Steering India into a US$5 trillion economy with Steel

December 2021

Confederation of Indian Industry

Building a better working world

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Foreword

India's economy is ranked 6th at about US$2600 billion in nominal GDP terms. CEBR forecasts that the Indian economy will expand by 9 per cent in 2021 and by 7 per cent in 2022 and therefore poised to be the 5th largest by 2024 and 3rd largest by 2030 at the current forecasted growth rates. The target is to be a US$5 trillion economy as measured by the nominal GDP by 2024-25.

To become a US$5 trillion economy, India's GDP needs to go faster than an average of 7.5 per cent in the next four years. Inflation needs to be at 4 per cent to ensure commensurate increase in purchasing power. The target of 5 trillion economy and a global economic powerhouse by 2024-25 is "challenging" but "realizable".

While services will be a key growth driver of the GDP for India, steel, sourced from India, for gross fixed capital formation in rail, road, ports, airports, irrigation, energy, housing, mining, oil and gas and petro-chemicals, creating capacity for manufacturing, construction, mining will be the cornerstone of setting the foundations of immediate and long-term sustainability of meeting GDP growth targets of the future.

The India steel sector has been vibrant and has been growing at a CAGR of about 5%-6% y-o-y. With a V-shaped demand recovery post-COVID, policy announcements made by the government across sectors, including rail, road, aviation, gas pipeline, and housing and changes in global supply demand equations, the industry has made record production and growth. To sustain and accelerate the trend and use it as an opportunity to invest the Indian steel industry needs:

- Policy formulation and implementation for steel and other allied industries which are likely to impact demand of steel from India for India.
- Preparation for making the most of upcoming export opportunities for Indian Steel.
- Rapid execution of building the required logistics infrastructure to ensure speed of service and permit simplicity and scale of operations of steel making.
- Increased investments in domestic R&D or sourcing technology through strategic partnerships of steel manufacturing for a significant uplift in quality, yield and reducing emissions.

While the government would provide support to the steel industry for rapid growth through policy formulation and strict governance on meeting execution of those, industry players have to play their part in demonstrating discipline of capital spends and foresight on investment in the right technologies for expansion. The global forces of global trade and sustainability, notwithstanding, the government and the industry would need to work in sync to execute existing strategic plan, update it on the basis of emerging threats and opportunities which are unique and relevant to India, and draw up a collaborative game plan to nurture the future of a robust and a sustainable steel industry.

CII and EY have created this joint report to articulate the key impediments to accomplishing a fast-paced sectoral growth, the progress made against the current plan and suggestions for support from all the key stakeholders. CII and EY wish to thank the leaders and captains of the industry for the time spent in sharing their inputs through the creation of this thought paper.

We hope you enjoy reading the report.

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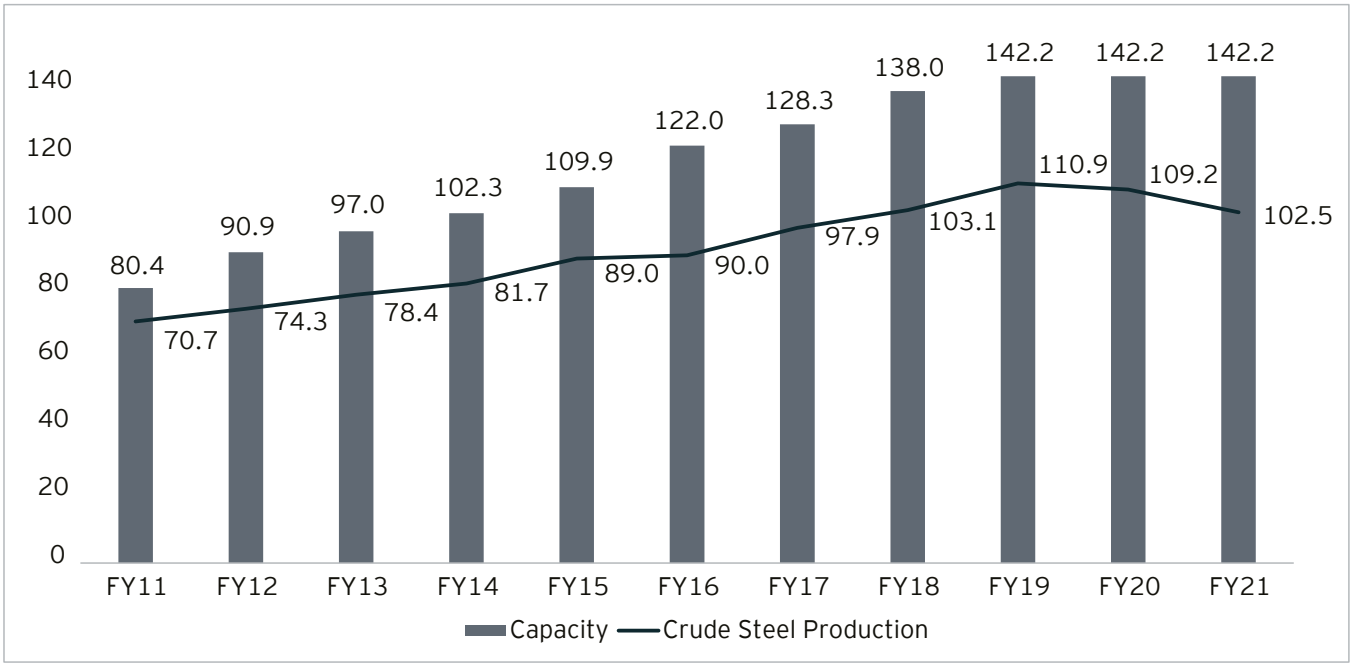
Introduction

The economic development of India is dependent to a considerable extent on the performance of country's steel sector. Steel as a commodity has multiple applications across sectors like infrastructure and manufacturing, and contributes to a great extent towards the economic growth of the nation. Today, India is the second largest crude steel producer (production of ~102 MT in FY21[1]) with an installed capacity of ~142 MT[2].

India – crude steel capacity and production (MT)

During FY11-21, growth in crude steel production (CAGR of 3.8%) has not kept pace with the growth in capacity (CAGR of 5.9%) leading to under-utilization



Source: Ministry of Steel, Govt. of India

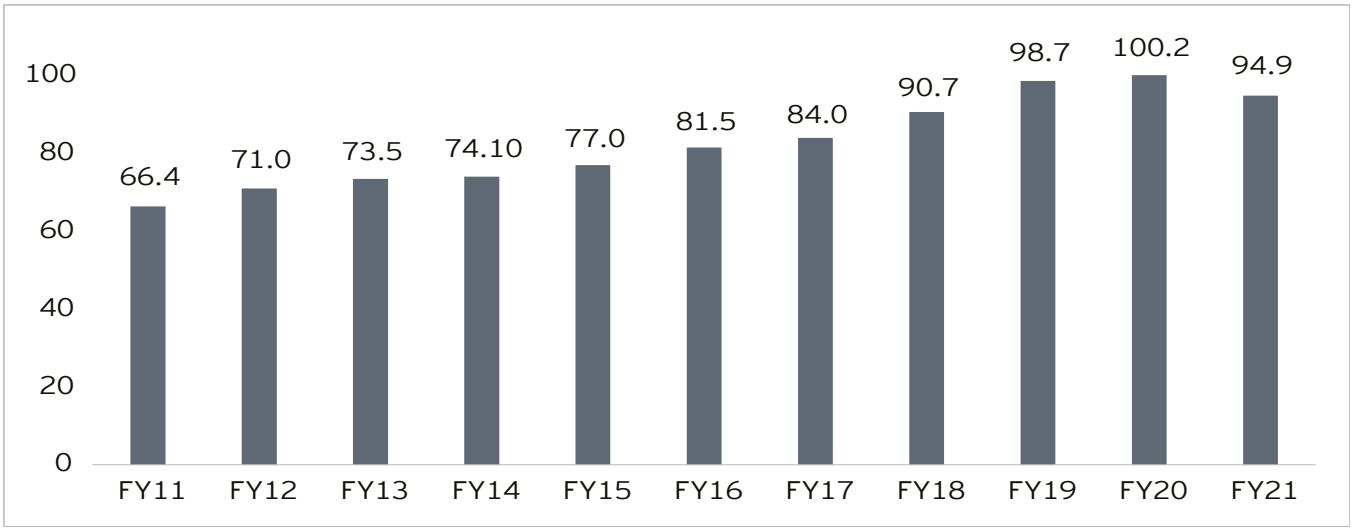
The steel sector in India contributes ~2% to the Gross Domestic Product (GDP)[3] of the country and employs about 0.5 million people directly and about 2 million people indirectly[4]. The sector has an output multiplier of 1.4x[5] and an employment multiplier of 6.8x[6]. India's steel production and GDP have followed a similar growth path over the years which demonstrates the economy's dependence on steel.

[1] IBEF
[2] Annual Report 2020-21 – Ministry of Steel, Government of India
[3 4 5 6] National Steel Policy 2017

On the consumption front, India is the third largest steel consumer in the world with a finished steel consumption of ~95 MT in FY21[7]. While the finished steel demand has kept pace with the growth in production, India's per capita steel consumption of finished steel for the year 2019-20 was 74.6 kg[8] against the world average of 229 kg.

