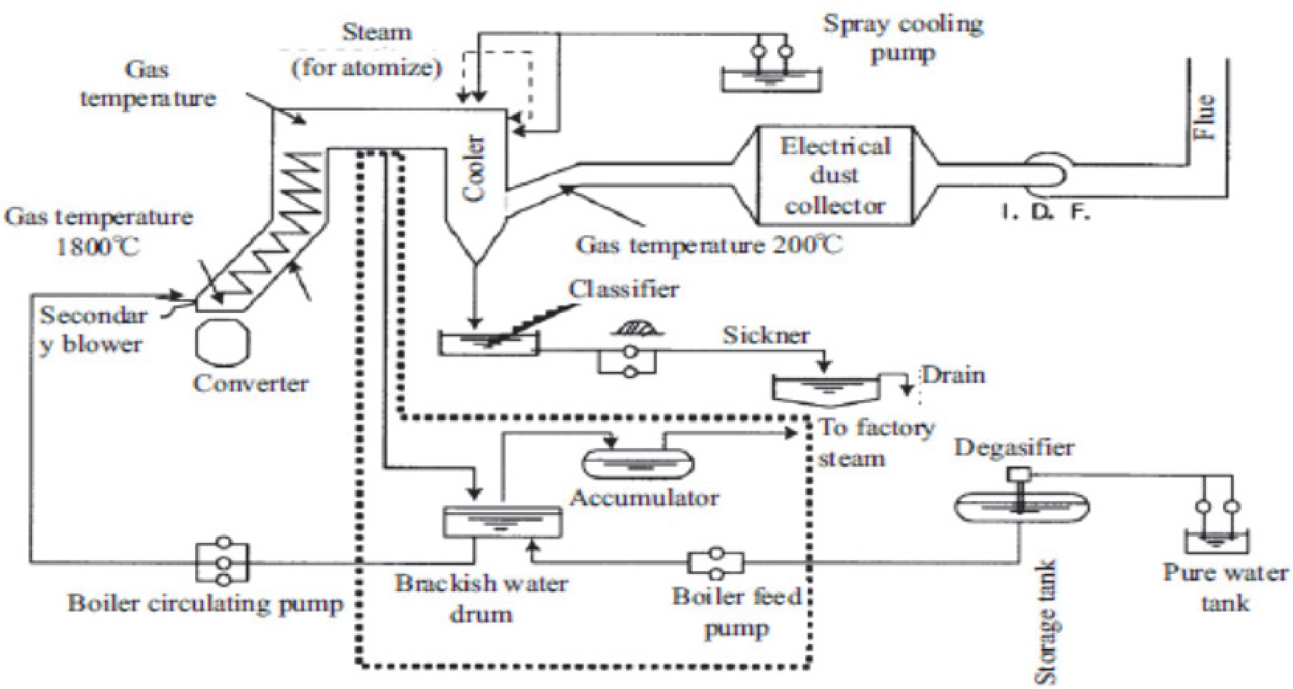
This device recovers and makes efficient use of the converter gas sensible heat. While the converter waste gas recovery device recovers the waste gas itself, this device burns the converter waste gas to transform latent heat to sensible heat and recovers the energy as sensible heat. Therefore, it is structured to have a sufficient space between the converter and the hood so that sufficient air can be supplied from the secondary air blower for combustion. Principal equipment are the brackish water drum, the accumulator, and the boiler, etc.

Table 34: Converter Gas Recovery Device

Investment cost	Equipment cost: INR 35 Crore (Equipment for 110 t/charge converter scale; includes construction cost) converter capacity: 110 t/charge
Reduction of CO_2 emission	12.0 kg-CO_2/t-Crude Steel
Fuel saving	0.126 GJ/t-CS

Process flow chart

Figure 55: Converter Gas Sensible Heat Recovery Device



9.11 Ecological and Economical Arc Furnace

Technology definition

The off-gas from ECOARC includes a large volume of combustible ingredients, which minimizes the necessary amount of fuel for post-combustion. The off-gas volume itself is also minimized by the use of a semi-airtight furnace and off-gas dusts.

The ECOARC system consists of:

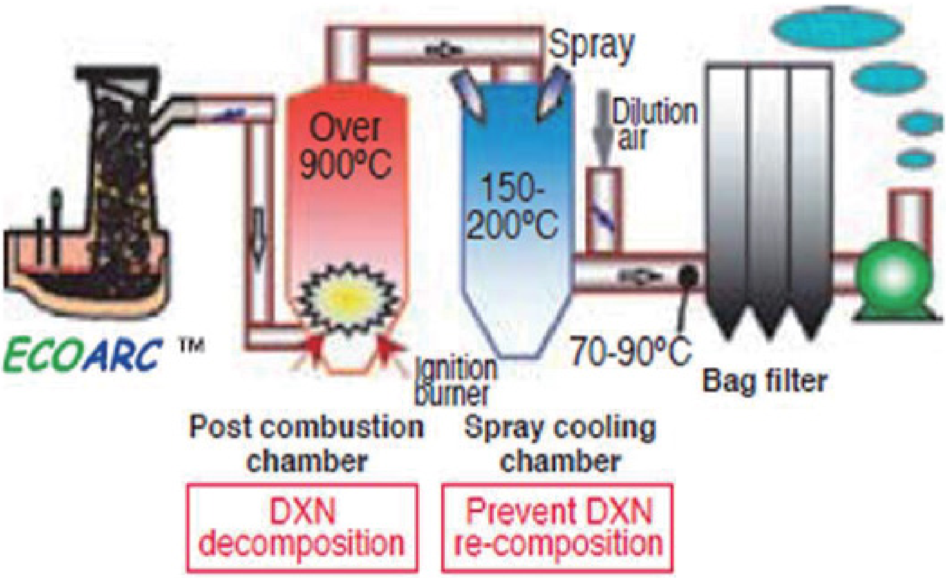
- Scrap charging facilities
- Scrap preheating duct by using off-gas
- Post-combustion chamber for DXN decomposition
- Spray cooling chamber for prevention of DXN re-composition
- Dust collector by Bag filter

Table 36: Ecological and Economical Arc Furnace

Reduction of CO_2 emission	15%
Electricity Savings	200 KWh/t-steel at 40 Nm³/t-steel oxygen

Process flow chart

Figure 56: Ecological and Economical Arc Furnace



9.12 Waste Heat Recovery from EAF

Technology definition/specification

The waste heat of the electric arc furnace exhaust gas (especially the furnace for DRI melting) is recovered as steam, hot water or electric energy. The electric arc furnace for melting DRI (direct reduction iron) discharges approximately 430 kwh/t-s of exhaust gas, while taking 1,050 kwh/t-s of heat in total. By introducing the steam or hot water recovery boiler to the duct, discharging this gas, approximately 130 kwh/t-s of energy can be recovered (efficiency 30%).

The steam thus recovered can be directly used for power generation, sea water desalination, freezers, air separation, degasification systems, etc. It is also possible to make superheated steam to enhance the power generation efficiency (operational control by combining multiple electric furnaces, control by combining exhaust heat boilers with auxiliary burners, etc.).

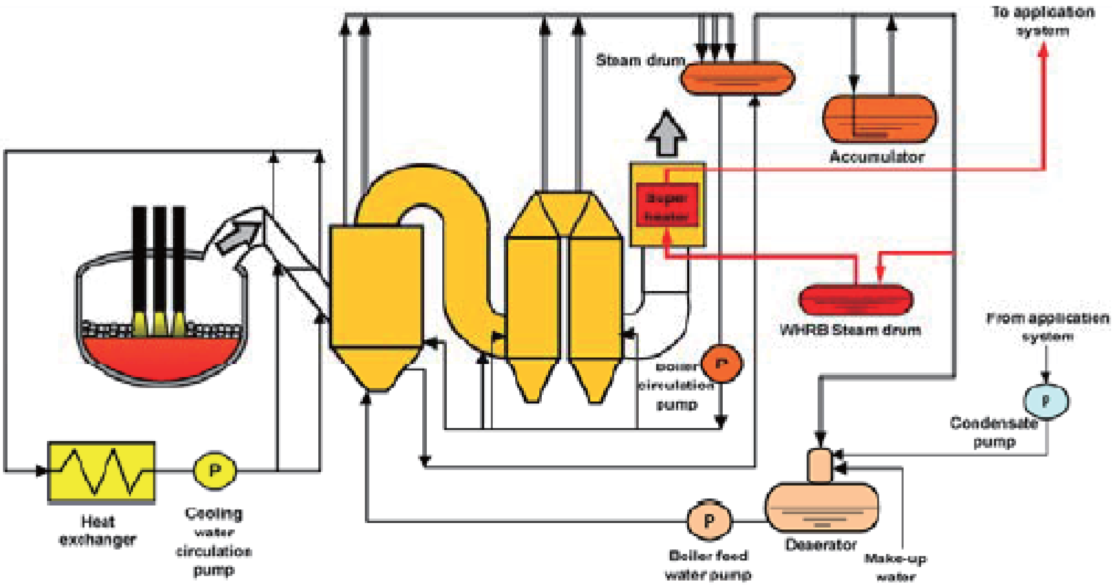
The exhaust gas cooling duct for the electric arc furnace is directly used as a steam generation boiler, and the sensible heat from the exhaust gas of approximately 1,100°C recovered. The steam intermittently generated by the intermittent operation of the electric arc furnace is smoothed by accumulator and supplied to the equipment using steam. For the power generation by the superheated steam, the steam superheated and the exhaust heat with an auxiliary burner are additionally installed downstream to conduct combined operational control.

Table 37: Waste Heat Recovery from EAF

Investment cost and operating life	Equipment cost: INR 8.9 Crore/ Blast furnace; 1 million t/y. (Plate type; includes civil construction and installation costs)
Reduction of CO_2 emission	78.9 kg-CO_2/t-hot metal
Electricity saving	87.7 kWh/t-steel
Payback	2.8 years

Process flow chart

Figure 57: Waste Heat Recovery from EAF



9.13 Rotary Hearth Furnace Dust Recycling System

Technology Definition

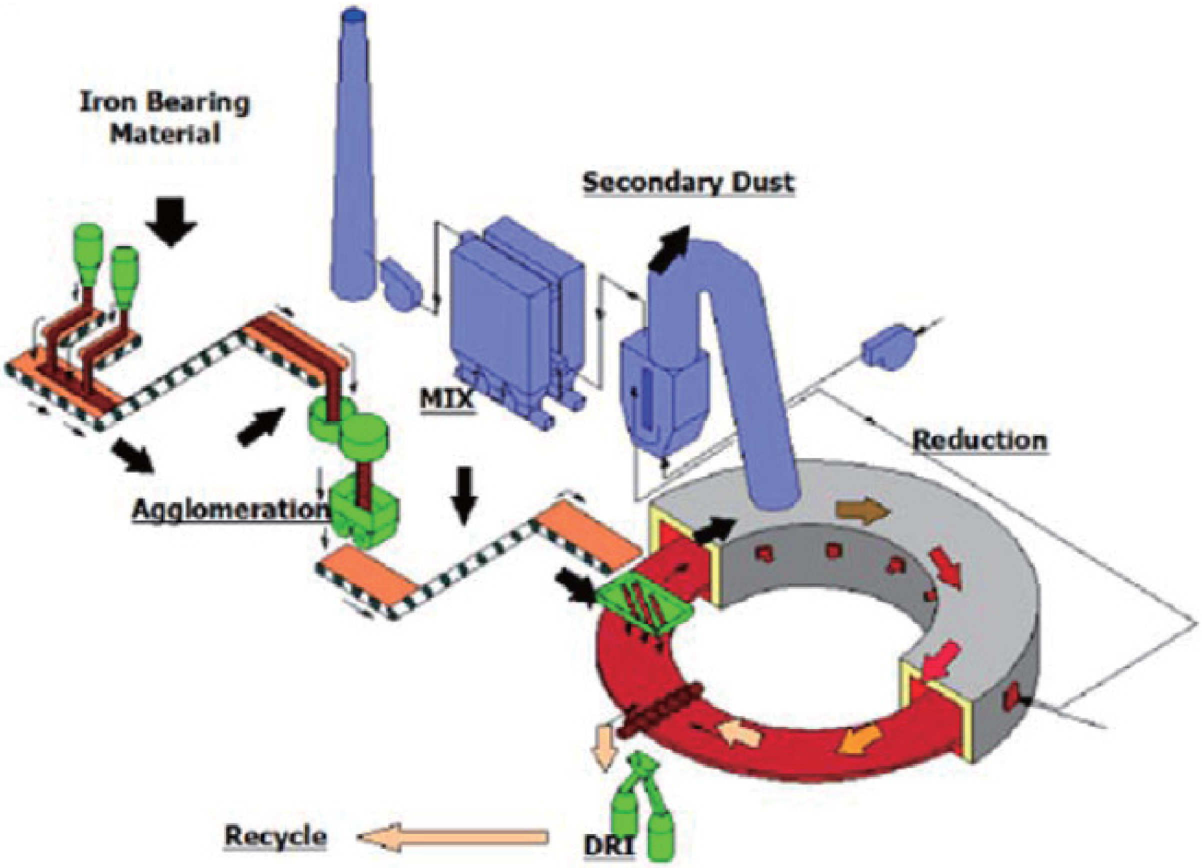
Dust recycling in the rotary hearth furnace (RHF) was applied at Nippon steel in 2000. The dust and sludge, along with iron oxide and carbon, are agglomerated into shaped article and the iron oxide is reduced at high temperature. Zinc and other impurities in the dust and sludge are expelled and exhaust once into off-gas. The exhaust gas containing zinc is cooled using a boiler and remunerator and then, the secondary dust containing zinc is collected.

Table 38: Rotary Hearth Furnace Dust Recycling System

Reduction of CO_2 emission	22.8 kg-CO_2 / t-pig iron
Fuel saving	0.21 GJ / t-pig iron

Process flow chart

Figure 58: Rotary Hearth Furnace dust recycling System



9.14 Regenerative Burner Total System for Reheating Furnace

Technology definition

A Burner with Regenerator ensures highly efficient, selectable thermal storage:

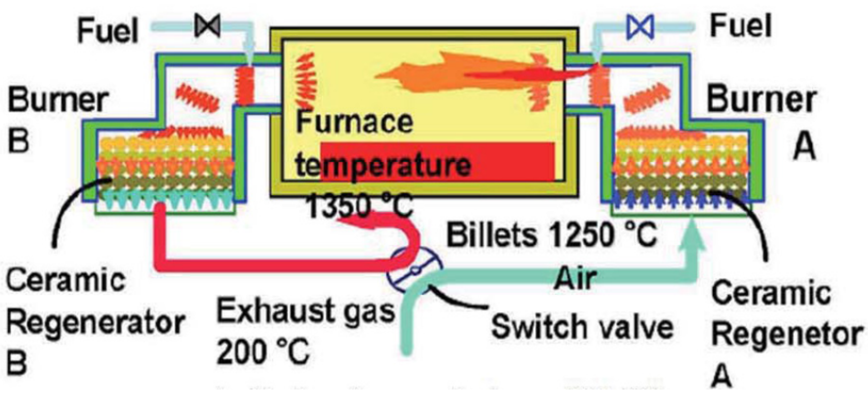
- The burner body is compact and of mono-block construction, incorporating a value to select air or exhaust gas.
- The whole system can be downsized with a reduction in cost.
- This product is applicable to compact high-temperature furnace where the introduction of conventional regenerative systems is difficult.
- The regenerative media uses an alumina ball that is economical and excellent in heat resistance and corrosion resistance.
- The product is ideal for forge furnace, open flame heat treatment furnace, nonferrous metal melting furnaces, and other high-temperature furnace that are comparatively compact in capacity.

Table 39: Regenerative Burner Total System for Reheating Furnace

Reduction of CO_2 emission	16.2-20.0 kg-CO_2/t-billet
Fuel saving	0.17-0.21 GJ/t-steel billet [1.7-2.0 Crore]

Process flow chart

Figure 59: Regenerative Burner Total System for Reheating Furnace



9.15 Cogeneration (Including Gas Turbine Combined Cycle (GTCC))

Technology definition

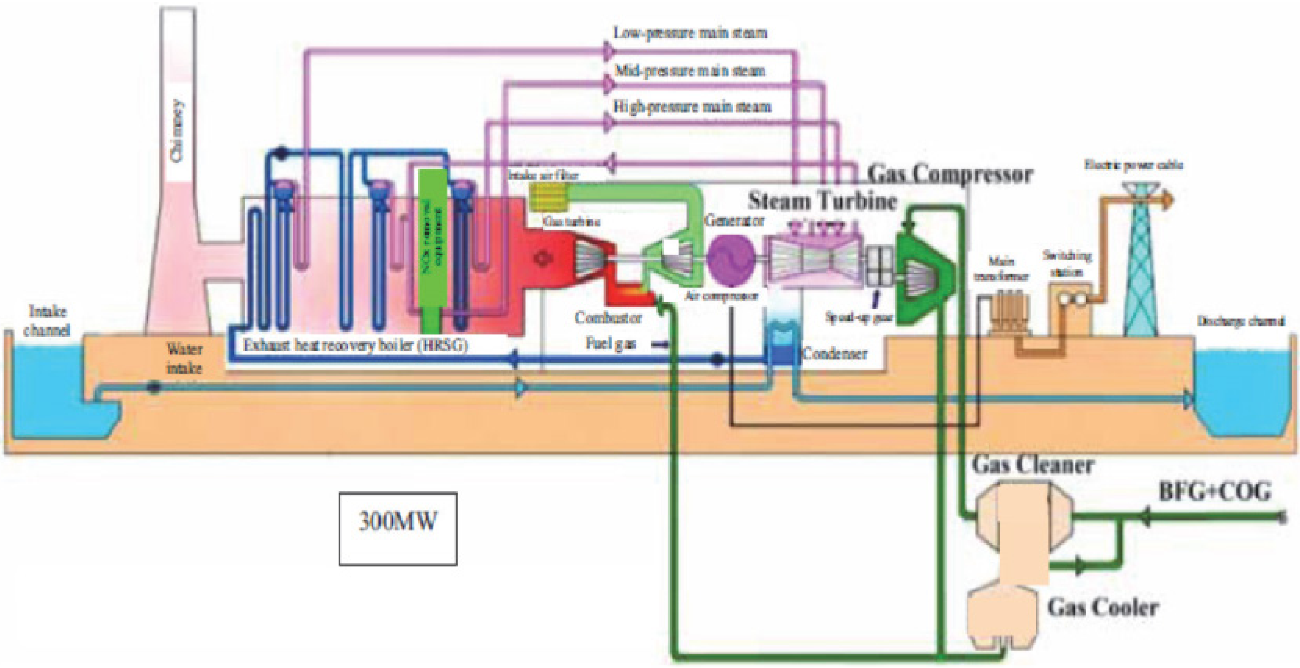
This equipment is a high-efficiency (47.5%, HHV Base) combined generator set using the by-product gas produced during iron and steel manufacturing process as the fuel.

This equipment is an iron and steel by-product gas fired combined generator set, in which the gas turbine is operated by high-temperature gas (1,300⊠) generated by mixing the blast furnace gas with the coke oven gas with a heat amount of 4,400 kJ/Nm³ and burning it after the pressure is increased to about 1.4MPa. At the same time, the steam turbine is operated by the steam generated by directing the high-temperature (approx. 550⊠) gas discharged from the gas turbine to the exhaust heat recovery boiler.

Table 40: Cogeneration (Including Gas Turbine Combined Cycle (GTCC))

Investment cost and operating life	Turbine systems: Approx. INR 70,000/kW. Total investment costs estimated to be INR 1,000/t crude steel.
Reduction of CO_2 emission	56.1 kg⊠CO_2/t-PI
Electricity saving	Increased electricity generation of 1.1 GJ/t crude steel.

Figure 60: Cogeneration (Including Gas Turbine Combined Cycle (GTCC))



9.16 Power Recovery by Installation of Steam Turbine in Steam Pressure Reducing Line

Technology definition/specification

In cases where high pressure steam generated by a boiler is used by pressure reduction, this technology reduces refrigerator power consumption by installing a steam turning in place of the steam pressure reducing valve and driving the refrigerator with the power recovered by the steam turbine. Although steam consumption is increased somewhat, a total energy saving is achieved.

Principle, operation and features of technology:

In Figure 61, the capacity of the boiler installed was approximately steam pressure: 12 kg/cm2 and steam output: 50 t/h. However, this steam was used as process steam after pressure reduction. In one case, the reduced-pressure conditions were 10 kg/cm2 and 28t/h, and in another, 4 kg/cm^2 and 22t/h (approximate values). That is, steam at a pressure of 12 kg/cm^2, was reduced to 10 kg/cm^2 and 4 kg/cm^2 by pressure reducing valves. In Figure 27, a steam turbine is used in place of a pressure reducing valve, and the system was modified so that a refrigerator is driven by the rotational force of the turbine using steam as a power source. Pressure reducing valves reduce pressure by causing a pressure loss when the valve port in the valve is restricted, utilizing the difference in enthalpy drop due to adiabatic restriction. The principle of the steam turbine is the same as this, in that power is generated by utilizing the difference in enthalpy drop. The energy saving by adoption of this system is as follows: Reduction of electric power consumption – fuel for increase of steam consumption = Energy saving.

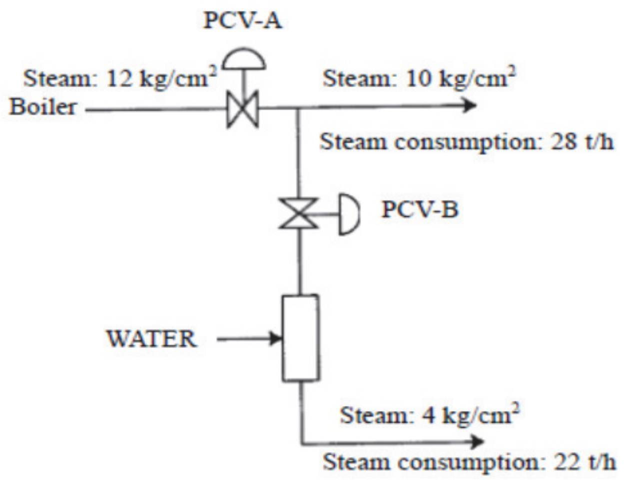
Table 41: Power Recovery by Installation of Steam Turbine in Steam Pressure Reducing Line

Investment cost and operating life	Approx. 50 million (equipment), approx. 20 million (construction).
Electricity saving	544 (approx.) kW →⊠544 kW*24 h*330 d/y=4,308 MWh/y

Process flow chart

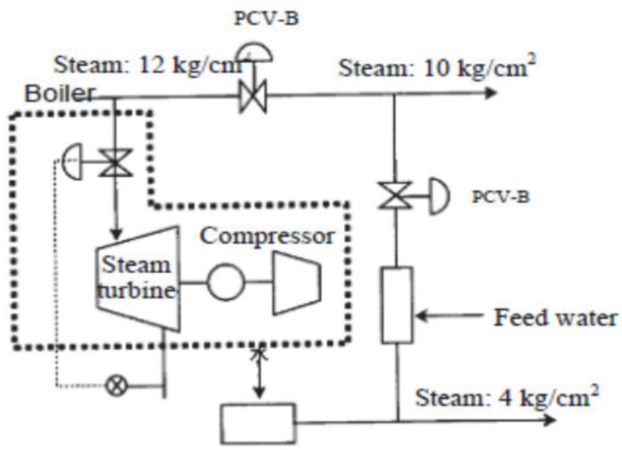
Steam pressure reducing system before improvement:

Figure 61: Steam pressure reducing system before improvement



System after improvement by introduction of steam turbine:

Figure 62: System after improvement by introduction of steam turbine



10. Conclusion

The Iron & Steel sector is of paramount value in supporting growth in various sectors. With increase in economic activity, the demand for steel is expected to go up by at least two times by 2030. For this energy-and GHG-intensive sector, it is imperative that steel produced in 2030 has a much lower environmental footprint than it does today.

The current levels of energy performance in the Indian steel sector are lower than those of the best performing plants globally. It can be concluded that the Indian steel sector has the potential to improve its energy performance by 40%. This performance improvement can be achieved by implementing new technology upgradation projects and ensuring that the new capacity additions have all the latest technologies and practices that ensure the best energy efficiency levels.

The GHG emissions from the Iron & Steel sector are in the range of 2.6-3.1 T CO_2/t steel. In addition, the sector's high dependence on fossil fuels necessitates certain actions and strategies to decarbonize the sector in the long-term, if the Paris Agreement is to be honoured. The efficiency programs will result in reduction of CO_2 emissions, but because of the fuel input and process emissions, the sector would not be able to eliminate the emissions completely. This necessitates application of new and emerging process technologies, such as using Hydrogen (H_2) in place of Pulverised Coal Injection (partial replacement of Coke) or Hydrogen-based direct reduction (complete replacement of coal).

Tapping the energy efficiency and other decarbonisation opportunities requires existing plants to adopt/retrofit the current processes and technologies, or install new capacity additions with best available technologies and practices. The adoption of said measures and their impacts will differ based on current technology, technical feasibility, raw material & fuel quality, availability and cost of scrap, market demands, etc. Moving forward, the energy efficiency and decarbonization approach will be driven by the following key aspects:

Figure 63: **Enablers – Decarbonisation in Iron & Steel Sector**

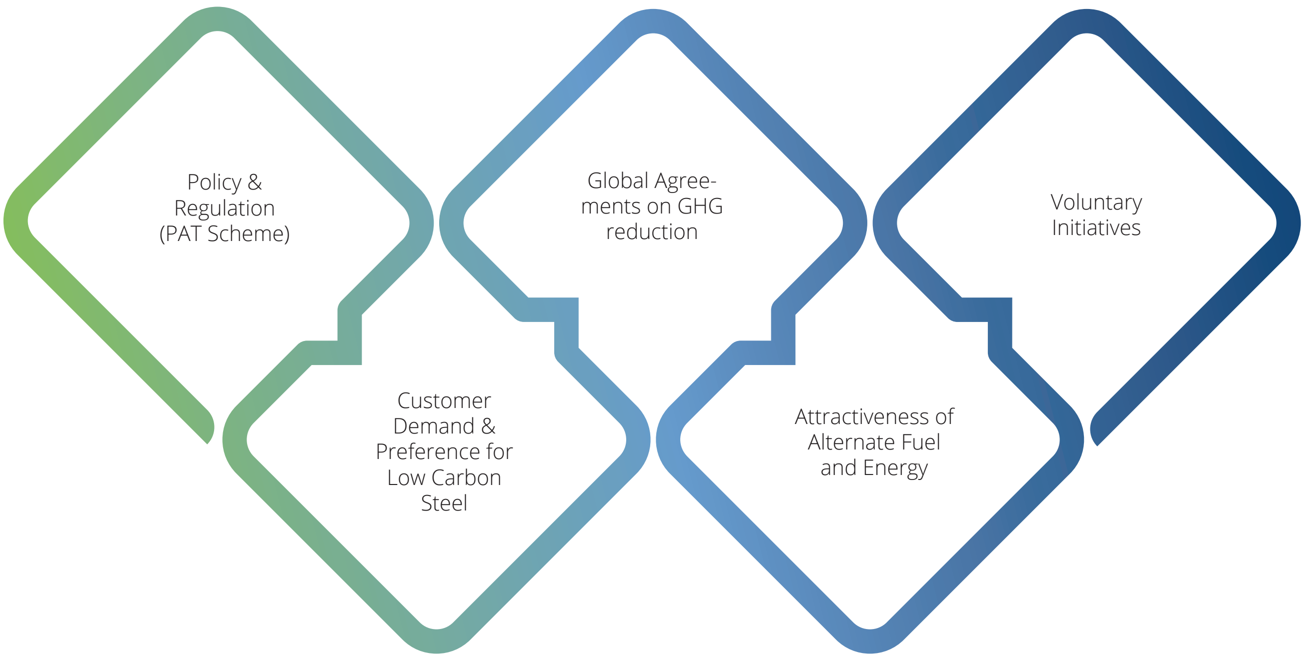


Figure 64: Enablers – Decarbonisation in Iron & Steel Sector

Key recommendations to tap energy efficiency potential and enable deep decarbonisation in the sector are as follows:

Recommendation 1	Focused Program on Energy Efficiency in BF-BOF Route
Current Status: In short to medium term (10-15 years), the major impact reduction (EE & GHG) in the sector can be driven by implementation of the energy efficiency program in BF-BOF route. Currently, the average energy consumption in Indian steel plants is 6.6 GCal/TCS, and in the best operating plant in India around 5.6 GCal/TCS. Upon comparison with the BAPT performance, potential is seen to improve energy performance by 40-45%. In India, steel production through BF-BOF route is around 45% and is expected to increase to 50-55% with addition of new capacities. This way, energy efficiency improvements can yield significant benefits. At present, many opportunities such as application of Waste Heat Recovery, installation of pressure recovery turbine, use of coke oven gas, etc., are yet to be tapped by the majority of plants; implementation and adoption of such technologies can improve the energy efficiency.	
Action: The Ministry of Steel, Government of India, Bureau of Energy Efficiency and other industry stakeholders can develop an Energy Efficiency Action Plan for the BF-BOF sector, and can identify technology options and levers to improve energy efficiency. The government can provide necessary support in terms of incentives to implement such measures in the plant. In addition, the new expansion and capacity additions can be planned with best available technologies and better efficiency than current operations. The focus of the program can be on Key Performance Indicators such as BF productivity, BF Coke Rate, specific energy consumption, and specific GHG emissions, in line with the global benchmarks.	
Outlook: The energy efficiency program can yield GHG reduction in short-medium term and can play an important role in achieving global targets. However, these measures will not eliminate the GHG emissions from the process completely. Many technologies are being implemented by the steel industry with support from Ministry of Steel and other international organisations such as New Energy & industrial technology Development Organisation (NEDO), Japan. These technologies are readily available and can be implemented by the steel plants in their existing plants (depending on the technical feasibility) and in their new plants. In the long term, the energy efficiency program can help the steel plants achieve 5 GCal/TCS (average) by 2040, resulting in improvement of energy performance by 8% as compared to baseline scenario.	