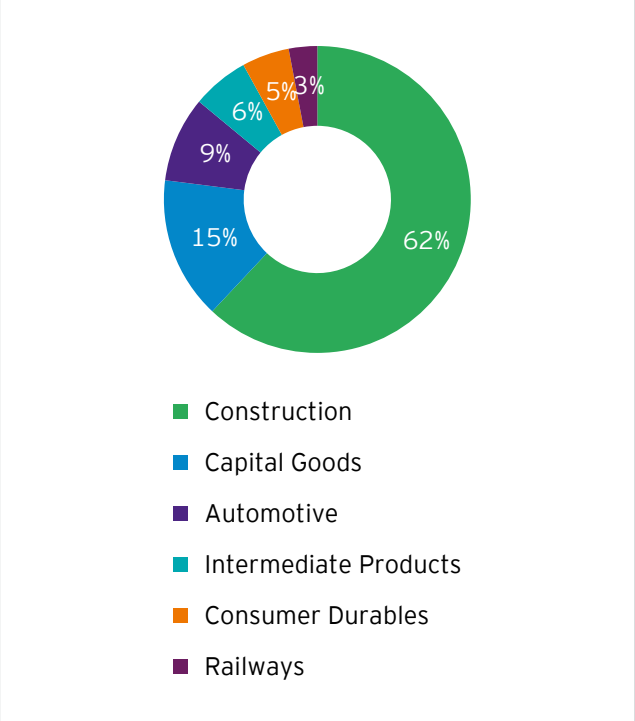
India – finished steel consumption (MT)

Finished steel consumption has grown at a CAGR of ~4% (between FY11-21) with construction sector accounting for ~62% of demand



Source: Ministry of Steel, Govt. of India

India – end-use sectors of finished steel



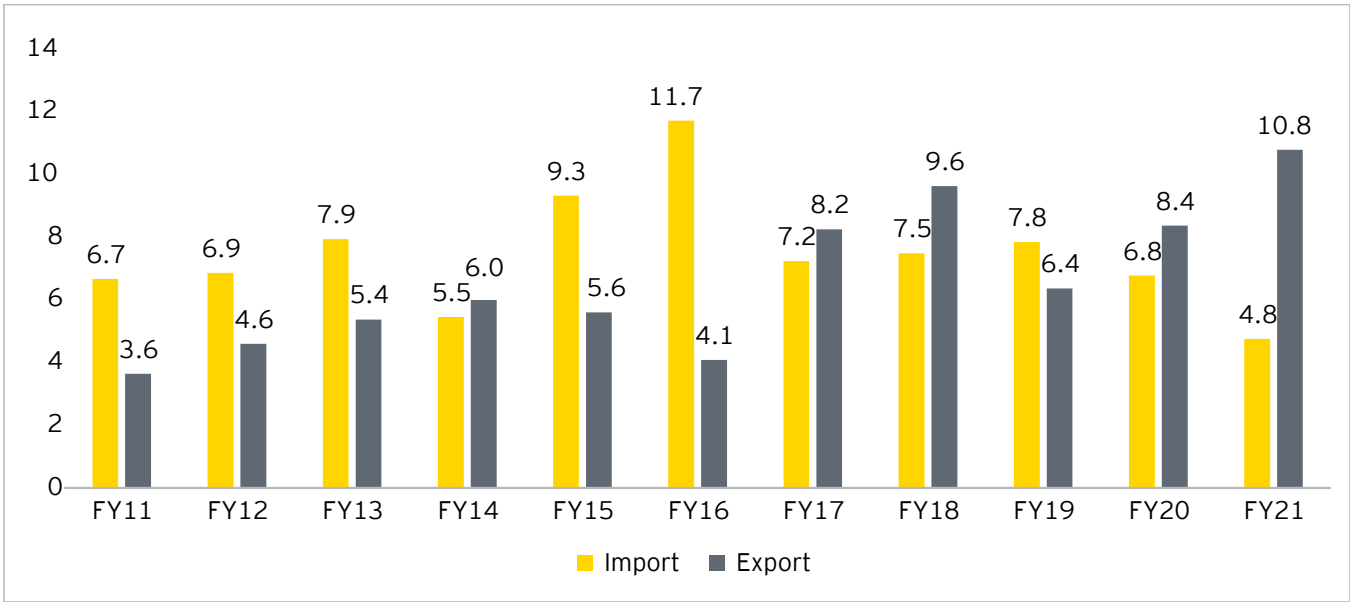
Source: Research report on Metals: Steel Industry by CARE (July 2021)

[7] IBEF
[8] Ministry of Steel, Government of India

India has traditionally been a net importer of finished steel. However, in recent years, India has become a net exporter of finished steel. In FY20-21, steel imports to India was ~30% lower y-o-y while steel exports increased by ~50% y-o-y[9]. The growth in exports during the last two years has predominantly been on account of subdued domestic demand. India is cost competitive with respect to finished steel production but loses this advantage once the material moves out of the plant due to higher logistics cost, associated taxes and levies resulting in a price differential[10] with respect to international prices.

India – export and import of finished steel (MT)

Between FY11 and FY21, finished steel import has decreased at a CAGR of 3.3%, whereas export has increased at a CAGR of 11.5%.



Source: CMIE

India has foreign trade agreements (FTAs) with countries like Japan and South Korea, but both these countries export value-added steel products to India compared to India which exports mostly hot rolled coils (HRCs) to these countries. This is evident from India's average import value of steel which is considerably higher (due to import of high-grade steel)[11], compared to the average export value (due to export of basic grade steel). Markets like EU and USA have imposed protectionist measures like quota restrictions and additional tariffs respectively on imports while Middle East is also considering similar measures. Even though India is the second-largest producer of finished steel globally, value added / specialty steel accounted for only 18% share[12] in FY21. Specialty steel production in India was able to meet 85% of the domestic demand in FY21, with the balance met through imports. A significant portion of steel import was of specialty steel comprising high grade alloy steel and specialty steel.

Government of India has formulated policies aimed at strengthening the domestic steel sector. Some of the key policies include the National Steel Policy 2017, Steel scrap policy, Domestically Manufactured Iron and Steel Products (DMI & SP) policy in Government procurement. In addition to the above policies, the government has announced a host of initiatives which includes launching the Production linked incentive (PLI) scheme for specialty steel, ensuring raw material security for steel sector focused on iron ore and coal, support to MSMEs of EEPC for promotion of exports, enhancing the scope of Quality Control orders on steel and setting up an Empowered Group of Secretaries (EGoS) and Project Development Cells (PDCs) in Ministries/ Departments for attracting investments and to handhold and further smoothen investment inflows.

Steel making is energy intensive, comprising the use of coal and contributes around 7% of total global emissions

[9] CMIE
[10] Industry research
[11] [12] PLI scheme for specialized steel is a big boost for the industry (livemint.com)

of carbon dioxide. Reducing emissions in the steel making process remains a major challenge as it requires an informed choice of clean technologies while balancing business risks, quality of end products and capital cost.

Various players in the sector are assessing and adopting clean technologies, setting targets for meeting their energy requirements from renewable sources, carbon emission, water, solid waste and safety. There is also a concerted effort to adopt circular economy principles in the steel industry. Key players in the steel industry have started sharing ESG related updates on a quarterly basis and the investor community is placing considerable importance on organization's ESG standards. Companies with a better ESG performance will have access to better and larger pool of financing, reduce operational risk and be more resilient against economic shocks. In the recently held COP26 in Glasgow, India has promised to increase its non-fossil fuel energy capacity to 500 GW by 2030; fulfil 50% of its energy requirements from renewable energy sources by 2030; reduce its total projected carbon emissions by 1 billion tonnes between now and 2030; reduce the carbon intensity of its economy by 45% by 2030; and achieve the target of net zero emissions by 2070[13]. Considering the current positioning with respect to emission, energy intensity and usage of fossil fuel, the steel industry will play a pivotal role towards India meeting the above targets.

The steel sector relies on the availability of resources like iron ore, coking/metallurgical coal. steel scrap and power. India has adequate iron ore reserves but has deposits which are of lower grade. Utilization of iron ore fines and low-grade iron ore is a key determinant for the success of the industry. India does not have sufficient reserves of coking/metallurgical coal and is dependent on imported coking coal which are subject to wide price fluctuation. The industry has undertaken multiple initiatives aimed at optimizing the consumption of critical resources and reducing wastage across the iron and steel value chain. Use of digital technologies and advanced analytics as an enabler for optimizing the resource utilization have been initiated by the key players in the industry.

Another area which is crucial towards contributing to economic growth is to enhance the presence of the steel industry in the value-added product segment. While India produces value added steel, the steel product portfolio is tilted towards the low to mid-range of value-added products. India is dependent on imports of high grade/special steels for some advanced applications because the country does not either have the technology know-how for steel grades or has not been able to create a sizeable market for manufacturing such grades on an economic scale.

The Indian steel sector has bounced back in FY22 reversing the performance in FY21 which was impacted by a significant decrease in economic activity due to the COVID-19 pandemic. With the revival in economic activity, India is expected to grow at 9.5% in FY22[14]. Steel demand is expected to pick up as the key end-use sectors have shown signs of revival.

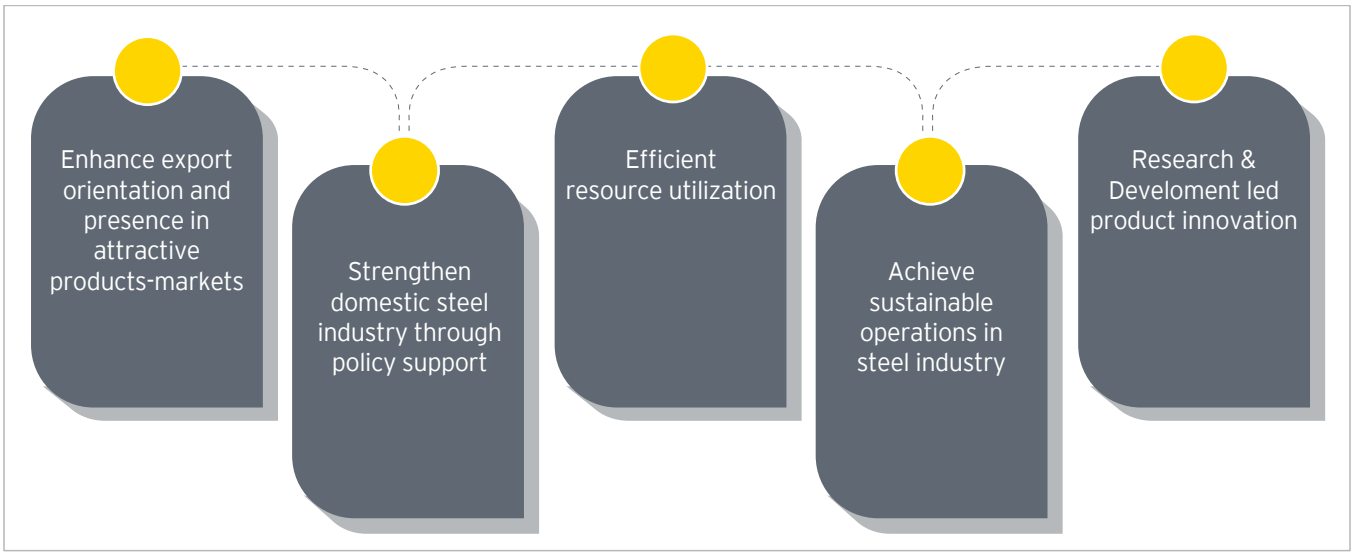
While the prospects of the steel sector look promising, for it to play a key role in steering to make India into a US$5 trillion economy the following aspects should be addressed.

> To drive inclusive economic growth and meet projected targets , the Indian Steel Industry needs to follow a three point agenda-
>
> Foremost, the sector needs to focus on efficient utilisation of resources to optimise production and thereby increase the nation's Steel output. This will foster economic development,aid more value creation and generate job opportunities across the value chain.
>
> Secondly, to focus on Steel to be the material of choice for National infrastructure and construction projects.
>
> Finally, promote 'Make in India' by leveraging domestic capabilities to manufacture engineering products for the domestic and International markets

Jayant Acharya, Director - Commercial and Marketing, JSW Steel

[13] https://www.hindustantimes.com/world-news/indias-pledge-among-most-substantive-climate-expert-101636406598856.html

[14] https://retail.economictimes.indiatimes.com/news/industry/india-economy-poised-to-attain-double-digit-growth-in-fy22-phdcci/86956237



The following sections provides a deep dive on the above areas and present the challenges, suggest ways to address these challenges and the role which key stakeholders should play in supporting the steel sector to achieve its full potential.

Challenges, interventions and role of key stakeholders

1

Enhance export orientation and presence in attractive products-markets

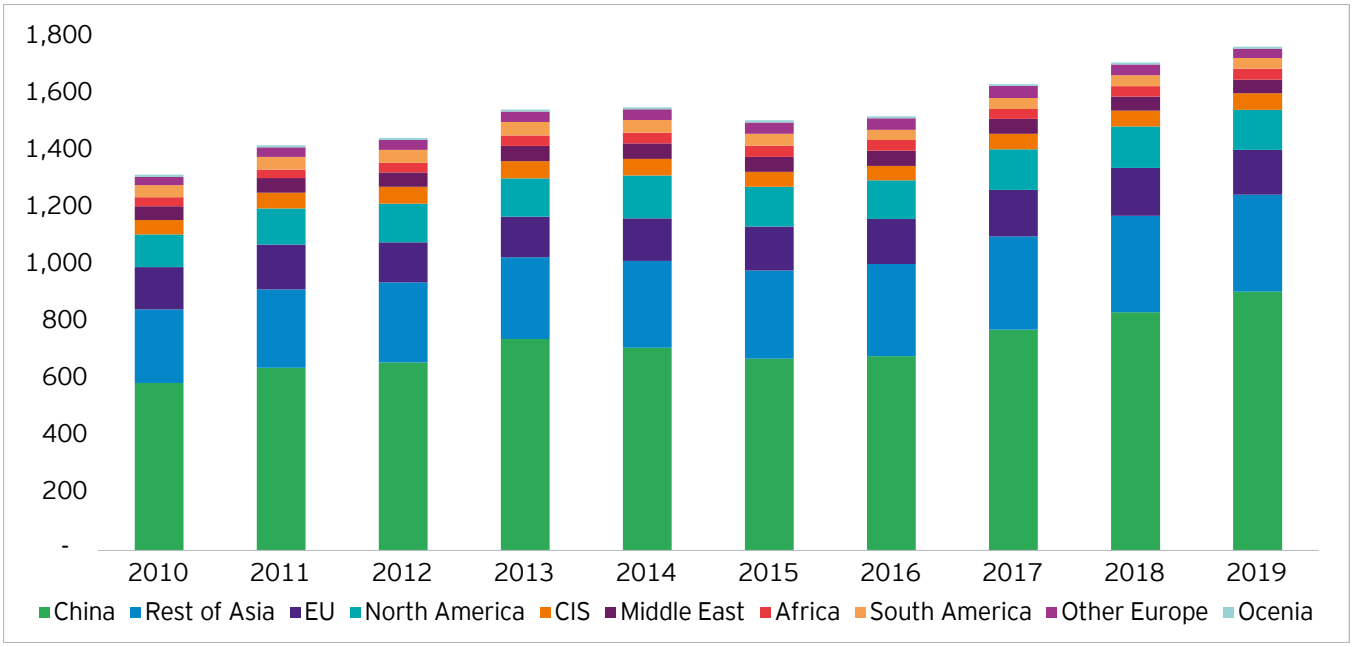
Context

Demand for steel in the 20th century was led by USA and Europe and was linked to the entry of these countries / regions into the industrialization phase. Steel consumption has a strong co-relation with growth in an economy. Economic growth drives spend on infrastructure as well as consumption resulting in spending on automobiles and white goods which are drivers of steel demand. With the onset of the century the demand centre shifted to Asia with China becoming the key driver for global steel demand.

The global demand for finished steel grew at a rapid rate of ~9%[15] during the first decade of this century powered by industrialization and demand from end-use sectors. In the next decade the finished steel demand witnessed a growth of ~3%[16].

Global steel demand - finished steel products (MT)

Compared to overall growth rate, China and Rest of Asia grew at a faster rate; EU, USMCA, CIS and Africa grew at a slower rate; Oceania, South America and Middle East have witnessed a de-growth between 2010-19

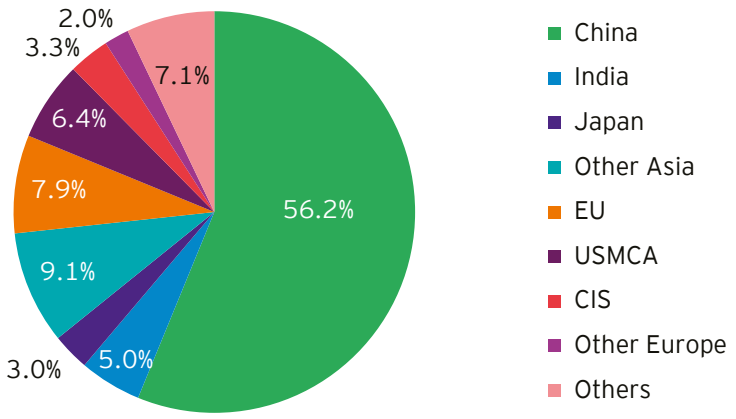


Source: Worldsteel Association

[15] [16] Worldsteel Association

Share of demand for finished steel products (2020)

Finished steel products usage was 1772 MT (y-o-y growth of 0.3%) with China, India and Japan being the top three consuming countries with a combined share of ~64%

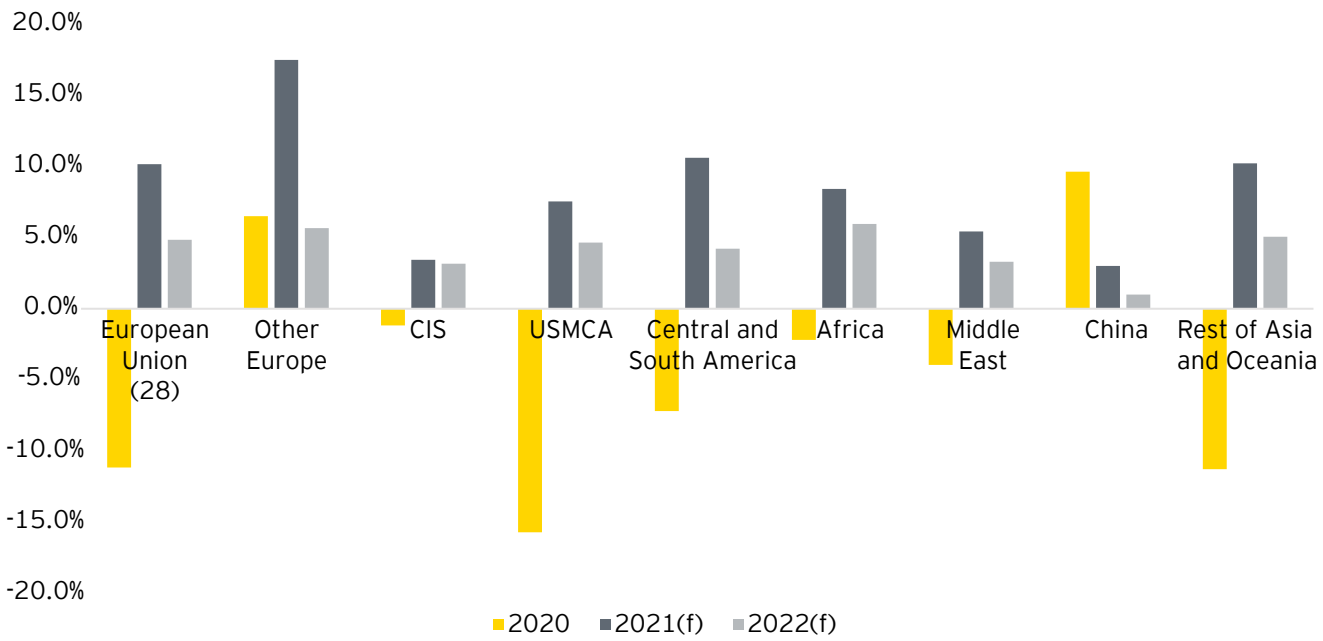


Source: Worldsteel Association

The global steel industry faced recessionary pressure in 2019. Towards the end of 2019 the COVID-19 pandemic struck which led to stoppage / slowing down of economic activity across regions including the end-use industries of steel. However, there was no major impact on overall global steel demand in 2020 due to the quick recovery in China. Emerging economies were impacted more by the pandemic due to lock-down.

Finished steel demand across regions (y-o-y growth rate)

In 2020, steel demand in China grew at 9.6% (y-o-y) while the demand in rest of the world dipped by a similar extent. Rest of Asia (excluding China) & Oceania, USMCA and EU were the worst impacted.



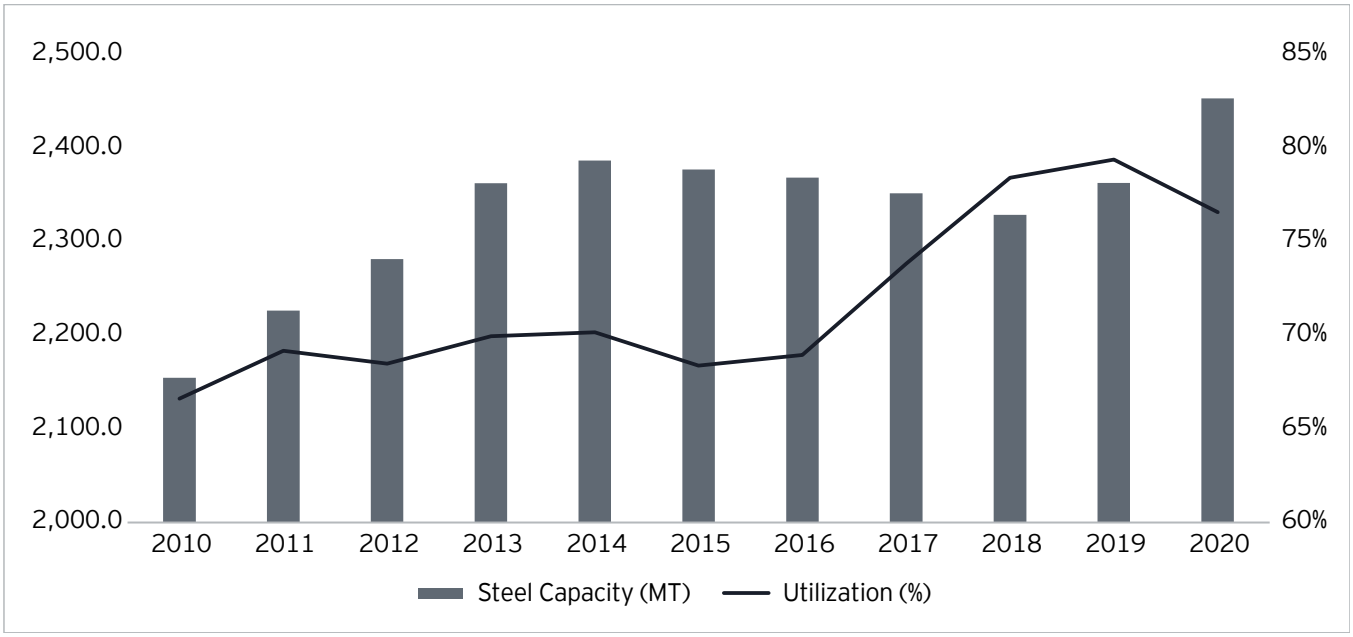
Source: Worldsteel Short Range Outlook (SRO) April 2021

In 2021, steel demand has bounced back in both the developed and developing economies. While steel demand in developing economies have returned to the pre-pandemic levels, some of developed economies will probably take a bit longer to reach to the pre-pandemic levels. The recovery in steel demand will be dependent on factors like evolution of the virus and progress of vaccinations, withdrawal of supportive fiscal and monetary policies, geo-politics and trade relations.