Recommendation 2	Creating Demand for Low Carbon Steel
Current Status: A tonne of steel produced in India has 40-60% higher emissions than the global average. The emissions are on the higher side primarily due to energy efficiency levels, quality of raw material, and availability of scrap and other materials. However, there is a growing awareness among consumers of the impact of the products they use, and of new GHG reduction ambitions, such as net zero carbon and carbon neutrality across the value chain. The steel sector can take this as an opportunity and create a market of Low Carbon Steel, with lower emissions. This can enable the sector to adopt new and emerging technologies to bring down the emissions for steel production, by adopting various measures such as energy efficiency, utilization of scrap, alternate fuel, etc. The customer demand and customer requirements for Low Carbon Steel can act as a pull strategy for the sector and as a complimentary initiative to ongoing initiatives by the Ministry of Steel and Bureau of Energy Efficiency, for improving energy efficiency and GHG emission reductions in the sector.	
Action: The Ministry of Steel and other industry stakeholders can start a voluntary initiative on Low Carbon Steel, where the steel products with lower carbon footprint are recognized. An ecosystem can hence be created where consumers can make informed decisions about steel products. The standards for Low Carbon Steel can be regularly updated to reflect the developments in technology and practices. This initiative can also help the sector reach out to new markets and consumers, and help improve the competitiveness of the steel sector in the long term.	
Outlook: The demand for Low Carbon Steel is expected to increase as many users of steel are now aiming to reduce their GHG impacts across the value chain. Sectors such as Buildings and Automobiles, which are major users of steel, are planning to achieve Net Zero Carbon in the long term, and the steel sector can play a critical role in the success of such initiatives.	

Recommendation 3	Energy Efficiency in DRI-EAF and Scrap Utilization in DRI-EAF
Current Status: The DRI-EAF route share in India has also increased over the years, mostly driven by medium size companies. Currently, the average energy consumption in Indian steel plants is 7.07 GCal/TCS (DRI-EAF). In comparison with BAPT performance, there is potential to improve energy performance by 40-45%. In addition to that, though the gas-based DRI has better performance (energy & GHG), the utilization has been on the lower side, due to lack of gas availability where major steel plants are located. At present, many opportunities such as application of Waste Heat Recovery, high efficiency burners, application of VFD, increase utilisation of scrap, etc., are yet to be tapped by the majority of plants; implementation and adoption of such technologies can improve the energy efficiency.	
Action: Energy Efficiency: The Ministry of Steel, Government of India, Bureau of Energy Efficiency and other industry stakeholders can develop an Energy Efficiency Action Plan for the DRI-EAF sector and can identify technology options and levers to improve the energy consumption. The government can provide necessary support in terms of incentives to implement such measures in the plant. In addition, the new expansion and capacity additions can be planned with best available technologies and better efficiency than current operations. Scrap utilization in EAF/IF: Utilization of more scrap in EAF/IF (coupled with Green Power) can result in significant reduction of energy and GHG emissions. However, increasing the share of scrap-based EAF/IF requires availability of high-quality scrap and renewable energy. The focus of the program can be on Key Performance Indicators such as kCal/t sponge iron, kWh/t, utilization of waste heat recovery, etc.	

<table>
<tr><th>Recommendation 3</th><th>Energy Efficiency in DRI-EAF and Scrap Utilization in DRI-EAF</th></tr>
<tr><td colspan="2">Outlook: In India, DRI-EAF/IF share has significantly increased in the last 10 years, and with lower investment and gestation period, more capacity will be added in the future.

With various Government initiatives planned in the direction of resource efficiency and existing stock, the availability of scrap will encourage many players to implement and plan DRI-EAF production.

As India will have around 40-50% production from this route by 2040 (based on current analysis), the energy efficiency and utilization of scrap can play an important role in accelerating the shift towards decarbonisation.</td></tr>
</table>

<table>
<tr><th>Recommendation 4</th><th>Hydrogen Based Green Steel Production</th></tr>
<tr><td colspan="2">Current Status: Hydrogen as alternate fuel in steel production is among the most impactful measures to reduce the GHG emissions from steel process. The use of Hydrogen in BF-BOF route can yield partial GHG reduction, but for the DRI-EAF route, H_2 can completely replace the coal use in the direct reduction process, thus resulting in significant GHG reduction. Globally, there have been pilots for demonstrating the use of Hydrogen as fuel for steel production, but in Indian steel plants, the demonstrations have not been initiated yet.

The success of Hydrogen-based steel production also depends on availability of renewable power at reasonable price, the price of electrolyzers, and the generation source of Hydrogen. Presently, there are three routes – Grey Hydrogen – Fossil Fuel based generation (Steam – Methane reforming), Blue Hydrogen (fossil fuel based generation + Carbon Capture & Storage) and Green Hydrogen – Hydrogen produced through electricity-intensive electrolysis of water (electricity using renewable energy sources).

Green Hydrogen based steel production (DRI-EAF-H_2) can yield the maximum reduction of GHG emissions, and can produce nearly carbon neutral steel. However, the success of the initiative is dependent on generation of Green Hydrogen using renewable energy sources.</td></tr>
<tr><td colspan="2">Action: In the long term, Hydrogen based steel production will drive decarbonization in the sector. However, it is important that the country should be prepared for it, and when these technologies become technically and commercially feasible, the steel plants should adopt them quickly.

The Government can start working out the Roadmap for Hydrogen Application in the steel sector, and support the industry – including large and medium steel plants in implementation of pilots for demonstration of such technologies. As India already has 55% of crude steel through DRI-EAF-IF route, the Hydrogen application in the sub-sector can play an important role in driving the decarbonization of steel production.</td></tr>
<tr><td colspan="2">Outlook: The use of renewable energy in Hydrogen production is crucial. The success of the initiative will depend on government support and price of Green hydrogen, which is high today but is expected to decrease rapidly over time, with increase in commercial applications.

Since capital investment decisions are made for the long term, and since industrial sites have a lifespan of many decades, it is important that actions towards utilisation of Hydrogen are taken from now on, to ensure an effective transition of the steel sector towards “Green Steel” production.</td></tr>
</table>

Recommendation 5	Demand Shift
Current Status: The average capacity utilization of these large steel plants is 77%, which means large steel producers are not utilizing the fullest capacity for ~2,000 hrs in a year. Average annual peak hour restriction from grid is calculated to be ~1,500 hrs. (Average 4 hrs per day). Similarly, most of the captive power plants in the steel sector are not utilized to their fullest capacity. The average Plant Load Factor (PLF) of the captive power plant of big steel producers is 79%. Most of the captive power plants, including waste heat power generation of steel plants, are not able to inject the excess power to the State transmission system due to the current regulatory framework.	
Action: By shifting the non-essential load from steel plant operation during the peak hours, steel plants can export the surplus power to grid. For the large steel producers alone, possible load shifting works out to be 1.7 GWh of plant load. Increasing the average Plant Load Factor (PLF) of the captive power plant will lead to 1,160 MW of additional generation that can be exported to the grid to support the peak requirement. In total, large producers of steel can export ~3 GW of power to the grid and support peak hour demand in the electrical system. Support in enabling regulation for Power Purchase Agreement (PPA) for the CPP who have the ability to export the excess power to grid.	
Outlook: Excess power available due to shifting the non-essential load from steel plant, and increased average Plant Load Factor (PLF) of the captive power plant, can help meet the deficit power during the peak hours, which was 1.3 GW in the year 2019-20, and, potentially, can reduce peak power purchase costs for an additional ~1.5 GW. For a typical large captive power plant (above 25 MW), electricity generation cost is generally below INR 5.0/kWh, depending on the type of fuel and location of the plant. On the other hand, electricity tariffs across key industrial states go as high as ~INR 8.0/kWh, which proves strong economics for captive power plant to increase their revenue. State grid can meet the peak demand and shortage of energy requirement this way.	

Bibliography

[1] O. E. Wolrd Steel Association, “THE ROLE OF STEEL MANUFACTURING IN THE GLOBAL ECONOMY,” Oxford Econnomics & World Steel Association, London, 2019.

[2] W. S. Association, “World Steel Statistics,” World Steel Association , Burssels, 2019.

[3] W. S. Association, “FACT SHEET Steel & RAW MATERIALS,” World Steel Association, Brussels, 2019.

[4] W. S. Association, “ENERGY USE IN STEEL INDUSTRY,” World Steel Association, Brussels, 2019.

[5] I. International Energy Agency, “IEA (2020), Iron and Steel, IEA, Paris,” International Energy Agency, IEA, 22 07 2020. [Online]. Available: https://www.iea.org/reports/iron-and-steel. [Accessed 22 07 2020].

[6] M. o. Steel, “National Steel Policy,” Ministry of Steel, New Delhi, 2017.

[7] M. o. Steel, “Annual Reports,” Ministry of Steel, New Delhi, 2019-20.

[8] JPC, “Performance,” JPC, 2019-20.

[9] J. P. Commitee, “Steel-April-2020,” IBEF, New Delhi, 2020.

[10] JPC, “Iron & Steel Database,” JPC, 2019-20.

[11] W. S. Association, “World Steel Facts,” [Online]. Available: https://www.worldsteel.org/about-steel/steel-facts.html.

[12] MoeF, “India 2nd Bienial Update Report,” MoeF, New Delhi, 2014.

[13] G. o. I. Ministry of Steel, “Background Note on Assumptions to Arrive at Probable INDC Values and Investment,” Ministry of Steel, Government of India, 2018.

[14] B. o. E. Efficiency, “Improving Energy Efficiency in Iron & Steel Sector (Achievements and Way Forward),” Bureau of Energy Efficiency and GIZ, New Delhi, 2018.

[15] B. o. E. Efficiency, “A Report on Impact of Energy Efficiency Measures for the year 2018-19,” Bureau of Energy Efficiency, New Delhi, 2020.

[16] Ernst Worell, Lynn Price, Maarten Neelis, “World Best Practice Energy Intensity Values for Selected Industrial Sectors,” Lawrence Berkeley National Laboratory, 2007.

[17] T. S. Limited, “Integrated Report & Annual Accounts for Financial Year 2019-20 of Tata Steel Limited (‘Company’),” Tata Steel, 2020.

[18] G. o. I. Ministry of Steel, “Annual Reports,” Ministry of Steel, Government of India, 2003-2019.

[19] T. W. Bank, “World Bank National Accounts Data and OECD National Accounts data files,” The World Bank, 2020.

[20] M. o. Steel, “Background Note on Assumptions to Arrive at Probable INDC Values,” Ministry of Steel, New Delhi, 2016.

[21] G. o. I. Ministry of Environment Forestry and Climate Change, “Second Biennial Update Report to the United Nations Framework Convention on Climate Change,” Ministry of Environment Forestry and Climate Change, Government of India, 2018.

Annexures

Annexure A: Key Stakeholders – Iron & Steel Sector

S no	Steel Stakeholder	Role & Responsibility	Address & contact details
1	Joint Plant Committee	Joint Plant Committee (JPC) is officially empowered by the Ministry of Steel, Government of India, to collect data on the Indian Iron & Steel industry.	ISPAT NIKETAN 52/1A Ballygunge Circular Road Kolkata 700019 Tel : +91-33-2461 4055 , Fax: +91-33-2461 4063 email:jpc.kolkata@gmail.com
2	Economic Research Unit (ERU)	The Economic Research Unit (ERU) serves as a wing of JPC to carry out techno-economic studies and policy analysis. Economic Research Unit (ERU) is headed by Joint Secretary to the Government of India, Ministry of Steel, as its Chairman, and has representatives from SAIL, RINL, Tata Steel and Railway Board as its esteemed Members.	301/306 Aurobindo Place Hauz Khas New Delhi-110016 Tel: 011-26538313 Fax: 011-26862536 Email: jpceru1@del3.vsnl.net.in
3	Institute for Steel Development and Growth (INSDAG)	Institute of Steel Development & Growth (INSDAG) is a non-profit member-based organization established by the Govt. of India (Ministry of Steel). This Institute primarily works towards the development of advanced design methodologies and technical marketing by expanding applications of steel in different segments of the industry, upgrading skills and know-how, creating awareness amongst potential users and communicating the benefits of steel vis-à-vis other competitive materials, etc.	ISPAT PRAGATI BHAWAN 793, ANANDAPUR, KOLKATA – 700107 Email: insdag@rediffmail.com, ins.steel@gmail.com Tel: 033-24434045/4047/4409 Fax: 033-24434045/40489
4	Indian Steel Association	Indian Steel Association (ISA) is working closely with the Government on matters affecting the steel industry. ISA works with the technical wing of the Ministry of Steel (MoS), Government of India, as well as the Bureau of Indian Standards (BIS) and other national standard bodies to formulate and implement Indian Standards for specific steel products. ISA plays a vital role in bringing the concerns of its members to the attention of policymakers. ISA provides suggestions on laws and regulations relating to raw materials essential to the steel industry, such as coal, gas and iron ore.	Upper Ground Floor No. 4, Kanchenjunga Building, 18, Barakhamba Road, New Delhi-110001 Phone: 011 – 42668800 Fax: 011 – 42668805 media.isa@indsteel.org