On the supply front, the steel industry continues to face the challenge of excess capacity.

Global crude steel capacity and utilization

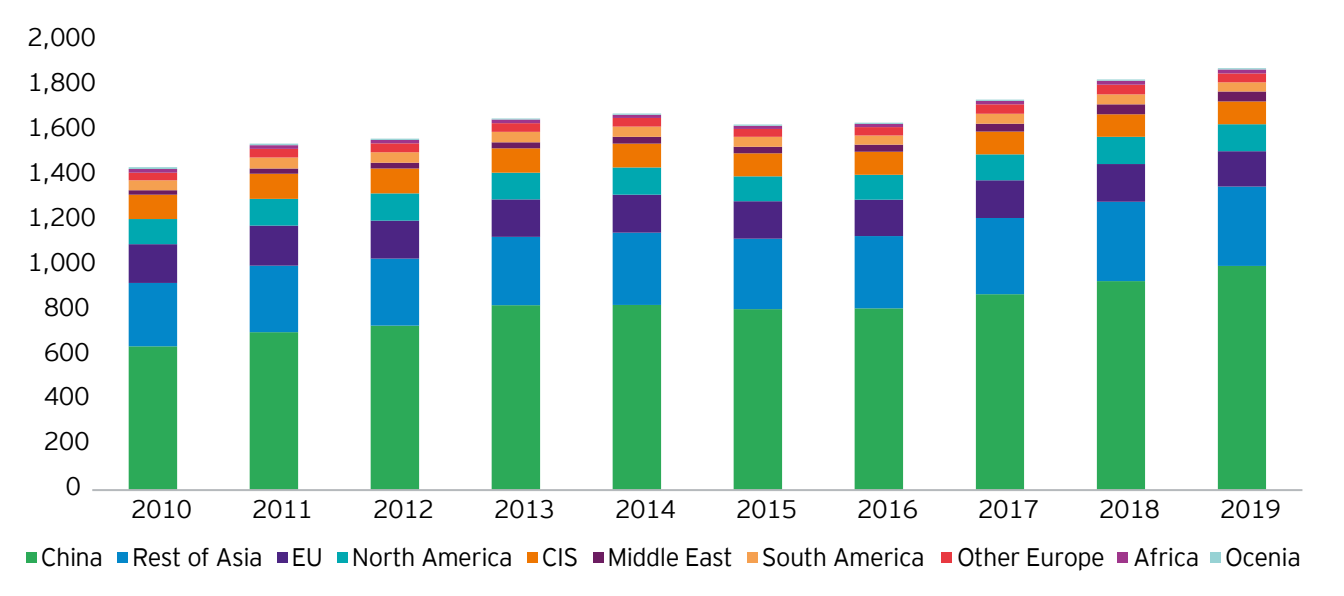
Even though the utilization levels have improved over the last decade, there is still a considerable gap between capacity and production.



Source: Worldsteel Association

Global crude steel production (MT)

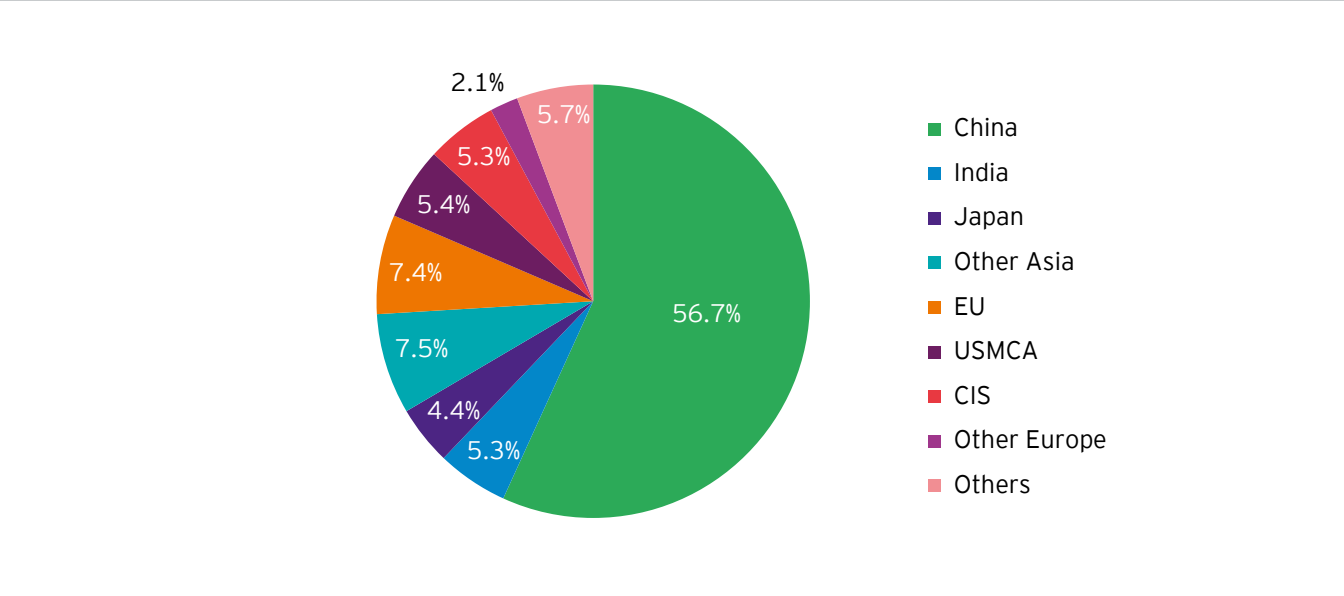
Crude steel production witnessed a growth of ~3% during 2010-2019.[17] Compared to overall crude steel production growth rate, China and Middle East grew at a faster rate; Rest of Asia, North America, Other Europe and Africa grew at a slower rate; EU, CIS, South America and Oceania have witnessed a de-growth between 2010-19



Source: Worldsteel Association

Share of global crude steel production (2020)

Crude steel production was 1878 MT with China accounting for 56.7% of the share, followed by India (~5.3%) and Japan (4.4%).



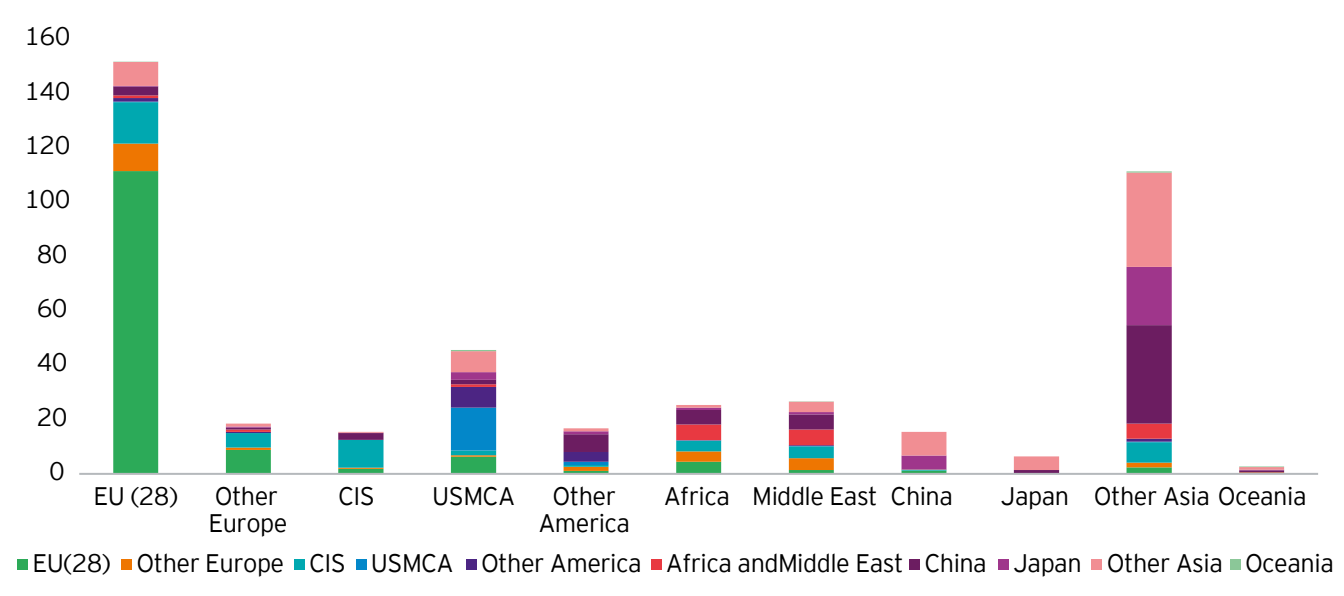
Source: Worldsteel Association

In 2019, the global steel trade was around 436 million tons of which extra-regional trade accounted for ~57% (~248 million tons)[18].

[17] [18] Worldsteel Association

World steel trade in 2019 (MT) - import by destination area and contribution of source areas

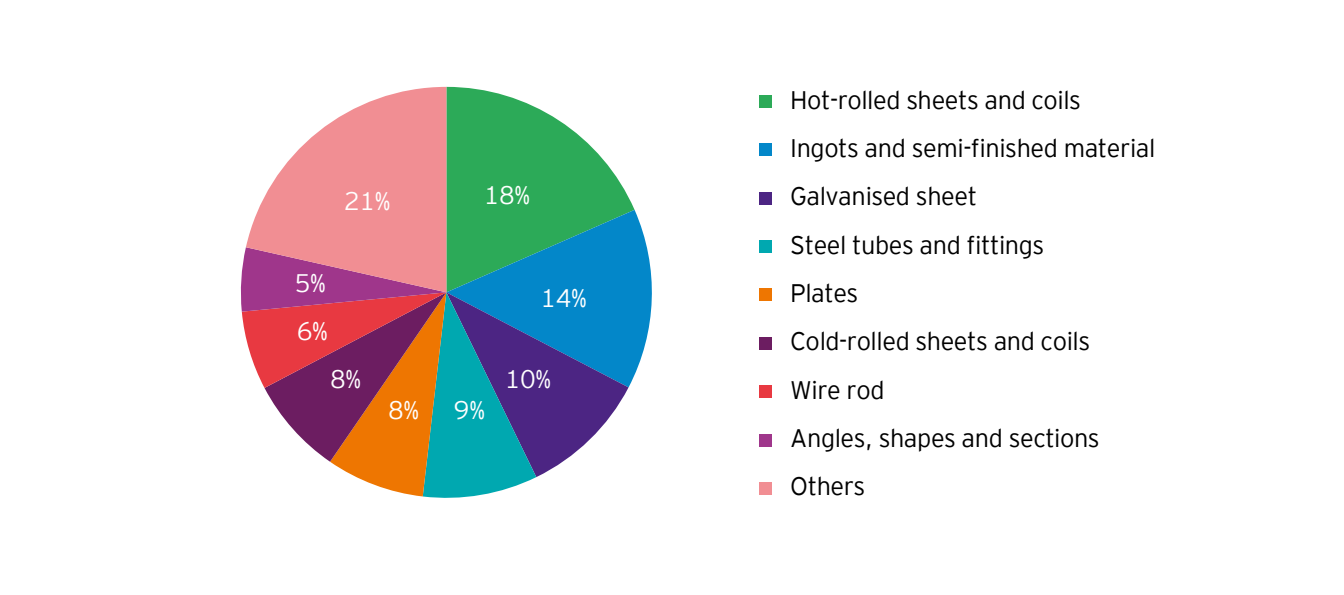
Africa and Middle East, USMCA, EU (28) and Other Asia (excluding China, Japan, India, South Korea) were net importer whereas China, Japan, CIS and India were net exporter of steel. South-East Asia (Thailand, Vietnam, Indonesia, Philippines), US and the EU (28) were the major steel importers in 2019.



Source: Worldsteel Association

World steel exports by product (2019)

Around 20 categories of steel products were traded in 2019 of which the top 8 (indicated below) accounted for ~80% in volume terms.

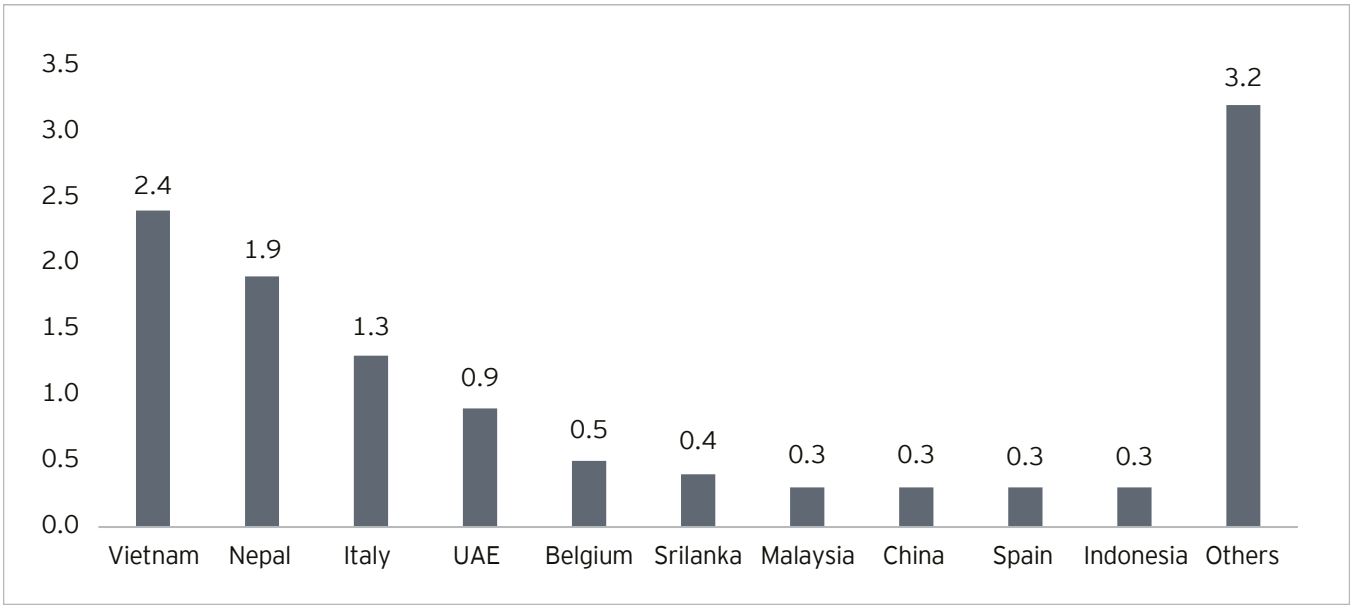


Source: Worldsteel Association

India was the world's 12th largest steel exporter in 2019 with an export of 11.8 MT of steel, an increase of 18% from the 9.7 MT exported in 2018[19]. India's steel export volume was ~12% of its production in 2019[20]. Over the past few years, India has alternated between being a net steel importer and a net steel exporter.

Top export market of steel for India in 2019 (MT)

In terms of export, the top 10 markets of steel from India account for ~73% of the total steel exported from India. India exports steel to over 180 countries with steel accounting for ~60% of the total exports from India.



Source: SteelMint – India EXIM Report CY19

India's top export markets by volume vary across types of steel products. In flat products, India's largest export category, Vietnam accounted for the largest share of imports in 2019 at 28%[21]. Around 36% of India's long products exports (0.35 MnT) were sent to Nepal in 2019[22]. Nepal also accounted for 39% (0.96 MnT) of India's exports of semi-finished (billets) steel[23].

[19 20 21 22 23] SteelMint – India EXIM Report CY19

India steel export in 2019 – by products and sub-products (MT)

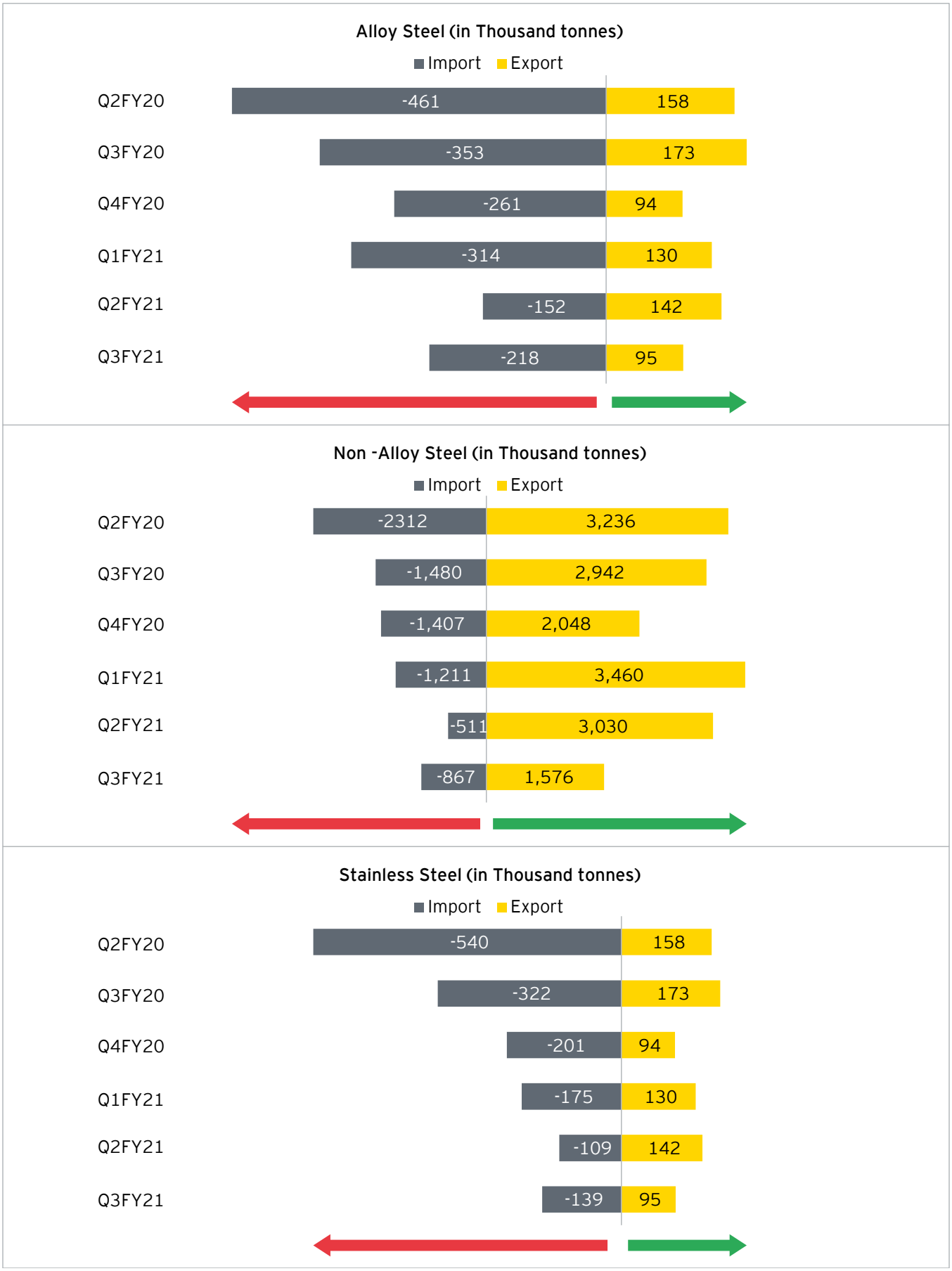
Of the total exports in 2019, flat products accounted for ~71% of the volume, while long products and semi-finished steel accounted for ~8% and ~21% respectively. HRC/Plate in Flats and Rebar in Longs were the dominant sub-products exported.

Product	Sub-Product	Export volume (MT)
Finish Flat	HRC/Plate	5.45
	Galvanized Steel	1.07
	Pipes and Tubes	1.06
	CRC	0.62
	Electrical Steel	0.11
	Others	0.07
Total		**8.39**
Finish Long	Rebar	0.51
	Wire Rod	0.25
	Structure	0.19
Total		**0.95**
Sem-Finish	Billet	2.46
Overall		**11.80**

Source: SteelMint – India EXIM Report CY19

While India, at an overall level, has become a net exporter of finished steel, it still is a net importer for alloy and stainless steel. On one side, the domestic stainless-steel industry has a low-capacity utilization due to low price imports, we are also dependent on import of most of the super duplex, super austenitic and high alloyed varieties of stainless steel for stringent end use applications.