S no	Steel Stakeholder	Role & Responsibility	Address & contact details
5	All India Steel Re-rollers Association	All India Steel Re-rollers Association (AISRA) is an Apex body of more than 1,000 members. AISRA is promoting Re-Rolling technology (R&D) and rendering all assistance to members for efficient running of their units. It is helping the industry in pollution control/BIS/coal and for other reasons.AISRA is liaisoning with UNDP for infrastructure update and R&D to help its members to use the technology at their Re-Rolling mills.	Mahatma Jyoti Rao Phule Marg Area, New Delhi, Delhi, India +91-11-23389957
6	Steel Re-rolling Mills Association of India	Steel Re-rolling Mills Association of India (SRMA) is functioning across India since 1940. The Steel Re-rolling sector comes in the 'secondary producers' category in the steel industry. This association works with the industrial units that has long products mills with re-heating furnace and rolling mills and a few units which has induction furnaces to melt scrap and DRI cast by ingot or continuous casting.	Everest, 46-C, Chowringhee Road (10th Floor), Kolkata-700 071 Tel: (033) 2288-5697 Tele Fax: (033) 2288-5558 Email: srmakol@srma.co.in / info@srma.co.in
7	Cold Rolled Steel Manufacturers Association	Cold Rolled Steel Manufacturers Association of India is a non-govt company incorporated on 28 Jan, 1991. Cold Rolled Steel Manufacturers Association of India majorly is involved with the Manufacturing (Metals & Chemicals, and products thereof) business for the last 29 years.	D - 15, Panchsheel Enclave, New Delhi Phone: (011) 26495730 Fax: 011-5174 8021
8	Indian Stainless-Steel Development Association	Indian Stainless Steel Development Association (ISSDA) is a not-for-profit organization committed to the growth and development of the Stainless Steel industry in India. ISSDA was founded in 1989 by leading stainless steel producers. It was formed with the objective of diversifying the applications of stainless steel in India and increasing usage volumes. ISSDA has a membership base of over 145 companies engaged in the production and processing of stainless steel.	L-22/4, Ground Floor, DLF Phase-II Gurgaon - 122 002 Email: nissda@gmail.com
9	Sponge Iron Manufacturers Association	SIMA represents the Indian DRI Industry and provides a common platform for regular interface with the Government of India and other regulatory authorities.	1501, Hemkunt Tower, 98, Nehru Place, New Delhi - 110019 Phone: +91 11 41619204 | 11 26294492 Fax: +91 11 26294491 E-mail: dkashiva@sima.co.in

S no	Steel Stakeholder	Role & Responsibility	Address & contact details
10	Steel Wire Manufacturers Association of India	Steel Wire Manufacturers Association of India is the national body of steel wire and wire rope manufacturers in India. The Association has membership of steel wire drawing units and wire rope manufacturing units that produce the bulk quantity of steel wires and wire ropes in India. SWMAI is recognized by the Government of India and steel producers as the representative body of steel wire and wire rope manufacturers, and is consulted by them on issues pertaining to the Steel Wire & Wire Rope industry.	Anandalok top floor, 227 A.J.C Bose Road, Kolkata-700 020, India Phone: 033-65260888, 09831731013 E-mail: swmai@swmai.org, membership@swmai.org.
11	The Indian Ferro Alloy Producers' Association	The Indian Ferro Alloys Producers' Association (IFAPA) was established in 1961 to promote and protect the interests common to the Ferro Alloy Industry, especially with regard to level playing field, bringing together and promoting cooperation among Ferro Alloy Producers in India, and maintaining uniformity in the rules and regulations and usages of the industry. IFAPA is an apex body representing manufacturers of Bulk and Noble Ferro Alloys in the country.	1-B, Haji Moosa Patrawala Industrial Estate 20, Dr. E. Moses Road, Mahalaxmi (West) Mumbai, 400 011, India. Phone: +(91)(22)-2496 2754, +(91)(22)-2496 2755 Email: memberservices@ifapaindia.org
12	Pellet Manufacturers Association of India	Pellet Manufacturers Association of India (PMAI) is the official industry body of pellet manufacturers in India. It was set up in March 2013 with a fundamental premise to have a common forum for its members to share and exchange each other's views and problems, to promote and protect the interests of the Indian Pellet industry, including all its stakeholders. PMAI members include stand-alone pellet plants as well units producing down-stream products like Sponge Iron and finished steel.	170 Satya Niketan New Delhi 110021 Phone: 011-41462000, 41462380 Email: pmaioffice@gmail.com
13	Alloy Steel Producers Association of India	Alloy Steel Producers Association of India was established in 1968. This Association represents producers of alloys and special steels, including stainless steel, in the country. The Association widely represents the domestic Alloy Steel industry. It seeks to promote the common interests of alloy and special steel manufacturers in India. It continuously interacts with the Government of India's relevant Ministries, mainly Steel, Commerce and Finance, on policies and procedures that affect alloy steel industry.	Mukand Limited Belapur Road, Kalwe, Mumbai, 400605 Phone: +91-22-21727500 Email: mulay.pallavi@gmail.com
14	All India Induction Furnace Association	All India Induction Furnaces Association (AIIFA), being the premier steel industry association of Electric Induction Furnaces in the country, represents a major section of steel units, producing steel through this route.	504, Pearls Omaxe, Tower- I Netaji Subhash Place, Pitampura, New Delhi, 110034 Phone: +011 27351345/47/42725051 Email: aaiifa6@gmail.com

S no	Steel Stakeholder	Role & Responsibility	Address & contact details
15	Steel Furnace Association of India	Steel Furnace Association of India is involved in promoting the interests of the electric arc furnace industry and other steel producers operating other furnaces to produce steel/ downstream products such as mini-blast furnace-EOF, COREX-BOF, Induction Furnace routes, etc. Foreign steel companies and suppliers/manufacturers of inputs, technology machinery, etc., are also enrolled as Foreign Members and Associate Members respectively.	N-22, 2nd Floor, Green Park Extension, New Delhi, 110016 Phone: 011 2671 4240
16	Federation of Indian Mineral Industries	Federation of Indian Mineral Industries (FIMI), established in 1966, is an all-India apex body established to promote the interests of all mining (including coal), mineral processing, metal making and other mineral-based industries, and to attend to the problems faced by them in lease grants, renewals, tenures, production, taxation, trade, exports, labour, etc. FIMI envelopes in its fold mining, mineral processing, metal making, cement, coal and other mineral-derived industries as well as granite, stone, marble and slate industries.	FIMI House, B-311, Okhla Industrial Area, Phase-I, New Delhi, 110 020 Phone: +91-11-26814596 Email: fimi@fedmin.com
17	Indian Refractory Makers Association	Indian Refractory Makers Association is a national organization for the refractory manufacturing companies in India. There are currently 75 manufacturing units in the membership of IRMA. These units produce a wide range of insulating, abrasion-resistant and corrosion-resistant refractories, ranging from firebricks and insulating refractories to a wide variety of high alumina, silica, magnesite and speciality refractories.	Duckback House, Unit-2B, 2nd Floor 41, Shakespeare Sarani, Kolkata, 700017. Phone: 033-4003-2748, Email: support@irmaindia.org
18	Metal Recycling Association of India	Metal Recycling Association of India began in 2011 as the industry body of metal industry stakeholders and has metamorphosed into a full-blown trade body at the instance of the Government, which directed it to embrace and extend the benefits of its efforts to all the recycling and recyclable commodity stakeholders, not limiting them to the metal sector alone.	105/106, A Wing, Dynasty Business Park, Andheri-Kurla Road, Andheri (E), Mumbai – 400059 Phone: +91 2249701290 Email: mail@mrai.org.in
19	Bureau of International Recycling (BIR)	BIR was the first federation to support the interests of the recycling industry on an international scale. BIR comprises four commodity divisions: Iron & Steel, Non-Ferrous Metals, Paper, and Textiles. It has four Commodity Committees dealing with Stainless Steel & Special Alloys, Plastics, Tyres & Rubber, and E-scrap	24 Avenue Franklin Roosevelt 1050 Brussels,Belgium +32 2 627 57 70 bir@bir.org

S no	Steel Stakeholder	Role & Responsibility	Address & contact details
20	Inland Importers and Consumers Association (IICA)	Inland Importers and Consumers Association (IICA) was founded in 2007. IICA is a national association representing the interest of India's Ferrous & Non-Ferrous metals recycling industry and regional association like MRAI, ANMA, JEMMA, BNFM, BME, and AIIFA. IICA organizes international conferences and seminars engaging various Govt officials and Departments.	631, Gali No. 11, Sadar Bazar, Delhi – 10006 Phone: 011-23671944 Fax: 011-26242842 / 43 Email: president@iica.org.in info@iica.org.in
21	National Institute of Secondary Steel Technology (NISST)	National Institute of Secondary Steel Technology addresses all requirements of the secondary steel sector by various means, such as providing trained manpower to the secondary steel sector, extending consultancy services, and offering research & development. NISST also undertakes projects for the industry to provide technology outputs, and act as a depository of all relevant information and knowledge. It also provide interface between industry and educational/research institutes in secondary steel technology and re-rolling industry.	Post Box No. 92, GT Road, Mandi Gobindgarh-147 301 (Punjab) Dist: Fatehgarh Sahib. Phone: 01765-258080, 259532, 252558, 259367, 250574 Fax: 01765-258079 Email: nisst@dataone.in, info@nisst.org
22	Biju Patnaik National Steel Institute (NSI)	Biju Patnaik National Steel Institute (BPNSI) helps the domestic secondary steel industry adopt to the rapid transformation that the global and Indian steel industries have been undergoing. Presently, BPNSI is conducting courses on Software Engineering and Computer Systems Maintenance, Welding & Fabrication, and Steel Making Technology, etc.	Sarbodaya Road, Behind Gundicha Temple Puri – 752002, Odisha Phone: (06752)-232820 Email: bpnsi@bpnsi.org
23	Institute for Steel Development and Growth (INSDAG)	NSDAG strives to expand the use of steel in the residential, commercial, infrastructure, industrial and rural segments of the construction industry. The Institute primarily works towards the development of technology in steel usage and the market for the steel fraternity.	ISPAT Pragati Bhawan, 793, ANANDAPUR, KOLKATA – 700107 Phone: 033-24434045/4047/4409 Fax: 033-24434045/40489 Email: insdag@rediffmail.com, ins.steel@gmail.com

Annexure B: List of Steel Plants

Sr. No	Company Name	Route	Capacity	State
1	ARJAS STEEL PVT LTD (GERDAU STEEL), TADIPATRI	BF	300000	Andhra Pradesh
2	SATHAVAHANA ISPAT LTD., HARESAMUDRAM	BF	240000	Andhra Pradesh
3	SRI KALAHASTHI PIPES LIMITED (LANCO), RACHAGUNNERI	BF	300000	Andhra Pradesh
4	VIZAG STEEL PLANT	BF	6300000	Andhra Pradesh
5	ARJAS STEEL PVT LTD (GERDAU STEEL), TADIPATRI	BOF	300000	Andhra Pradesh
6	VIZAG STEEL PLANT	BOF	6300000	Andhra Pradesh
7	AGARWAL INDUCTION FURNACE PRIVATE LIMITED, HINDUPUR	IF	120000	Andhra Pradesh
8	EMJAY STEEL UDYYOG PRIVATE LIMITED, NELLORE	IF	150000	Andhra Pradesh
9	MAA MAHAMAYA INDUSTRIES LTD., VIZIANAGARAM	IF	118300	Andhra Pradesh
10	PRAKASH FERROUS INDUSTRIES PVT LTD, SRIKALAHASTI	IF	300000	Andhra Pradesh
11	SAKTHI FERRO ALLOYS PVT LTD (JBA), GOLLAPALLE	IF	156000	Andhra Pradesh
12	STEEL EXCHANGE INDIA LTD - SRIRAMPURAM	IF	250000	Andhra Pradesh
13	ARJAS STEEL PVT LTD (GERDAU STEEL)	Re-Rolling	400000	Andhra Pradesh
14	BEEKAY STRUCTURAL STEELS, VISAKHAPATNAM	Re-Rolling	100000	Andhra Pradesh
15	BEEKAY STRUCTURAL STEELS(TMT BAR DIVISION), BONANGI VILLAGE	Re-Rolling	200000	Andhra Pradesh
16	MAA MAHAMAYA INDUSTRIES LTD., VIZIANAGARAM	Re-Rolling	105000	Andhra Pradesh
17	P R ROLLING MILLS PVT LTD, GAJULAMANDYAM	Re-Rolling	100000	Andhra Pradesh
18	PRAKASH FERROUS INDUSTRIES PVT LTD, SRIKALAHASTI	Re-Rolling	300000	Andhra Pradesh
19	SAKTHI FERRO ALLOYS PVT LTD (JBA), GOLLAPALLE	Re-Rolling	144000	Andhra Pradesh
20	SPLENDID METAL PRODUCTS LTD, VIZAG (SUJANA), SANIVADA VILLAGE	Re-Rolling	120000	Andhra Pradesh
21	STEEL EXCHANGE INDIA LTD - SRIRAMPURAM	Re-Rolling	250000	Andhra Pradesh
22	VIZAG STEEL PLANT	Re-Rolling	4074000	Andhra Pradesh

Sr. No	Company Name	Route	Capacity	State
23	APPLE INDUSTRIES LIMITED, HIREHAL	Sponge Iron	150000	Andhra Pradesh
24	MAA MAHAMAYA INDUSTRIES LTD., VIZIANAGARAM	Sponge Iron	112000	Andhra Pradesh
25	STEEL EXCHANGE INDIA LTD - SRIRAMPURAM	Sponge Iron	250000	Andhra Pradesh
26	ARCELOR MITTAL NIPPON STEEL INDIA LTD (ESSAR), VISAKHAPATNAM	Pellets	8000000	Andhra Pradesh
27	DINA METALS LTD	IF	115200	Bihar
28	NEEL KAMAL STEELS PVT. LTD.	IF	198000	Bihar
29	DADIJI STEELS PVT. LTD.	Re-Rolling	105000	Bihar
30	JMD ALLOYS LTD	Re-Rolling	180500	Bihar
31	MAGADH INDUSTRIES PVT LTD	Re-Rolling	250000	Bihar
32	NEEL KAMAL STEELS PVT. LTD.	Re-Rolling	300000	Bihar
33	BHUSHAN POWER & STEEL LTD - CHANDIGARH (C R DIV)	C R Products	120000	Chandigarh
34	JAYASWALS NECO INDS LTD.	BF	650000	Chhattisgarh
35	JINDAL STEEL AND POWER LTD - CHHATTISGARH	BF	2125000	Chhattisgarh
36	MONNET ISPAT AND ENERGY LTD - RAIGARH	BF	612500	Chhattisgarh
37	SAIL - BHILAI STEEL PLANT	BF	3925000	Chhattisgarh
38	SAIL - BHILAI STEEL PLANT	BOF	6000000	Chhattisgarh
39	JAYASWALS NECO INDS LTD., SILTARA	EAF	1188000	Chhattisgarh
40	JINDAL STEEL AND POWER LTD - CHHATTISGARH	EAF	3600000	Chhattisgarh
41	MONNET ISPAT AND ENERGY LTD - RAIGARH	EAF	1500000	Chhattisgarh
42	BALAJEE LOHA LTD (TMT DIVISION)	IF	100000	Chhattisgarh
43	CREST STEEL AND POWER PVT LTD	IF	210000	Chhattisgarh
44	DROLIA ELECTROSTEELS PVT LTD	IF	145200	Chhattisgarh
45	GODAWARI POWER AND ISPAT LTD., SILTARA	IF	400000	Chhattisgarh
46	HI-TECH POWER AND STEEL LTD.	IF	108000	Chhattisgarh
47	JAI BALAJI INDUSTRIES LTD.	IF	100000	Chhattisgarh
48	JORAWAR ENGG AND FOUNDRY FORGE PVT LTD	IF	150000	Chhattisgarh
49	MAHAMAYA STEEL INDUSTRIES LTD.	IF	200000	Chhattisgarh
50	MONNET ISPAT AND ENERGY LTD. - RAIPUR	IF	300000	Chhattisgarh
51	MSP STEEL AND POWER LTD, JAMGAON	IF	272000	Chhattisgarh
52	NALWA STEEL AND POWER LTD., TARAIMAL	IF	160000	Chhattisgarh
53	RASHMI SPONGE IRON AND POWER INDUSTRIES LTD, SILTARA	IF	100000	Chhattisgarh
54	REAL ISPAT AND POWER LTD., BORJHARA	IF	385000	Chhattisgarh
55	SARDA ENERGY AND MINERALS LTD., SILTARA	IF	200000	Chhattisgarh
56	SHREE NAKODA ISPAT LTD., MOWA	IF	115000	Chhattisgarh