Quarterly trend of export and import of alloy non-alloy and stainless steel



Source: EMIS

Though India is the world's second largest steel producing nation, it ranks way below Japan, US, Korea, and Europe when it comes to the production of high-grade steel or specialty steel. India meets 15% of its annual demand for specialty steel through imports[24]. Out of India's total steel imports of 6.7 MT, nearly 60% can be attributed to the imports of specialty steel.This import constitutes specialty steel[25] including the steel grades used in coated/plated steel products, specialty rails, high-strength-wear resistant steel products, electrical steel, wires, and alloy steel products amongst others.

[24] https://www.livemint.com/companies/news/pli-scheme-for-specialized-steel-a-big-positive-says-jsw-steel-s-seshagiri-rao-11627212593451.html
[25] https://www.livemint.com/industry/manufacturing/cabinet-approves-6-322-cr-pli-scheme-for-specialty-steel-11626953892961.html

A view of the key emerging and industrialized markets is presented below:

Region	Steel demand and supply in the region
South-East Asia	▸ Consumption of ~80 MTPA in 2018[26] ▸ Vietnam is fastest growing steel consuming country in the region[27] ▸ Flats account of ~51%[28] of demand ▸ Demand for long products met through domestic supply and flats through imports ▸ Construction is the largest steel consuming sector (~73% share) [29] ▸ Demand expected to grow by ~6% to reach ~75MT in 2021[30]
Middle East	▸ Apparent steel use in 2020 was ~46 MT with Iran being the largest consumer (~17 MT)[33] ▸ Construction and infrastructure are the key end-use industry ▸ Government stimulus package expected to support the construction industry[34] ▸ Crude steel production was ~45 MT in 2020[35]. Iran was the largest crude steel producer (29MT)[36]. ~95%[37] of crude steel produced through electric route
EU	▸ Demand of ~78 MT of flats in 2020 with 82% met through European deliveries[42] ▸ HR flat products, coated sheets and cold rolled sheet are the key flat categories used ▸ Demand of ~50 MT of long products in 2020 with 91% of the demand met through European deliveries[43] ▸ Rebars, wire rods, merchant bars are the key long categories used ▸ End- use industries and their share - Construction (38%), Automotive (16%), Mechanical Engineering (15%), Metalware (14%), Tubes (10%) and Others (~6%)[44] ▸ Demand is expected to re-bound by ~13% y-o-y in 2021 and grow by ~3% through 2022[45]
USMCA	▸ ~5.4% (101 MT)[50] of global crude steel production in 2020 ▸ ~6.4% (~114 MT)[51] of global finished steel products used in 2020 ▸ Flat trend in steel use during 2016-2019 with a sharp dip in 2020 due to the impact of the COVID-19 pandemic
Latin america	▸ Apparent steel use in 2020 was ~39MT with Brazil accounting for ~55% share[55] ▸ Construction and automotive sector together account for ~67% of steel demand[56] ▸ Steel consumption has recovered and performed better than the pre-pandemic level ▸ Crude steel production was ~39MT (in 2020) with Brazil accounting for ~80% share[57] ▸ ~68% crude steel production is through BOF route[58] ▸ Continuous cast steel output was ~38MT (in 2020)[59] ▸ Crude steel production has bounced back performing slightly better than pre-pandemic level

[26 27 28 29 30 31] The ASEAN Steel Industry Situation - SEAISI

[30] SEAISI

[33 35 36 37 38 39 40 50 51 52 55 60 57 58 59 60 61 62] Worldsteel Association

[34] https://www.oecd.org/industry/ind/steel-market-developments-Q2-2021.pdf

[41] https://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=DSTI/SC(2021)1/FINAL&docLanguage=En

Steel trade	Key pointers for Indian steel industry
▸ Region is a net importer: ~50%[31] of demand met through imports ▸ China is the largest source of steel imports ▸ Largest export market for India (~3 MT in 2019)[32] ▸ Key categories of import include HR Coils, Coated Sheets, CR Coils and HR Plates in flats and Wire Rods, Bar and Section in longs	▸ Key destination for HRC/Plates produced in India which is value added in the region ▸ Sufficient downstream capacities but limited upstream capacities ▸ Key market for India considering China's policy of curtailing production and discontinuation of export incentive ▸ Increased focus on value addition in India may impact steel availability for export
▸ Region imported ~26MT of steel in 2020 (~20MT imported from other regions)[38] ▸ Saudi Arabia is a key importer (net imports of ~5.7MT)[39] ▸ Turkey is a net exporter (export of 18.5 MT and import of 12.5 MT)[40]	▸ Government stimulus packages to continue driving demand in the region ▸ Iranian steel industry expected to become export oriented (~20 - 25 MT) targeted for export by 2025[41] ▸ Market proximity provides comparative advantage for steel exports from India

▸ Net importer of finished steel products in 2020[46]
▸ ~21 MT of finished steel products imported in 2020
  ▸ ~12 million tons were from EU (28), ~8 million tons from Asia[47]
  ▸ 78.5% was flat products[48]
▸ India exported 1.3 MT and 0.5 MT to Italy and Belgium respectively in 2019[49]
	▸ EU dependent on other regions for certain grades not manufactured locally
	  ▸ Indian steel players have developed such products/ grades for customers in the region. However, trade protectionist measures are impacting India's potential to supply steel

▸ Region imported ~36 MT of steel in 2020 of which ~60% was from other regions[52] ▸ Region is a net importer of steel ▸ USA is world's leading importer of steel with import of ~20 MT ▸ Flats accounts for the 33% of imports followed by semi-finished products (27%), pipe and tube products (20%), long products (17%)[53] and stainless-steel products (3%)[54] ▸ India is one of the leading sources of stainless steel imported by US	▸ Export of steel from India to this region has witnessed a dip due to a series of anti-dumping cases and more recently due to imposition of tariffs
▸ Region was a net importer of steel in 2020 (net import of 3.1 MT)[60] ▸ Import from outside the region account for 11.5 MT[61] ▸ Brazil is a key steel exporter globally (net exporter of 8.7 MT)[62]	▸ Region has been primarily considered as a source for iron ore ▸ However, Latin America offers potential market for Indian steel export especially in the wake of China curbing domestic production and removing export incentive

[41 42 43 44 45 46 47] European Steel in Figures 2021 - Eurofer
[49] India EXIM report CY19 - SteelMint
[53 54] https://legacy.trade.gov/steel/countries/pdfs/imports-us.pdf
[56] https://www.alacero.org/sites/default/files/publicacion/america_latina_en_cifras_2020_es-en_09nov.pdf

Challenges related to export of finished steel

Indian steel industry faces specific challenges with respect to export of finished steel:

- Limited emphasis on developing a well-defined strategy for export of steel products. Typically steel is available for export when there is a dip in domestic demand and/or when the export market offers better realization.
- Large portions of Indian steel exports comprise Hot Rolled Coils/Plates and Billets which are on the low end of the steel value chain. These products are further value added by the importing countries / regions and either locally consumed or exported. India lacks sufficient capacity for value added steel like galvanized, colour coated and Restriction of Hazardous ROHS compliant galvanized products.
- Absence of trade agreements with countries / regions where Indian exports are competitive. Additionally, some of the existing trade agreements have not benefitted the Indian steel industry in terms of facilitating export of value-added steel products resulting in adverse balance of trade position.
- Outbound logistics of finished steel places Indian steel producers at a disadvantage. While new ports are coming up in Eastern coast and ports are becoming more efficent from an operations stand point, speed of implementation remains an area of concern. Quick evacuation of finished steel from factory and timely movement to the port are other areas of improvement. Additionaly, availabilty of containers has become a challange due to the disruption in global supply chains.
- Steel produced in India is not cost competitive on Free On Board (FOB) basis. Due to lack of cost competitiveness, India does not have a significant presence in the export market for certain grades of steel (high grade/ special steel) as these require economic scale of production. Goods and services tax (GST) and customs duties for inputs required to manufacture products for export are either exempted or refunded. However, certain duties are outside the ambit of goods and service tax (GST) and are not refunded to exporters, such as value-added tax on transportation fuel, mandi tax and duty on electricity for manufacturing. The commerce ministry has announced the implementation of Remission of Duties and Taxes on Exported Products (RoDTEP) scheme. However, steel sector is not covered under this scheme.
- Imposition of trade barriers / protectionist measures implemented in some regions. For example, EU has a quota system for import of steel by product type and country. Supplies beyond the fixed quota attracts 25% duty. The quota available to India for color coated and other downstream products is very limited. There is a demand for such products (of thinner gauge) from the customers (in construction, automotive and general engineering) in EU and Indian steel producers have developed these products for their customers in the region as they are not produced locally. With such protectionist policies and measures in place, access of value-added Indian steel products in the export market is getting adversely impacted.
- India's export of engineering goods is limited which restricts capability development in the steel industry. A case in point is the automotive sector which is a key end-use industry for finished steel. Due to requirements which the automotive industry places on its suppliers in terms of quality, cost and delivery, the steel industry in India has had to make its internal processes more robust and efficient.

Interventions and role of key stakeholders in enhancing export orientation and presence in attractive products-markets

As India aspires to become a global supply base for steel products the steel industry needs to develop an export-oriented roadmap and start putting in concerted efforts and actions aimed at achieving this aspiration in the short, medium and long term. The key areas where the steel industry should collectively work in making India a global supply base for steel products are:

> India needs to focus on making steel for export of assemblies / sub-assemblies of engineering goods. This would not only contribute towards enhancing exports but also help in improving our capabilities, cost competitiveness, quality and production efficiency

Vineet Singh
Chief Sales Manager - West (Industrial Products and Projects) Tata Steel Ltd.