Sr. No	Company Name	Route	Capacity	State
57	SHRI BAJRANG POWER AND ISPAT LTD., BORJHARA	IF	235200	Chhattisgarh
58	SHRI SHYAM ISPAT (INDIA) PVT LTD, TARAIMAL	IF	100000	Chhattisgarh
59	SKS ISPAT AND POWER LTD. SILTARA	IF	331500	Chhattisgarh
60	TOPWORTH STEELS AND POWER PVT LTD, BORAI	IF	144000	Chhattisgarh
61	VANDANA GLOBAL LTD., SILTARA	IF	178200	Chhattisgarh
62	API ISPAT AND POWERTECH PVT LTD, SILTARA	Re-Rolling	145250	Chhattisgarh
63	C G ISPAT PVT. LTD., SILTARA	Re-Rolling	110000	Chhattisgarh
64	HIRA STEELS LIMITED, RAWABHATA INDUSTRIAL AREA	Re-Rolling	120000	Chhattisgarh
65	HI-TECH POWER AND STEEL LTD., SIGMA	Re-Rolling	150000	Chhattisgarh
66	ISHWAR ISPAT INDUSTRIES PVT LTD-UNIT IV, URLA	Re-Rolling	231000	Chhattisgarh
67	JAYASWALS NECO INDS LTD., SILTARA	Re-Rolling	1188000	Chhattisgarh
68	JINDAL STEEL AND POWER LTD - CHHATTISGARH, RAIGARH	Re-Rolling	1450000	Chhattisgarh
69	JORAWAR ENGG AND FOUNDRY FORGE PVT LTD, SILTARA	Re-Rolling	150000	Chhattisgarh
70	KHYATI ISPAT PVT LTD	Re-Rolling	114000	Chhattisgarh
71	LINGRAJ STEEL AND POWER PVT. LTD., URLA	Re-Rolling	150000	Chhattisgarh
72	MAHAMAYA STEEL INDUSTRIES LTD., URLA	Re-Rolling	255000	Chhattisgarh
73	MONNET ISPAT AND ENERGY LTD - RAIGARH, NAHARPALI	Re-Rolling	450000	Chhattisgarh
74	MONNET ISPAT AND ENERGY LTD. - RAIPUR, MONNET MARG	Re-Rolling	200000	Chhattisgarh
75	MSP STEEL AND POWER LTD, JAMGAON	Re-Rolling	303000	Chhattisgarh
76	NALWA STEEL AND POWER LTD., TARAIMAL	Re-Rolling	250000	Chhattisgarh
77	NAV DURGA FUEL PVT LTD, SARAIPALLI	Re-Rolling	100000	Chhattisgarh
78	NUTAN ISPAT AND POWER PVT. LTD., TARRA	Re-Rolling	150000	Chhattisgarh
79	PRIME ISPAT LIMITED, BANA	Re-Rolling	108000	Chhattisgarh
80	R R ISPAT LTD., URLA	Re-Rolling	214000	Chhattisgarh
81	RAMA POWER & STEEL PVT LTD, BORJHARA	Re-Rolling	120000	Chhattisgarh

Sr. No	Company Name	Route	Capacity	State
82	REAL ISPAT AND POWER LTD., URLA	Re-Rolling	370000	Chhattisgarh
83	SAIL - BHILAI STEEL PLANT	Re-Rolling	2275000	Chhattisgarh
84	SARDA ENERGY AND MINERALS LTD, SILTARA	Re-Rolling	180000	Chhattisgarh
85	SHREE NAKODA ISPAT LTD., MOWA	Re-Rolling	120000	Chhattisgarh
86	SHRI BAJRANG POWER AND ISPAT LTD., BORJHARA	Re-Rolling	345000	Chhattisgarh
87	SKS ISPAT AND POWER LTD, SILTARA	Re-Rolling	384000	Chhattisgarh
88	TOPWORTH STEELS AND POWER PVT LTD, BORAI	Re-Rolling	450000	Chhattisgarh
89	VANDANA GLOBAL LTD., SILTARA	Re-Rolling	178200	Chhattisgarh
90	JINDAL STEEL AND POWER LTD - CHHATTISGARH	HR Products	1000000	Chhattisgarh
91	ANJANI STEELS LTD, UJALPUR	Sponge Iron	108000	Chhattisgarh
92	API ISPAT AND POWERTECH PVT LTD, SILTARA	Sponge Iron	210000	Chhattisgarh
93	B S SPONGE PVT LTD, TARAIMAL	Sponge Iron	180000	Chhattisgarh
94	CREST STEEL AND POWER PVT LTD, JORATARAI	Sponge Iron	210000	Chhattisgarh
95	GODAWARI POWER AND ISPAT LTD., SILTARA	Sponge Iron	495000	Chhattisgarh
96	JAI BALAJI INDUSTRIES LTD., BARAI	Sponge Iron	120000	Chhattisgarh
97	JAYASWALS NECO INDS LTD., SILTARA	Sponge Iron	270000	Chhattisgarh
98	JINDAL STEEL AND POWER LTD - CHHATTISGARH, RAIGARH	Sponge Iron	1320000	Chhattisgarh
99	MAHENDRA SPONGE AND POWER PVT. LTD., SILTARA	Sponge Iron	120000	Chhattisgarh
100	MONNET ISPAT AND ENERGY LTD - RAIGARH, NAHARPALI	Sponge Iron	500000	Chhattisgarh
101	MONNET ISPAT AND ENERGY LTD. - RAIPUR, MONNET MARG	Sponge Iron	300000	Chhattisgarh
102	MSP STEEL AND POWER LTD, JAMGAON	Sponge Iron	300000	Chhattisgarh
103	NALWA STEEL AND POWER LTD., TARAIMAL	Sponge Iron	198000	Chhattisgarh
104	NRVS STEELS LIMITED (FORMALLY SELENO STEELS LTD), TARAIMAL	Sponge Iron	135000	Chhattisgarh

Sr. No	Company Name	Route	Capacity	State
105	RAIGARH ISPAT AND POWER PVT. LTD.	Sponge Iron	120000	Chhattisgarh
106	SARDA ENERGY AND MINERALS LTD., SILTARA	Sponge Iron	360000	Chhattisgarh
107	SCANIA STEELS AND POWERS LIMITED,	Sponge Iron	132000	Chhattisgarh
108	SHREE NAKODA ISPAT LTD., MOWA	Sponge Iron	171000	Chhattisgarh
109	SHRI BAJRANG POWER AND ISPAT LTD., BORJHARA	Sponge Iron	610000	Chhattisgarh
110	SINGHAL ENTERPRISES PVT. LTD. - CHHATTISGARH	Sponge Iron	253500	Chhattisgarh
111	SKS ISPAT AND POWER LTD, SILTARA	Sponge Iron	270000	Chhattisgarh
112	TOPWORTH STEELS AND POWER PVT LTD, BORAI	Sponge Iron	165000	Chhattisgarh
113	VANDANA GLOBAL LTD., SILTARA	Sponge Iron	231000	Chhattisgarh
114	GODAWARI POWER AND ISPAT LTD., SILTARA	Pellets	2100000	Chhattisgarh
115	JAYASWALS NECO INDS LTD., SILTARA	Pellets	1200000	Chhattisgarh
116	MONNET ISPAT AND ENERGY LTD - RAIGARH, NAHARPALI	Pellets	2000000	Chhattisgarh
117	MSP STEEL AND POWER LTD, JAMGAON	Pellets	900000	Chhattisgarh
118	RASHI STEEL AND POWER LTD, BILASPUR	Pellets	400000	Chhattisgarh
119	SARDA ENERGY AND MINERALS LTD., SILTARA	Pellets	600000	Chhattisgarh
120	SHRI BAJRANG POWER AND ISPAT LTD., BORJHARA	Pellets	1200000	Chhattisgarh
121	APARANT IRON AND STEEL PVT. LTD.,SANGUEM	BF	125000	Goa
122	VEDANTA LIMITED, SOUTH GOA	BF	625000	Goa
123	ARCELOR MITTAL NIPPON STEEL INDIA	BF	3490000	Gujarat
124	ELECTROTHERM(INDIA) LTD	BF	277200	Gujarat
125	ARCELOR MITTAL NIPPON STEEL INDIA	Electric arc furnace	10000000	Gujarat
126	PANCHMAHAL STEEL LTD.	Electric arc furnace	150000	Gujarat
127	WELSPUN SPECIALTY SOLUTIONS LIMITED	Electric arc furnace	150000	Gujarat
128	ELECTROTHERM(INDIA) LTD	IF	400000	Gujarat
129	HANS ISPAT LTD	IF	100000	Gujarat
130	LAXCON STEELS LTD.	IF	108000	Gujarat
131	NILKANTH CONCAST PRIVATE LTD	IF	180000	Gujarat
132	SHAH ALLOYS LTD.	IF	300000	Gujarat
133	SHREEYAM POWER AND STEEL IND LTD	IF	300000	Gujarat

Sr. No	Company Name	Route	Capacity	State
134	WELSPUN STEEL LTD	IF	150000	Gujarat
135	ELECTROTHERM(INDIA) LTD	Re-Rolling	400000	Gujarat
136	GALLANTT METAL LIMITED	Re-Rolling	274980	Gujarat
137	GRACE CASTINGS LTD.	Re-Rolling	200000	Gujarat
138	HANS ISPAT LTD	Re-Rolling	150000	Gujarat
139	LAXCON STEELS LTD.	Re-Rolling	120000	Gujarat
140	MONO STEEL (INDIA) LTD	Re-Rolling	110000	Gujarat
141	NILKANTH CONCAST PRIVATE LTD	Re-Rolling	180000	Gujarat
142	SHAH ALLOYS LTD.	Re-Rolling	120000	Gujarat
143	SHREEYAM POWER AND STEEL IND LTD	Re-Rolling	120000	Gujarat
144	VISHAL ISPAT	Re-Rolling	100000	Gujarat
145	WELSPUN SPECIALTY SOLUTIONS LIMITED	Re-Rolling	100000	Gujarat
146	ARCELOR MITTAL NIPPON STEEL INDIA	H R Products	7100000	Gujarat
147	ARCELOR MITTAL NIPPON STEEL INDIA (PLATE MILL)	H R Products	1500000	Gujarat
148	SHAH ALLOYS LTD.	H R Products	150000	Gujarat
149	WELSPUN CORP LIMITED	H R Products	1500000	Gujarat
150	ARCELOR MITTAL NIPPON STEEL INDIA	C R Products	1700000	Gujarat
151	CHINA STEEL CORPORATION INDIA PVT LTD	C R Products	200000	Gujarat
152	INDIAN STEEL CORPORATION LTD	C R Products	600000	Gujarat
153	STEELCO GUJARAT LTD.	C R Products	184000	Gujarat
154	ARCELOR MITTAL NIPPON STEEL INDIA	GP/GC Products	450000	Gujarat
155	INDIAN STEEL CORPORATION LTD	GP/GC Products	360000	Gujarat
156	MANAKSIA COATED METALS AND INDUSTRIES LIMITED	GP/GC Products	108000	Gujarat

Sr. No	Company Name	Route	Capacity	State
157	INDIAN STEEL CORPORATION LTD	Colour coated products	120000	Gujarat
158	ARCELOR MITTAL NIPPON STEEL INDIA	Pipes	600000	Gujarat
159	JINDAL SAW - GUJARAT	Pipes	600000	Gujarat
160	MAN INDUSTRIES(I)LIMITED	Pipes	1000000	Gujarat
161	RATNAMANI METALS AND TUBES LTD-BHIMASAR	Pipes	300000	Gujarat
162	WELSPUN CORP LIMITED	Pipes	1295000	Gujarat
163	WELSPUN SPECIALTY SOLUTIONS LIMITED	Pipes	350000	Gujarat
164	ARCELOR MITTAL NIPPON STEEL INDIA	Sponge Iron	6700000	Gujarat
165	ELECTROTHERM(INDIA) LTD	Sponge Iron	288000	Gujarat
166	MONO STEEL (INDIA) LTD	Sponge Iron	120000	Gujarat
167	SAL STEEL LTD.	Sponge Iron	325000	Gujarat
168	SHREEYAM POWER AND STEEL IND LTD	Sponge Iron	200000	Gujarat
169	WELSPUN STEEL LTD	Sponge Iron	150000	Gujarat
170	JINDAL STAINLESS (HISSAR) LTD	Electric arc furnace	780000	Haryana
171	JINDAL STAINLESS (HISSAR) LTD	H R Products	920000	Haryana
172	JINDAL STAINLESS (HISSAR) LTD	C R Products	415000	Haryana
173	SURYA ROSHNI LTD.	C R Products	115000	Haryana
174	SWASTIK PIPE LTD	C R Products	100000	Haryana
175	SWASTIK PIPE LTD	Pipes	120000	Haryana
176	CREST STEEL UNA PVT LTD	IF	108000	Himachal Pradesh
177	J B ROLLING MILLS LTD	IF	234000	Himachal Pradesh
178	CREST STEEL UNA PVT LTD	Re-Rolling	108000	Himachal Pradesh
179	J B ROLLING MILLS LTD	Re-Rolling	236000	Himachal Pradesh
180	KASHMIR STEEL ROLLING MILLS	Re-Rolling	101760	Jammu and Kashmir
181	ATIBIR INDUSTRIES CO. LTD. (UNIT II)	BF	600000	Jharkhand
182	ELECTRO STEELS LTD	BF	1450000	Jharkhand
183	SAIL - BOKARO STEEL PLANT	BF	4360000	Jharkhand

Sr. No	Company Name	Route	Capacity	State
184	TATA STEEL LONG PRODUCTS LIMITED	BF	650000	Jharkhand
185	TATA STEEL LTD - JAMSHEDPUR WORKS	BF	9600000	Jharkhand
186	ELECTRO STEELS LTD	BOF	1877000	Jharkhand
187	SAIL - BOKARO STEEL PLANT	BOF	4600000	Jharkhand
188	TATA STEEL LTD - JAMSHEDPUR WORKS	Electric arc furnace	10000000	Jharkhand
189	TATA STEEL LONG PRODUCTS LIMITED	Electric arc furnace	1000000	Jharkhand
190	ADHUNIK ALLOYS AND POWER	IF	180000	Jharkhand
191	BALMUKUND SPONGE IRON LTD	IF	126000	Jharkhand
192	BRAHMAPUTRA METALLICS LTD	IF	200000	Jharkhand
193	CHINTPURNI STEEL PVT LTD	IF	100000	Jharkhand
194	RUNGTA MINES LIMITED-CHALIYAMA STEEL PLANT	IF	554400	Jharkhand
195	RUNGTA MINES LIMITED-CHALIYAMA STEEL PLANT	IF	110000	Jharkhand
196	ELECTRO STEELS LTD - JHARKHAND	IF	1450000	Jharkhand
197	JINDAL STEEL AND POWER LTD	Re-Rolling	600000	Jharkhand
198	PRANEET ISPAT PVT LTD	Re-Rolling	120000	Jharkhand
199	RUNGTA MINES LIMITED-CHALIYAMA STEEL PLANT	Re-Rolling	217325	Jharkhand
200	SAI ELECTRO CASTINGS LTD	Re-Rolling	100000	Jharkhand
201	TATA STEEL LONG PRODUCTS LIMITED	Re-Rolling	700000	Jharkhand
202	TATA STEEL LTD - JAMSHEDPUR WORKS	Re-Rolling	2020000	Jharkhand
203	TSL CONVERSION AGENT - EPA	Re-Rolling	1422000	Jharkhand
204	SAIL - BOKARO STEEL PLANT	H R Products	3995000	Jharkhand
205	TATA STEEL LTD - JAMSHEDPUR WORKS	H R Products	6700000	Jharkhand
206	BANSAL MECHANICAL WORKS LTD (TATA STEEL LTD - GAMHARIA)	C R Products	250000	Jharkhand
207	SAIL - BOKARO STEEL PLANT	C R Products	2860000	Jharkhand
208	TATA STEEL LTD - BARA (JHARKHAND)	C R Products	250000	Jharkhand
209	TATA STEEL LTD - JAMSHEDPUR WORKS	C R Products	2045000	Jharkhand
210	BANSAL MECHANICAL WORKS LTD (TATA STEEL LTD - GAMHARIA)	GP/GC Products	180000	Jharkhand

Sr. No	Company Name	Route	Capacity	State
211	SAIL - BOKARO STEEL PLANT	GP/GC Products	120000	Jharkhand
212	TATA BLUESCOPE LTD	Colour coated products	100000	Jharkhand
213	TATA STEEL LTD - JAMSHEDPUR WORKS	Colour coated products	540000	Jharkhand
214	TATA BLUESCOPE LTD	Colour coated products	150000	Jharkhand
215	THE TINPLATE CO. OF INDIA	Colour coated products	380000	Jharkhand
216	ADHUNIK ALLOYS AND POWER	Tin Plates	270000	Jharkhand
217	ALOKE STEELS INDUSTRIES PVT. LTD.	Sponge Iron	120000	Jharkhand
218	ANINDITA STEELS LTD	Sponge Iron	120000	Jharkhand
219	ATIBIR INDUSTRIES CO. LTD. (UNIT II)	Sponge Iron	120000	Jharkhand
220	BALMUKUND SPONGE IRON LTD	Sponge Iron	108000	Jharkhand
221	BRAHMAPUTRA METALLICS LTD	Sponge Iron	105000	Jharkhand
222	JHARKHAND ISPAT	Sponge Iron	120000	Jharkhand
223	NILACHAL IRON AND POWER LTD	Sponge Iron	165000	Jharkhand
224	RUNGTA MINES LIMITED-CHALIYAMA STEEL PLANT	Sponge Iron	658000	Jharkhand
225	SRI VENKATESH IRON AND ALLOYS(I) LTD	Sponge Iron	120000	Jharkhand
226	TATA STEEL LONG PRODUCTS LIMITED	Sponge Iron	575000	Jharkhand
227	ATIBIR INDUSTRIES CO. LTD. (UNIT II)	Pelletts	300000	Jharkhand
228	ORISSA MANGANESE AND MINERALS LIMITED	Pelletts	1200000	Jharkhand
229	TATA STEEL LONG PRODUCTS LIMITED	Pelletts	1200000	Jharkhand
230	TATA STEEL LTD - JAMSHEDPUR WORKS	Pelletts	6000000	Jharkhand
231	J S W STEEL LTD. - VIJAYNAGAR	BF	12000000	Karnataka
232	KALYANI STEELS LTD.	BF	480000	Karnataka
233	KIRLOSKAR FERROUS INDS LTD.	BF	385000	Karnataka
234	SAIL - VISVESWARAYA IRON AND STEEL LTD.	BF	118000	Karnataka
235	SLR METALIKS LTD	BF	240000	Karnataka
236	J S W STEEL LTD. - VIJAYNAGAR	BOF	10000000	Karnataka

Sr. No	Company Name	Route	Capacity	State
237	MUKAND LTD.	BOF	700000	Karnataka
238	SAIL - VISVESWARAYA IRON AND STEEL LTD.	BOF	118000	Karnataka
239	SLR METALIKS LTD	BOF	300000	Karnataka
240	J S W STEEL LTD. - VIJAYNAGAR	Electric arc furnace	2000000	Karnataka
241	BMM ISPAT LTD.	IF	1350000	Karnataka
242	KHAYATI STEEL INDUSTRIES PVT LTD	IF	120000	Karnataka
243	BMM ISPAT LTD.	Re-Rolling	1090000	Karnataka
244	J S W STEEL LTD. - VIJAYNAGAR	Re-Rolling	3600000	Karnataka
245	KHAYATI STEEL INDUSTRIES PVT LTD	Re-Rolling	101000	Karnataka
246	M S METALS & STEELS PVT LTD (HRG)	Re-Rolling	109500	Karnataka
247	PRAKASH SPONGE IRON AND POWER PVT LTD	Re-Rolling	180000	Karnataka
248	SLR METALIKS LTD	Re-Rolling	300000	Karnataka
249	J S W STEEL LTD. - VIJAYNAGAR	H R Products	8200000	Karnataka
250	J S W STEEL LTD. - VIJAYNAGAR	CR Product	3100000	Karnataka
251	J S W STEEL LTD. - VIJAYNAGAR	GP/GC Products	500000	Karnataka
252	WELSPUN CORP LIMITED(MANDYA)	Pipes	150000	Karnataka
253	BMM ISPAT LTD.	Sponge Iron	720000	Karnataka
254	HARE KRISHNA METALLICS PVT. LTD.	Sponge Iron	120000	Karnataka
255	J S W STEEL LTD. - VIJAYNAGAR	Sponge Iron	1200000	Karnataka
256	JANKI CORPORATION LTD.	Sponge Iron	180000	Karnataka
257	M S METALS & STEELS PVT LTD (HRG)	Sponge Iron	105000	Karnataka
258	MINERA STEEL AND POWER PRIVATE LIMITED (KMMI STEEL)	Sponge Iron	150000	Karnataka
259	BMM ISPAT LTD.	Pellets	2400000	Karnataka
260	J S W STEEL LTD. - VIJAYNAGAR		8400000	Karnataka
261	JANKI CORPORATION LTD.		600000	Karnataka
262	KIOCL LIMITED		3500000	Karnataka
263	MINERA STEEL AND POWER PRIVATE LIMITED (KMMI STEEL)		600000	Karnataka
264	MSPL LIMITED		1200000	Karnataka

Sr. No	Company Name	Route	Capacity	State
265	NMDC LIMITED-PELLET		1200000	Karnataka
266	XINDIA STEELS LTD		800000	Karnataka
267	MITTAL CORP LIMITED	IF	120000	Madhya Pradesh
268	RATHI IRON STEEL INDUSTRIES LTD		250000	Madhya Pradesh
269	INDORE STEEL AND IRON MILLS LTD.	Re-Rolling	100000	Madhya Pradesh
270	JAIDEEP ISPAT AND ALLOYS PVT LTD - II		350000	Madhya Pradesh
271	MITTAL CORP LIMITED UNIT-II		150000	Madhya Pradesh
272	NATIONAL STEEL AND AGRO INDUSTRIES LTD.	CR Product	350000	Madhya Pradesh
273	RSAL STEEL LTD		100000	Madhya Pradesh
274	NATIONAL STEEL AND AGRO INDUSTRIES LTD.	GP/GC Products	330000	Madhya Pradesh
275	NATIONAL STEEL AND AGRO INDUSTRIES LTD.	Colour coated products	160000	Madhya Pradesh
276	JSW STEEL LTD. - DOLVI UNIT 1	BF	3500000	Maharashtra
277	UTTAM GALVA METALLICS LTD	BF	600000	Maharashtra
278	ISMT LIMITED	Electric arc furnace	350000	Maharashtra
279	JSW STEEL LTD. - DOLVI UNIT 1	Electric arc furnace	3500000	Maharashtra
280	JSW STEEL LTD. - DOLVI UNIT 2	Electric arc furnace	1500000	Maharashtra
281	MAHINDRA SANYO SPECIAL STEEL PVT LTD.	Electric arc furnace	240000	Maharashtra
282	MUKAND LTD.	Electric arc furnace	310000	Maharashtra
283	SAARLOHA ADVANCED MATERIALS PVT LTD.	Electric arc furnace	200000	Maharashtra
284	SUNFLAG IRON AND STEEL CO LTD.	Electric arc furnace	525000	Maharashtra
285	UTTAM VALUE STEELS LIMITED	Electric arc furnace	6000000	Maharashtra

Sr. No	Company Name	Route	Capacity	State
286	BHAGWATI FERRO METAL PVT LTD	Electric arc furnace	150000	Maharashtra
287	BHAGWATI STEEL CAST P LTD	Electric arc furnace	108000	Maharashtra
288	BHAGYALAXMI ROLLING MILL PVT. LTD.	Electric arc furnace	225000	Maharashtra
289	GUARDIAN CASTINGS PVT. LTD.	IF	240000	Maharashtra
290	INDRAYANI FERROCAST PVT. LTD.	IF	108000	Maharashtra
291	JALNA SIDDHIVINAYAK ALLOYS PVT. LTD.	IF	108000	Maharashtra
292	KALIKA STEEL ALLOYS PVT LTD	IF	250000	Maharashtra
293	MAHALAXMI TMT PVT LTD	IF	360000	Maharashtra
294	MATSYODARI STEEL ALLOYS PVT. LTD.	IF	144000	Maharashtra
295	METAROLLS ISPAT PVT LTD.	IF	158000	Maharashtra
296	OMSAIRAM STEEL AND ALLOYS PVT. LTD.	IF	195000	Maharashtra
297	PADMAVATI DEVI STEEL PVT LTD	IF	168000	Maharashtra
298	R L STEELS AND ENERGY LTD.	IF	144000	Maharashtra
299	RAMSONS CASTING PVT LTD	IF	100000	Maharashtra
300	SRJ PEETY STEELS PVT. LTD.	IF	300000	Maharashtra
301	VIRAJ PROFILES LTD.	IF	528000	Maharashtra
302	BHAGWATI STEEL CAST P LTD	IF	108000	Maharashtra
303	BHAGYALAXMI ROLLING MILL PVT. LTD.	IF	300000	Maharashtra
304	BHULESHWAR STEEL AND ALLOYS PVT. LTD	IF	144000	Maharashtra
305	GEETAI STEELS PVT LTD	Re-Rolling	150000	Maharashtra
306	GUARDIAN CASTINGS PVT. LTD.	Re-Rolling	240000	Maharashtra
307	INDIA STEEL WORKS LTD.	Re-Rolling	120000	Maharashtra
308	ISMT LIMITED	Re-Rolling	350000	Maharashtra
309	JALNA SIDDHIVINAYAK ALLOYS PVT. LTD.	Re-Rolling	108000	Maharashtra
310	JSW STEEL LTD. - DOLVI UNIT 2	Re-Rolling	1500000	Maharashtra
311	KALIKA STEEL ALLOYS PVT LTD	Re-Rolling	250000	Maharashtra
312	MAHALAXMI TMT PVT LTD	Re-Rolling	560000	Maharashtra
313	METAROLLS ISPAT PVT LTD.	Re-Rolling	158000	Maharashtra
314	MUKAND LTD.	Re-Rolling	500000	Maharashtra