- Identification of competitive and attractive product-market combination for export – India exports a variety of steel products to over 180 countries. Competitiveness of India's steel products in the export market varies with products and markets due to multiple factors. It is crucial for the Indian steel industry to assess the competitiveness of products across markets as well as identify the trend in volume exported across products-markets to prioritize focus product-market combinations for export. The value proposition offered by steel producers exporting to different markets will be important to understand market specific nuances. Additionally, identifying and executing market development efforts in collaboration with end-use industries will be crucial to further penetrate in existing markets or enter new markets.
- Capacity planning and augmentation coupled with value addition – With a clear-cut strategy defined for export of steel products along with growth plans across product-market combinations, production capacities must be aligned and augmented. The steel industry should give more emphasis on producing value added steel products for new age applications as well as production of engineering goods.
- Explore possibilities of entering into trade agreements with countries / regions where exports are competitive. It is crucial that future policy actions focus more on such destinations with high potential for export of finished steel. The steel industry should work closely with the Govt. in identifying the prospective countries/ regions and product categories for export of steel and provide necessary inputs with respect to drafting the terms of the agreement as well as providing negotiation support. The government of India should engage with the identified countries / regions in finalizing such trade agreements in a time-bound manner. For existing trade agreements which have not served the intended purpose, the government of India will need to work towards re-negotiating and re-framing the terms of the trade agreements with the support of industry bodies.
- The government of India should explore the possibility of imposing reciprocative measures for countries / regions that have imposed trade barriers and are expected to continue with such safeguard mechanisms.
- Strengthening of logistics infrastructure for evacuation of steel products for export – With capacity of steel production set to increase in the coming years, the freight traffic is expected to significantly increase. India's existing infrastructure is already stretched with most of the road and rail network congested and many ports operating at high utilization rates. Without investment in new infrastructure, service levels will deteriorate and transit time will increase, thereby adversely impacting the user industries and resulting in economic loss. Export of steel from India will be also impacted as it will become less competitive on account of higher absolute transit time and variability in transit time. To address the issues related to evacuation of steel products, strengthening and augmentation of logistics infrastructure which includes development of additional ports, dedicated rail connectivity between plants and ports, coastal freight corridors, expressways, last mile road / rail and maintenance of roads could be explored. Additionally, the eco-system of container shipment needs to be strengthened along with improving the availability of containers.
- Steel industry bodies should continue to engage with the commerce ministry in presenting the case for the inclusion of steel sector under the RoDTEP scheme.

> FTAs should provide a win-win situation for the countries involved. Such agreements should have adequate safety mechanisms, periodic review and also a definite tenure after which they are reviewed for continuation or re-negotiation

Vinod Gupta, Executive Director - Commercial, SAIL

2

Strengthen domestic steel industry through policy support

India has done well to scale up its steel manufacturing capacities from 22 MTPA[63] in 1992 to 142 MTPA[64] in 2021. The growth has been slow and steady making it the second largest steel producer globally, directly contributing to 2% of India's GDP and employing about 5 lakh people directly and 22 lakh people indirectly[65]. Its end use in multifarious applications makes steel the bellwether of Indian economic progress. It is said that infrastructure is an enabler for growth and steel is an enabler for infrastructure.

Despite the steady growth some urgent policy interventions by the Indian government could build robustness, eliminate uncertainty and accelerate the growth of the steel sector. The sector would then become capable to support the 'India 5 trillion dollar' landmark and the ambitious NIP (National Infrastructure Pipeline) projects requiring steel for completion.

Basis our analysis, policy interventions would accomplish three outcomes:

- **Accelerate domestic demand across key steel end-use segments**
- **Create capacity for faster and frictionless haul to make and deliver raw material and finished goods equivalent of 300 MT of finished steel by 2030**
- **Ensure competitiveness and sustainability of Indian steel in global markets**

All of the above needs activation and push as early as can be made possible. Having one without the other will not be much helpful. Hence there is a need of specific policy and reformist interventions as described in the section below:

1 Acceleration of domestic demand

Overall steel demand has grown at a healthy CAGR of 5.3% over the past 7 years. However, India's annual per capita steel consumption is 74.1 kg and is one-third the global average (224.5 kg). India's rural per capita consumption at 19 kg per annum is well below the national level. There is large scope to improve the steel usage in various sectors[66].

Fall in demand amidst slow post COVID global economic growth has forced cross imposition of duties by major steel-producing nations. India has also imposed duties to safeguard its domestic steel industry, especially against dumping of flat products in the country. While China has been a major destination for all forms of steel exports during April 20 to September 21, the export volume is likely to go down in the medium term as China systematically transitions to more sustainable pathways of steel production.

All hopes are pinned on the revival and acceleration for the domestic market of the steel sector. However, compared to growth expectations, the sector has some ground to cover. Demand from infrastructure, construction and real estate sectors have been subdued for the last one year. Furthermore, major government infrastructure projects are still delayed as a direct fallout of COVID- 19.

Data from "Projects Today" showed that the number of new project announcements in electricity, infrastructure, irrigation, manufacturing and mining fell to 1,241 valued at 98,000 crore in the June quarter from 2,500 new projects

> India's growth in steel usage shall be driven by demand generated in rural and semi-urban areas. While steel companies are gearing up to address this, a strong system of micro-credit will go a long way in bolstering growth in steel consumption

R.V.Sridhar
Executive Director & CEO – Coated Steel, ArcelorMittal Nippon Steel India

[63] https://steel.gov.in/sites/default/files/draft-national-steel-policy-2017.pdf , National Steel Policy 2017
[64] https://pib.gov.in/newsite/PrintRelease.aspx?relid=196065, Press Information Bureau, GoI, Ministry of Steel
[65] https://www.investindia.gov.in/team-india-blogs/indias-road-towards-being-economic-powerhouse-paved-steel, India's Road Towards Being An Economic Powerhouse Is Paved On Steel
[66] https://steel.gov.in/sites/default/files/Annual Report-Ministry of Steel 2020-21.pdf, Annual Report – Ministry of Steel 2020-21

valued at 3.86 Lakh[67] crores in the same period last year. A few examples which are likely to affect both steel demand as also the capacity to scale the Pan India movement of Raw materials and finished goods of steel:

- The real estate sector is witnessing a continual demand slump due to excess inventory and severe price pressures. The sector is undergoing a transformation where consolidation is becoming the key to survival and success. More and more realtors are entering into joint venture partnerships with smaller players, to pull in resources.
- Bharatmala Pariyojana phase-1[68], the second-largest highways construction project in India, aimed at improving connectivity, especially along economic corridors, border areas and far-flung regions is estimated to be delayed by four years and is envisaged to be completed by 2025-26[69]
- Sagarmala Programme, at an estimated investment of approximately INR 9.7 lakh crores[70], identified across port modernization and new port development, port connectivity enhancement, port-linked coastal economic zone industrialization and coastal community development for phase wise implementation over the period 2015 to 2035 is running behind schedule. Of 98 road connectivity projects to ports, only 14 projects have been completed, similarly, out of 91 rail connectivity projects, only 28 projects have been completed so far[71].
- Auto sector has also witnessed nil to slow growth, resulting in lower demand for steel. The auto sector is caught in cyclic downturn, uncertain capacity utilization due to unavailability of microchips and is also slowing the return of domestic demand.
- The MSME and Capital Goods sectors in India, utilizing steel as an input raw material, exports most of its machinery products with high steel components to the US, UK, Germany, Mexico and UAE, whereas imports a majority of capital goods from South Korea, Japan, China, Hong Kong China and Vietnam. The inadequacy of scale for manufacturing for engineering grade steels has kept the Indian steel manufacturers from committing capacities to the industrial and engineering sector.

Already commenced

Building and construction and more specifically so the steel for housing sector is likely to be benefited by the demographic shifts in the country like urbanization, nuclearization of families, dependency ratios, kutcha to pucca housing and roofing requirements will automatically boost steel demand. PMAY U and G (Housing for All) scheme for building about 350 lakh units of housing will pull in a steady demand of long products to fulfil this need for steel.

The public infrastructure sector growth is getting driven through the NIP with over 9000 projects worth US$2 trillion to make infrastructure-led economic revival and increased Capex spending, which is likely to boost India's steel and cement company's growth[72].

The much-sought vehicle scrappage policy[73] with an aim to phase out old and unfit vehicles in an environment-friendly manner has been drafted and comes into effect from October 2021. This is likely to push consumers to invest more in the auto sector while bringing the cost of raw material down by the recycling of steel. The policy is estimated to cover 51 lakh Light Motor Vehicles (LMVs) that are above 20 years of age and another 34 lakh LMVs above 15 years of age. All vehicle manufacturers to offer 5% discount while selling a new vehicle against a scrapping certificate issued by a registered and authorized scrapping centres.

In Union Budget 2021, the government reduced customs duty to 7.5% on semis, flat and long products of non-alloy, alloy and stainless steels to provide relief to MSMEs[74].

What is to be done

While many reforms and policy announcements have happened, many of these are recent and demonstrate real intent. The government, where possible, in partnership with private companies, will need to establish the speed of implementation of all such investments in order for such reforms to have a bearing on the future of steel industry in India.

[67] https://steel.gov.in/sites/default/files/Annual Report-Ministry of Steel 2020-21.pdf, Annual Report – Ministry of Steel 2020-21
states-go-slow-on-infra-spend-amid-fund-crunch/story-kes6GKQFSItmaJkzSpKaZJ.html

[68] https://www.india.gov.in/spotlight/bharatmala-pariyojana-stepping-stone-towards-new-india

[69] 'Bharatmala Pariyojana likely to get delayed by four years and witness cost escalation', https://www.icra.in/Media/OpenMedia?Key=67b7dfe3-dfcf-4259-b6e2-49c5d84d43e9

[70] https://en.wikipedia.org/wiki/Sagar_Mala_project

[71] Give reasons for delay in projects under Sagarmala programme: Panel - The Hindu BusinessLine

[72] Report of the Task Force Department of Economic Affairs, Ministry of Finance, Government of India https://dea.gov.in/sites/default/files/Report%20of%20the%20Task%20Force%20National%20Infrastructure%20Pipeline%20%28NIP%29%20-%20volume-i_1.pdf

[73] Government announces details of vehicle scrappage policy, https://www.hindustantimes.com/india-news/govt-to-provide-tax-incentives-against-vehicle-scrappage-gadkari-101616057294684.html

[74] https://www.indiabudget.gov.in/

2 Capacity to haul, make and deliver to Atmanirbhar Bharat targets of 300 MT by 2030

Steel plants in India are in the inlands, often in remote areas with severe logistics challenges. Furthermore, as a thumb rule, nearly 3 tons of raw material is needed in form of iron ore and coke to produce 1 ton of steel. Hence, the inbound logistics requirement for steel-making is also significantly high. Thus, raw material and steel travels through a multimodal network of ports, railways and roads to reach the intended destinations.

Steel transportation till now has been heavily reliant on railways as it meets more than 70% of the industry's transportation needs. NITI Aayog estimates a relative cost disadvantage for Indian steelmakers at US$20-25 per ton of finished steel[75]. This high cost is resulting from the compulsion of Indian railways to subsidize passenger carrying cost with freight earnings or alternatively use road logistics instead of rail where necessary. Also, during lockdowns necessitated by COVID19 the capacity of Indian railways was dedicated to freight movements. This led to improvements of over 100% in delivery lead times of finished goods. With lockdowns lifted and passenger traffic back, delivery schedules are expected to be back to pre-COVID days with delays and issues in rake availability and rake placements, creating bottleneck points in the entire supply chain. Dedicated Freight Corridor (DFC) which is an ambitious project approved back in 2006, with the aim of decongesting the railway network by laying special tracks made exclusively for goods trains has to be expedited and not delayed any more. It is very critical for the steel industry to reach its targets of production outputs.