Sr. No	Company Name	Route	Capacity	State
315	OMSAIRAM STEEL AND ALLOYS PVT. LTD.	Re-Rolling	195000	Maharashtra
316	PUSHPAK STEEL INDUSTRIES PVT LTD- UNIT II	Re-Rolling	100000	Maharashtra
317	RAJURI STEEL PVT. LTD.	Re-Rolling	120000	Maharashtra
318	RAMSONS CASTING PVT LTD	Re-Rolling	100000	Maharashtra
319	SAARLOHA ADVANCED MATERIALS PVT LTD.	Re-Rolling	200000	Maharashtra
320	SHARDA SHREE ISPAT LTD.	Re-Rolling	270000	Maharashtra
321	SHILPA STEEL & POWER LTD	Re-Rolling	161000	Maharashtra
322	SRJ PEETY STEELS PVT. LTD.	Re-Rolling	300000	Maharashtra
323	SUNFLAG IRON AND STEEL CO LTD.	Re-Rolling	500000	Maharashtra
324	TATA STEEL LTD - GLOBAL WIRES	Re-Rolling	300000	Maharashtra
325	JSW STEEL LTD. - DOLVI UNIT 1	Re-Rolling	3500000	Maharashtra
326	UTTAM VALUE STEELS LIMITED	Re-Rolling	1000000	Maharashtra
327	ASIAN COLOUR COATED LTD.	CR Product	600000	Maharashtra
328	ESSAR STEEL INDIA LTD - PUNE (SHREE PRECOATED STEELS)	CR Product	600000	Maharashtra
329	JAI CORP LIMITED	CR Product	300000	Maharashtra
330	JSW STEEL COATED PRODUCTS LTD. - NAGPUR	CR Product	600000	Maharashtra
331	JSW STEEL COATED PRODUCTS LTD. - TARAPUR PLANT	CR Product	725000	Maharashtra
332	JSW STEEL COATED PRODUCTS LTD. - VASIND PLANT	CR Product	380000	Maharashtra
333	POSCO MAHARASHTRA STEEL PVT. LTD.	CR Product	1350000	Maharashtra
334	TATA STEEL BSL LTD	CR Product	600000	Maharashtra
335	TATA STEEL LTD - COLLED ROLLING COMPLEX (WEST)	CR Product	300000	Maharashtra
336	THYSSENKRUPP ELECTRICAL STEEL INDIA PVT. LTD.	CR Product	245000	Maharashtra
337	UTTAM GALVA STEELS LTD.	CR Product	1150000	Maharashtra

Sr. No	Company Name	Route	Capacity	State
338	UTTAM VALUE STEELS LIMITED	CR Product	350000	Maharashtra
339	ASIAN COLOUR COATED LTD	GP/GC Products	200000	Maharashtra
340	ESSAR STEEL INDIA LTD - PUNE (SHREE PRECOATED STEELS)	GP/GC Products	450000	Maharashtra
341	JAI CORP LIMITED	GP/GC Products	180000	Maharashtra
342	JSW STEEL COATED PRODUCTS LTD.	GP/GC Products	580000	Maharashtra
343	JSW STEEL COATED PRODUCTS LTD.	GP/GC Products	1006000	Maharashtra
344	JSW STEEL COATED PRODUCTS LTD.	GP/GC Products	525000	Maharashtra
345	POSCO MAHARASHTRA STEEL PVT. LTD.	GP/GC Products	450000	Maharashtra
346	TATA STEEL BSL LTD	GP/GC Products	320000	Maharashtra
347	UTTAM GALVA STEELS LTD.	GP/GC Products	754000	Maharashtra
348	UTTAM VALUE STEELS LIMITED	GP/GC Products	250000	Maharashtra
349	ASIAN COLOUR COATED LTD - MAHARASTRA	Colour coated products	150000	Maharashtra
350	ESSAR STEEL INDIA LTD - PUNE (SHREE PRECOATED STEELS)	Colour coated products	400000	Maharashtra
351	JSW STEEL COATED PRODUCTS LTD. - NAGPUR	Colour coated products	192000	Maharashtra
352	JSW STEEL COATED PRODUCTS LTD. - TARAPUR PLANT	Colour coated products	305000	Maharashtra
353	JSW STEEL COATED PRODUCTS LTD. - VASIND PLANT	Colour coated products	225000	Maharashtra
354	TATA STEEL BSL LTD	Colour coated products	150000	Maharashtra
355	UTTAM GALVA STEELS LTD.	Colour coated products	150000	Maharashtra
356	ISMT LIMITED	Pipes	475000	Maharashtra
357	MAHARASHTRA SEAMLESS LTD	Pipes	660000	Maharashtra
358	TATA STEEL BSL LTD	Pipes	500000	Maharashtra
359	VIBHOR STEEL TUBES PVT LTD.	Pipes	100000	Maharashtra

Sr. No	Company Name	Route	Capacity	State
360	JSW STEEL COATED PRODUCTS LTD. - TARAPUR PLANT	Tin Plates	200000	Maharashtra
361	GOPANI IRON AND POWER (INDIA) PVT LTD	Sponge Iron	144000	Maharashtra
362	GRACE INDUSTRIES LIMITED	Sponge Iron	144000	Maharashtra
363	JSW STEEL (SALAV) LTD.	Sponge Iron	900000	Maharashtra
364	JSW STEEL LTD. - DOLVI UNIT 1	Sponge Iron	1600000	Maharashtra
365	LLOYDS METALS AND ENERGY LTD.	Sponge Iron	300000	Maharashtra
366	SUNFLAG IRON AND STEEL CO LTD.	Sponge Iron	262000	Maharashtra
367	AMBA RIVER COKE LIMITED	pellets	4000000	Maharashtra
368	B R G IRON AND STEEL CO. PVT. LTD.	BF	120000	Odisha
369	BHUSHAN POWER AND STEEL LTD - ODISHA	BF	2500000	Odisha
370	JINDAL STEEL AND POWER LTD - ODISHA	BF	3200000	Odisha
371	MIDEAST INTEGRATED STEELS LTD.	BF	460000	Odisha
372	NEELACHAL ISPAT NIGAM LTD.	BF	1099000	Odisha
373	SAIL - ROURKELA STEEL PLANT	BF	4400000	Odisha
374	TATA STEEL BSL LTD - ODISHA	BF	3919000	Odisha
375	TATA STEEL BSL LTD - ODISHA	BF	3000000	Odisha
376	VISA STEEL LTD.	BF	225000	Odisha
377	NEELACHAL ISPAT NIGAM LTD.	BOF	900000	Odisha
378	SAIL - ROURKELA STEEL PLANT	BOF	3800000	Odisha
379	TATA STEEL BSL LTD - ODISHA	BOF	3700000	Odisha
380	TATA STEEL LTD - KALINGANAGAR WORKS	BOF	3000000	Odisha
381	AARTI STEEL LTD	EAF	200000	Odisha
382	B R G IRON AND STEEL CO. PVT. LTD.	EAF	120000	Odisha
383	BHUSHAN POWER AND STEEL LTD - ODISHA	EAF	3050000	Odisha
384	JINDAL STAINLESS LTD - ODISHA	EAF	800000	Odisha
385	JINDAL STEEL AND POWER LTD - ODISHA	EAF	5000000	Odisha
386	TATA STEEL BSL LTD - ODISHA	EAF	1700000	Odisha
387	JAI BALAJI JYOTI STEELS LTD.	IF	115200	Odisha
388	OCL IRON AND STEEL LTD.	IF	127500	Odisha
389	PATNAIK STEELS AND ALLOYS LTD.	IF	100000	Odisha
390	RELIABLE SPONGE PVT. LTD.	IF	120000	Odisha
391	RUNGTA MINES LTD.(KAMANDA)	IF	231000	Odisha
392	S M C POWER GENERATION LTD.	IF	350000	Odisha
393	SHREE GANESH METALIKS LTD.	IF	141000	Odisha
394	SHYAM METALICS AND ENERGY LTD	IF	363000	Odisha
395	SREE METALIKS LTD.	IF	180000	Odisha

Sr. No	Company Name	Route	Capacity	State
396	SURENDRA MINING INDUSTRIES PVT. LTD.	IF	100000	Odisha
397	THAKUR PRASAD SAO AND SONS PVT. LTD. - IV	IF	100000	Odisha
398	VIRAJ STEEL AND ENERGY PVT LTD	IF	100000	Odisha
399	JINDAL STEEL AND POWER LTD - ODISHA	Re-Rolling	1200000	Odisha
400	RELIABLE SPONGE PVT. LTD.	Re-Rolling	144000	Odisha
401	S M C POWER GENERATION LTD.	Re-Rolling	180000	Odisha
402	SCAN STEELS LTD. - I	Re-Rolling	120000	Odisha
403	SHYAM METALICS AND ENERGY LTD	Re-Rolling	120000	Odisha
404	THAKUR PRASAD SAO AND SONS PVT. LTD. - IV	Re-Rolling	100000	Odisha
405	BHUSHAN POWER AND STEEL LTD - ODISHA	HRP	2000000	Odisha
406	JINDAL STAINLESS LTD - ODISHA	HRP	1600000	Odisha
407	JINDAL STEEL AND POWER LTD - ODISHA	HRP	1200000	Odisha
408	SAIL - ROURKELA STEEL PLANT	HRP	3250000	Odisha
409	TATA STEEL BSL LTD - ODISHA	HRP	5400000	Odisha
410	TATA STEEL LTD - KALINGANAGAR WORKS	HRP	2940000	Odisha
411	BHUSHAN POWER AND STEEL LTD - ODISHA	CRP	1200000	Odisha
412	JINDAL STAINLESS LTD - ODISHA	CRP	800000	Odisha
413	SAIL - ROURKELA STEEL PLANT	CRP	678000	Odisha
414	TATA STEEL BSL LTD - ODISHA	CRP	700000	Odisha
415	BHUSHAN POWER AND STEEL LTD - ODISHA	GP/GCP	560000	Odisha
416	SAIL - ROURKELA STEEL PLANT	GP/GCP	180000	Odisha
417	TATA STEEL BSL LTD - ODISHA	GP/GCP	375000	Odisha
418	BHUSHAN POWER AND STEEL LTD - ODISHA	CCP	200000	Odisha
419	TATA STEEL BSL LTD - ODISHA	CCP	225000	Odisha
420	BHUSHAN POWER AND STEEL LTD - ODISHA	PIPES	380000	Odisha
421	SAIL - ROURKELA STEEL PLANT	PIPES	150000	Odisha
422	SAIL - ROURKELA STEEL PLANT	Tinplates	150000	Odisha
423	AARTI STEEL LTD	Sponge Iron	320000	Odisha
424	ARYAN ISPAT AND POWER PVT. LTD.	Sponge Iron	165000	Odisha
425	BHASKAR STEEL AND FERRO ALLOYS PVT. LTD	Sponge Iron	120000	Odisha
426	BHUSHAN POWER AND STEEL LTD - ODISHA	Sponge Iron	1800000	Odisha
427	GREWAL ASSOCIATES PVT. LTD.	Sponge Iron	120000	Odisha

Sr. No	Company Name	Route	Capacity	State
428	JAI BALAJI JYOTI STEELS LTD.	Sponge Iron	120000	Odisha
429	JINDAL STEEL AND POWER LTD - ODISHA	Sponge Iron	1800000	Odisha
430	KAMALJEET SINGH AHLUWALIA (STEEL AND POWER DIV)	Sponge Iron	300000	Odisha
431	MGM MNERALS LTD	Sponge Iron	105000	Odisha
432	NARBHERAM POWER & STEEL (P) LTD	Sponge Iron	100000	Odisha
433	OCL IRON AND STEEL LTD.	Sponge Iron	330000	Odisha
434	PATNAIK STEELS AND ALLOYS LTD.	Sponge Iron	110000	Odisha
435	RUNGTA MINES LTD.(KAMANDA)	Sponge Iron	556500	Odisha
436	RUNGTA MINES LTD.(KARAKOLHA)	Sponge Iron	180000	Odisha
437	S M C POWER GENERATION LTD.	Sponge Iron	200000	Odisha
438	SCAN STEELS LTD. - II	Sponge Iron	120000	Odisha
439	SHREE GANESH METALIKS LTD.	Sponge Iron	120000	Odisha
440	SHRI JAGANNATH STEELS AND POWER LTD	Sponge Iron	115500	Odisha
441	SHYAM METALICS AND ENERGY LTD	Sponge Iron	600000	Odisha
442	SREE METALIKS LTD.	Sponge Iron	240000	Odisha
443	TATA STEEL BSL LTD - ODISHA	Sponge Iron	1500000	Odisha
444	TATA STEEL LONG PRODUCTS LTD	Sponge Iron	425000	Odisha
445	THAKUR PRASAD SAO AND SONS PVT. LTD. - IV	Sponge Iron	110000	Odisha
446	VIRAJ STEEL AND ENERGY PVT LTD	Sponge Iron	220000	Odisha
447	VISA STEEL LTD.	Sponge Iron	300000	Odisha
448	ARDENT STEEL LIMITED	Pellets	600000	Odisha
449	ARYA IRON AND STEEL COMPANY PVT LTD	Pellets	1200000	Odisha
450	BHUSHAN POWER AND STEEL LTD - ODISHA	Pellets	3850000	Odisha
451	BRAHMANI RIVER PELLETS LIMITED	Pellets	4000000	Odisha
452	ESSAR STEEL INDIA LTD - ODISHA	Pellets	6000000	Odisha
453	JINDAL STEEL AND POWER LTD - ODISHA PELLET	Pellets	9000000	Odisha

Sr. No	Company Name	Route	Capacity	State
454	M S P SPONGE IRON PVT. LTD.	Pellets	600000	Odisha
455	SHRI JAGANNATH STEELS AND POWER LTD	Pellets	1200000	Odisha
456	SHRI MAHAVIR FERRO ALLOYS LTD.	Pellets	600000	Odisha
457	SHYAM METALICS AND ENERGY LTD	Pellets	300000	Odisha
458	SREE METALIKS LTD.	Pellets	600000	Odisha
459	SUMANGALA STEELS PRIVATE LIMITED	IF	150000	Puducherry
460	SUMANGALA STEELS PRIVATE LIMITED	Re-Rolling	138000	Puducherry
461	AARTI STEEL LTD.	EAF	118000	Punjab
462	ARORA IRON AND STEEL ROLLING MILLS	EAF	294000	Punjab
463	ARORA IRON AND STEEL ROLLING MILLS	EAF	125000	Punjab
464	VARDHMAN SPECIAL STEELS	EAF	225000	Punjab
465	BHAWANI INDUSTRIES PVT LTD.	IF	162000	Punjab
466	KISCO CASTINGS	IF	120000	Punjab
467	MADHAV ALLOYS PVT LTD (SMS DIVISION)	IF	310000	Punjab
468	AARTI STEEL LTD.	Re-Rolling	200000	Punjab
469	ALLIED RECYCLING LTD	Re-Rolling	112505	Punjab
470	ARORA IRON AND STEEL ROLLING MILLS	Re-Rolling	291000	Punjab
471	BHARAT ISPAT UDYOG	Re-Rolling	100000	Punjab
472	BHAWANI INDUSTRIES PVT LTD.	Re-Rolling	140000	Punjab
473	FORTUNE METALS LIMITED	Re-Rolling	100000	Punjab
474	G O STEEL PVT LTD	Re-Rolling	150000	Punjab
475	MADHAV ALLOYS PVT LTD (SMS DIVISION)	Re-Rolling	310000	Punjab
476	MADHAV STELCO PVT. LTD.	Re-Rolling	140000	Punjab
477	PRIME STEEL PROCESSORS	Re-Rolling	100000	Punjab
478	RASIK INDUSTRIES	Re-Rolling	100000	Punjab
479	UPPER INDIA STEEL MFG CO. LTD.	Re-Rolling	124300	Punjab
480	VARDHAMAN ADARSH ISPAT PVT. LTD.	Re-Rolling	120000	Punjab
481	VARDHMAN SPECIAL STEELS	Re-Rolling	200000	Punjab
482	AVON STEEL INDUSTRIES PVT LTD.(FORMERLY AVON ISPAT)	HRP	325000	Punjab
483	AVON ISPAT AND POWER LTD(COLD ROLLED STRIP DIVISION)	CRP	120000	Punjab

Sr. No	Company Name	Route	Capacity	State
484	HERO STEELS LTD(FORMERLY HERO CYCLE INDUSTRIES LTD.)	CRP	225000	Punjab
485	AVON STEEL INDUSTRIES PVT LTD.(FORMERLY AVON ISPAT)	PIPES	100000	Punjab
486	JTL INFRA LIMITED	PIPES	100000	Punjab
487	J S W L - VALLABH TINPLATE PRIVATE LIMITED	Tinplates	109000	Punjab
488	SYNERGY STEELS LTD.	IF	150000	Rajasthan
489	ASHIANA ISPAT LTD	Re-Rolling	135000	Rajasthan
490	ASHIANA MANUFACTURING INDIA LTD	Re-Rolling	180000	Rajasthan
491	ELEGANCE TMT PRIVATE LIMITED (FORMERLY D S R STEELS PVT. LTD.)	Re-Rolling	124500	Rajasthan
492	KAMDHENU LIMITED(FORMERLY KAMDHENU ISPAT LIMITED)	Re-Rolling	156000	Rajasthan
493	MANGALA ISPAT (JAIPUR) LTD UNIT NO II	Re-Rolling	120000	Rajasthan
494	PREMIER BARS PVT LTD	Re-Rolling	120000	Rajasthan
495	RATHI BARS LTD.	Re-Rolling	100000	Rajasthan
496	RATHI SPECIAL STEEL LTD	Re-Rolling	150000	Rajasthan
497	SHREE KRISHNA ROLLING (JAIPUR) MILLS	Re-Rolling	100000	Rajasthan
498	SHRI RATHI STEEL (DAKSHIN) LTD	Re-Rolling	120000	Rajasthan
499	SYNERGY STEELS LTD.	Re-Rolling	200000	Rajasthan
500	JINDAL SAW LTD	Pellets	1500000	Rajasthan
501	J S W STEEL LTD. - SALEM (SISCOL)	BF	1000000	Tamil Nadu
502	J S W STEEL LTD. - SALEM (SISCOL)	BOF	1000000	Tamil Nadu
503	SAIL - SALEM STEEL PLANT	EAF	180000	Tamil Nadu
504	AGNI STEELS PVT LTD - ERODE - UNIT II	IF	138700	Tamil Nadu
505	MTC BUSINESS PVT LTD(K L CONCAST)	IF	112000	Tamil Nadu
506	NOBLE TECH INDUSTRIES PVT LTD.	IF	264500	Tamil Nadu
507	SREE RENGARAAJ ISPAT PVT LTD - ERODE	IF	100000	Tamil Nadu
508	SURYADEV ALLOYS AND POWER PVT. LTD.	IF	179000	Tamil Nadu
509	TULSYAN NEC LTD.	IF	144300	Tamil Nadu
510	AGNI STEELS PVT LTD - UNIT II	Re-Rolling	164250	Tamil Nadu
511	ARS STEELS INTERNATIONAL PRIVATE LTD	Re-Rolling	128000	Tamil Nadu
512	ARUN VYOPAR UDYOG LTD.	Re-Rolling	120000	Tamil Nadu
513	J S W STEEL LTD. - SALEM (SISCOL)	Re-Rolling	1000000	Tamil Nadu

Sr. No	Company Name	Route	Capacity	State
514	KAMACHI INDUSTRIES LIMITED LTD	Re-Rolling	500000	Tamil Nadu
515	NOBLE TECH INDUSTRIES PVT LTD.	Re-Rolling	108000	Tamil Nadu
516	SURYADEV ALLOYS AND POWER PVT. LTD.	Re-Rolling	145000	Tamil Nadu
517	TULSYAN NEC LTD	Re-Rolling	300000	Tamil Nadu
518	SAIL - SALEM STEEL PLANT	HRP	500000	Tamil Nadu
519	SAIL - SALEM STEEL PLANT	CRP	125000	Tamil Nadu
520	TUBE PRODUCTS OF INDIA LTD	CRP	100120	Tamil Nadu
521	KAMACHI INDUSTRIES LIMITED LTD	Sponge Iron	120000	Tamil Nadu
522	NOBLE TECH INDUSTRIES PVT LTD.	Sponge Iron	165600	Tamil Nadu
523	SREE RENGARAAJ ISPAT PVT LTD	Sponge Iron	115830	Tamil Nadu
524	DEVASHREE ISPAT PVT LTD	IF	250000	Telangana
525	JEEVAKA INDUSTRIES LTD. - UNIT II	IF	120000	Telangana
526	RADHA SMELTERS LTD.	IF	207090	Telangana
527	SUGNA METALS PVT LTD	IF	120000	Telangana
528	JEEVAKA INDUSTRIES LTD. - UNIT II	IF	120000	Telangana
529	RADHA SMELTERS LTD - SHANKARAMPET	IF	277992	Telangana
530	RAYALASEEMA STEELS LTD.	IF	120000	Telangana
531	SCAN ENERGY AND POWER LTD	IF	150000	Telangana
532	SUGNA METALS PVT LTD	Re-Rolling	120000	Telangana
533	GALLANTT ISPAT LTD	IF	330000	Uttar Pradesh
534	RIMJHIM ISPAT LTD	IF	200000	Uttar Pradesh
535	GALLANTT ISPAT LTD	Re-Rolling	330000	Uttar Pradesh
536	K L RATHI STEELS LTD.	Re-Rolling	100000	Uttar Pradesh
537	K L STEELS (P) LTD.	Re-Rolling	100000	Uttar Pradesh
538	PANEM STEELS PVT LTD	Re-Rolling	100000	Uttar Pradesh
539	PANEM STEELS PVT LTD	Re-Rolling	200000	Uttar Pradesh
540	RATHI STEEL AND POWER LTD.	Re-Rolling	175000	Uttar Pradesh
541	SARVOTTAM ROLLING MILLS PVT LTD	Re-Rolling	100000	Uttar Pradesh
542	SHRI RATHI STEEL LTD	Re-Rolling	120000	Uttar Pradesh

Sr. No	Company Name	Route	Capacity	State
543	SHRI SATGURU METALLOYS PVT LTD	Re-Rolling	100000	Uttar Pradesh
544	SRI JAIBALAJI STEEL ROLLING MILLS PVT LTD	Re-Rolling	120000	Uttar Pradesh
545	HI-TECH PIPES LIMITED	CRP	180000	Uttar Pradesh
546	HI-TECH PIPES LIMITED	CRP	850000	Uttar Pradesh
547	TATA STEEL BSL LTD	GP/GCP	360000	Uttar Pradesh
548	TATA STEEL BSL LTD	CCP	100000	Uttar Pradesh
549	APOLLO METALEX PVT LTD(UNIT-II)	PIPES	144000	Uttar Pradesh
550	HI-TECH PIPES LIMITED	PIPES	180000	Uttar Pradesh
551	VISHAL PIPES LIMITED	PIPES	180000	Uttar Pradesh
552	GALLANTT ISPAT LTD	Sponge Iron	297000	Uttar Pradesh
553	GALWALIA ISPAT UDYOG PVT LTD	IF	237600	Uttarakhand
554	KASHIVISHWANATH STEEL	IF	134440	Uttarakhand
555	GALWALIA ISPAT UDYOG PVT LTD	Re-Rolling	292160	Uttarakhand
556	KASHIVISHWANATH STEEL	Re-Rolling	102610	Uttarakhand
557	SHREE SIDHBALI INDUSTRIES LTD.	Re-Rolling	120000	Uttarakhand
558	TEHRI IRON AND STEEL INDUSTRIES	Re-Rolling	145000	Uttarakhand
559	ELECTROSTEEL CASTINGS LIMITED- KHARDAH	BF	250000	West Bengal
560	JAI BALAJI INDUSTRIES LTD UNIT - 3	BF	428750	West Bengal
561	K I C METALIKS LTD.	BF	165000	West Bengal
562	NEO METALIKS LTD	BF	188000	West Bengal
563	RASHMI METALIKS LIMITED	BF	170333	West Bengal
564	SAIL - DURGAPUR STEEL PLANT	BF	1802000	West Bengal
565	SAIL - IISCO STEEL PLANT	BF	2500000	West Bengal
566	TATA METALIKS LTD.	BF	600000	West Bengal
567	SAIL - DURGAPUR STEEL PLANT	BOF	2200000	West Bengal
568	SAIL - IISCO STEEL PLANT	BOF	2500000	West Bengal
569	SAIL - ALLOY STEELS PLANT	EAF	234000	West Bengal
570	SHYAM STEEL INDUSTRIES LTD.	EAF	239600	West Bengal
571	ADHUNIK CORPORATION LTD.	IF	108000	West Bengal
572	BDG METAL AND POWER LIMITED	IF	346400	West Bengal
573	BRGD INGOTS PVT LTD	IF	140400	West Bengal
574	CONCAST STEEL AND POWER LTD.	IF	162000	West Bengal
575	EAST INDIA HOLDINGS PVT. LTD.	IF	130000	West Bengal
576	GAGAN FERROTECH LIMITED	IF	264000	West Bengal
577	JAI BALAJI INDUSTRIES LTD. UNIT - 4	IF	294030	West Bengal
578	RASHMI METALIKS LIMITED	IF	378000	West Bengal

Sr. No	Company Name	Route	Capacity	State
579	ROHIT FERRO TECH LTD	IF	100000	West Bengal
580	S P S STEEL ROLLING MILLS	IF	100000	West Bengal
581	SHAKAMBHARI ISPAT AND POWER . LTD.	IF	346800	West Bengal
582	SHIVAM INDIA LIMITED	IF	108000	West Bengal
583	SHREE PARASNATH RE-ROLLING MILLS LTD.	IF	119520	West Bengal
584	SHYAM SEL AND POWER LTD. JAMURIA	IF	201600	West Bengal
585	SHYAM STEEL INDUSTRIES LTD	IF	600000	West Bengal
586	SUPER SMELTERS LTD. - III	IF	160000	West Bengal
587	ADHUNIK INDUSTRIES LTD.	Re-Rolling	222000	West Bengal
588	BMA STAINLESS LIMITED (CAPTAIN STEEL)	Re-Rolling	120000	West Bengal
589	BRAHM (ALLOYS) PVT. LTD.	Re-Rolling	120000	West Bengal
590	BRGD INGOTS PVT LTD	Re-Rolling	140000	West Bengal
591	CONCAST STEEL AND POWER LTD.	Re-Rolling	140000	West Bengal
592	GAGAN FERROTECH LIMITED	Re-Rolling	294000	West Bengal
593	JAI BALAJI INDUSTRIES LTD UNIT - 4	Re-Rolling	260000	West Bengal
594	MAITHAN STEEL AND POWER LTD.	Re-Rolling	150000	West Bengal
595	RASHMI METALIKS LIMITED	Re-Rolling	115200	West Bengal
596	ROHIT FERRO TECH LTD	Re-Rolling	100000	West Bengal
597	S P S STEEL ROLLING MILLS	Re-Rolling	163875	West Bengal
598	S R M B SRIJAN LTD.	Re-Rolling	325000	West Bengal
599	SAIL - CONVERSION AGENT PLANT	Re-Rolling	813000	West Bengal
600	SAIL - DURGAPUR STEEL PLANT	Re-Rolling	560000	West Bengal
601	SAIL - IISCO STEEL PLANT	Re-Rolling	1485000	West Bengal
602	SHAKAMBHARI ISPAT AND POWER . LTD.	Re-Rolling	180000	West Bengal
603	SHIVAM INDIA LIMITED	Re-Rolling	100000	West Bengal
604	SHYAM SEL AND POWER LTD.	Re-Rolling	103008	West Bengal
605	SHYAM STEEL INDUSTRIES LTD	Re-Rolling	250000	West Bengal

Sr. No	Company Name	Route	Capacity	State
606	SHYAM STEEL INDUSTRIES LTD	Re-Rolling	231620	West Bengal
607	SKIPPER LIMITED	Re-Rolling	215000	West Bengal
608	SUPER SMELTERS LTD. - III	Re-Rolling	120000	West Bengal
609	SURYA ALLOY INDUSTRIES LTD.	Re-Rolling	161000	West Bengal
610	SAIL - CONVERSION AGENT PLANT	HRP	200000	West Bengal
611	BHUSHAN POWER AND STEEL LTD	CRP	380000	West Bengal
612	JINDAL (I) LTD.	CRP	400000	West Bengal
613	MANAKSIA LTD	CRP	120000	West Bengal
614	BHUSHAN POWER AND STEEL LTD.	GP/GCP	120000	West Bengal
615	JINDAL (I) LTD.	GP/GCP	400000	West Bengal
616	BRAVO SPONGE IRON PRIVATE LIMITED	Sponge Iron	138000	West Bengal
617	GAGAN FERROTECH LIMITED	Sponge Iron	138600	West Bengal
618	HALDIA STEELS LTD UNIT-I	Sponge Iron	120000	West Bengal
619	JAI BALAJI INDUSTRIES LTD. - I	Sponge Iron	105000	West Bengal
620	JAI BALAJI INDUSTRIES LTD. UNIT - 4	Sponge Iron	120000	West Bengal
621	ORISSA METTALIKS PVT LTD	Sponge Iron	313500	West Bengal
622	RASHMI CEMENT LIMITED (UNIT- III)	Sponge Iron	492750	West Bengal
623	SHAKAMBHARI ISPAT AND POWER . LTD.	Sponge Iron	130000	West Bengal
624	SHYAM SEL AND POWER LTD.	Sponge Iron	325800	West Bengal
625	SHYAM STEEL INDUSTRIES LTD.	Sponge Iron	102300	West Bengal
626	SHYAM STEEL MANUFACTURING UNIT	Sponge Iron	150000	West Bengal
627	SUPER SMELTERS LTD. - III	Sponge Iron	420000	West Bengal
628	ORISSA METTALIKS PVT LTD	Pellets	1320000	West Bengal
629	RASHMI METALIKS LIMITED	Pellets	900000	West Bengal
630	SHYAM SEL AND POWER LTD.	Pellets	600000	West Bengal
631	SUPER SMELTERS LTD. - III	Pellets	1000000	West Bengal