Ports suffer from low productivity, slow unloading, delayed stevedoring and other myriad of issues, lack of appropriate digitalization of the supply chain nodes, like document processing and clearances at ports, tracking and tracing of goods etc. Once again, the speed of execution of Sagarmala project will be key to ensuring inbound and out bound traffic of steel industry.

Already commenced

In the meantime, as recently as October 2021, the Prime Minister launched PM Gati Shakti National Master Plan (NMP) for Multi-modal Connectivity, essentially a digital platform to bring 16 Ministries including Railways and Roadways together for integrated planning and coordinated implementation of infrastructure projects. All Ministries and departments will now be able to visualize, review and monitor the progress of cross-sectoral projects, through the GIS platform, as the satellite imagery will give on-ground progress periodically and progress of the projects will be updated on a regular basis on the portal. It will help in identifying the vital interventions for enhancing and updating the master plan. It will facilitate speed, simplicity and connectivity for all such infra projects so critical for improving steel demand and for creating the much-needed network for pan India movement of goods in a multi modal means.

> Production of 300 MT of steel by 2030 will entail raw material movement of over 900 MT. While multiple projects have been unveiled towards infrastructure creation and upgradation, these need to be expedited for faster growth of the country. Role of government will be crucial and important in expediting project execution and providing access to low cost finance for enabling the envisaged growth

Vinod Gupta, Executive Director - Commercial, SAIL

[75] Need for a New Steel Policy, NITI Aayog working paper, Government of India

What is to be done

Delays on NIP projects linked to infrastructure creation needs to be considered and governed very closely for steel industry to truly benefit from and enable the country for its rapid economic growth.

3 Ensure competitiveness and sustainability of Indian Steel in global markets

The global high strength steel market estimated to be at US$29.6 billion in 2019 is projected to reach US$44.2 billion by 2024, at a CAGR of 8.4%[76]. This growth is likely to be driven by the:

- Automotive industry to improve the fuel efficiency of automobiles;
- Construction industry to ensure high strength and improved safety features of building and construction;
- Electric vehicles needing better high strength low weight solutions for enhanced battery life and vehicle safety; and
- Increasing electrification requiring electrical steel for transformers, electrical drives and generators.

"Specialty Steel" production in India is expected to grow to 42 million tons in 2026-27 from 18 million tons as of 2020-21[77] to support GDP growth driven by growing urbanization and need for safe housing. (Move from Asbestos and Thatched roofs) req coated steels, CRNO/ CRGO Specialized plant and Machinery requiring special alloy steels for machine parts. Expected multiplicative demand for Automobiles (ICE and EVs) in India requiring AHSS and UHSS and Expanding rail and metro network and the need for specialty steel tracks and electrification of the same will further up the demand.

While some investments and global partnerships by the first movers has happened and they enjoy a near monopolistic position to some key grades of steel, any schemes or policies which broad bases the sourcing of such specialty grades form the Indian sub-continent would be welcome.

On the other hand, taxes, cess and duties and royalties structure across the value chain from Iron Ore to metal continue to make the steel uncompetitive in the global markets.

Already commenced

- Production Linked Incentive (PLI) with a total outlay of **INR 6,322 crores**[78] was announced in October 2021 with a view to boosting domestic manufacturing and **help Indian steel industry mature to move up the value chain**, thereby increasing employment. The target segments for the scheme are coated/ plated steel products, high strength/ wear resistant steel, speciality rails, alloy steel products and steel wires and electrical steel.

> Level playing field is crucial for the Indian steel producers to become competitive in the international market as well as to strengthen the domestic steel industry

Alok Sahay, Secretary General, Indian Steel Association

[76] High Strength Steel Market, 'Market and Market' industry report
[77] https://www.thehindu.com/business/pli-plan-for-speciality-steel-gets-nod
[78] https://www.investindia.gov.in/production-linked-incentives-schemes-india

- While the details of the scheme are being made available, the PLI scheme has been welcomed by the captains of the industry as a right step towards Atmanirbhar Bharat and making India self-sufficient in grades of steel which were hitherto imported. A couple of areas require some additional clarity including, **eligibility**. For example, significance of incremental 'production' vs 'production rate' during scheme period and **permissible investment restricted to downstream facility such as, investment** in upstream facilities of input material has been specifically excluded. These need to be resolved as soon as possible.
- The recent Cabinet decision recommending the amendment of the MMDR Act 2015 and the Rules related to this should bring a course correction, with ease of surveys, FDI, environment and forest clearances, getting possession of land, the rationalization of royalties and double taxation, logistics improvement, etc. to make the access to ores, its availability, speed of evacuation to be much faster and efficient. But more needs to get done here.

What is to be done

Mining

Need to meet conditions set by the Minerals (Evidence of Mineral Contents) Rules 2015 for notifying unexplored blocks should be removed and investors should be allowed to invest in exploration with policy giving weightage to either the investment commitment for technology-intensive extraction of deep-lying minerals or faster production of bulk iron ore.

Another major step in the Cabinet-approved amendment is rationalization of stamp duty. In order to bring uniformity across States, necessary amendments in the Indian Stamp Act, 1899, will be brought, but the need is rationalise all royalty. The present amendment stops short of this. Effective tax rate (ETR) on mining in India is 64%, while the global average is 34-38 %[79].

At present, in addition to MMDR Act requirement of royalty, payment towards DMF and National Mineral Exploration Trust (NMET), a mine-operator is also required to pay other fees and levies for use of forest-land under the Forest Conservation Act, 1980 and the Indian Forest Act 1927, including forest tax levied on forest produce procured from forest areas and compensatory afforestation charges.

The cost of doing business is creeping up primarily due to issues pertaining to royalty. Due to exemptions from stacking and analysis, most mechanised mines are compelled to pay royalty at the rate charged for the highest grade of the ore, irrespective of the actual grade. The Centre, along with the governments of iron-rich states like Jharkhand, Odisha and Chhattisgarh, must develop a mechanism for accepting mechanised/joint sampling during wagon loading and reconciliation of royalty payments at actual grade.

[79] https://www.financialexpress.com/opinion/mining-reform-what-the-government-got-right/2205191/

Import/ Export duty/ Taxes

- Reduction of taxes and cess on Steel manufacturing inputs like iron ore and coke for domestic consumption
- Introduction of Border Adjustment Tax on import
- Expedite the imposition of Remission of Duties or Taxes on Export Product (RoDTEP) scheme
- A ban on imports of seconds, defectives and re-rollable scrap steel, which constitute hazard to Indian consumer
- Work out favourable quota and duty regimes with US, EU, GCC and other countries

Attracting capital investments

Need for fiscal incentives which can act as an enabler for players to set up steel mills:

- **Capital Linked:** a percentage of capital investment is received as a capital subsidy
- **Expenditure Linked:** incentive is available as cash refund/exemption of costs like electricity duty, power tariff, stamp duty
- **Sales Linked:** specified percentage of tax paid (GST) to the state government is given as a subsidy

3

Efficient resource utilization

Context

The Indian steel industry is facing challenges on multiple fronts relating to resource utilization which includes limited availability of high-grade ore and coking coal, overcapacities and energy efficiencies. The steel sector employs high temperature furnaces for iron and steel production, which has become the second largest energy consumer in the industry[80]. The increasing international focus on emissions and de-carbonization has led to the imminent requirement to double down on optimizing resource utilization in the production of steel.

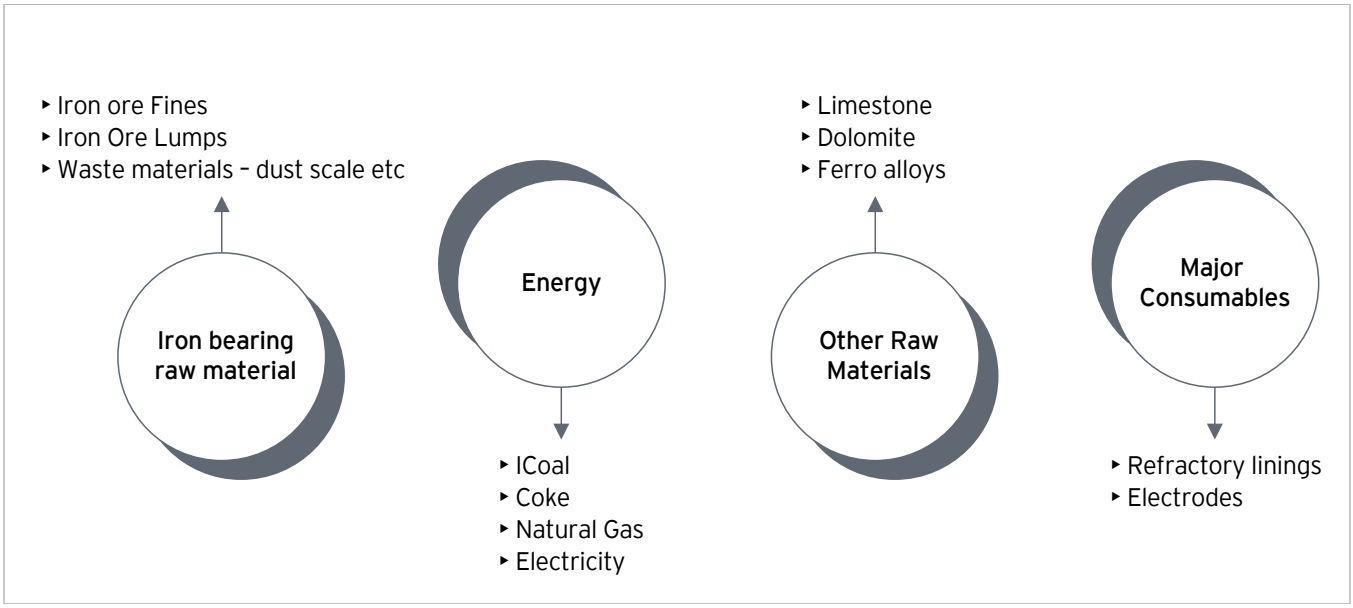
The call for resource optimization can be understood under the following primary drivers:

Cost competitiveness – With the standardization of processes and requirements and increase in quality of products, bulk of the steel production is commoditized. Moreover, as illustrated in (Overcapacity of steel industry figure-section 1), the steel industry continues to have overcapacity. In such an environment it is imperative for companies to focus continually on resource optimization to remain competitive.

Sustainable growth – The growth in population coupled with development has compounded demand and consumption of resources. The global population rose from 2.5 billion in 1950 to 7.6 billion by 2017 with the urban population rising from ~36% in 1960 to ~56% in 2020, has driven the demand. India has large deposits of raw materials. However, the availability of coking coal and high-grade iron ore is a challenge. Under this domestic backdrop, driving efficiencies in resource consumption is essential for sustainable growth.

Environmental concerns – Steelmaking contributes to 8% of the world's total carbon emissions. With the world attention keenly moving towards environmental sustainability practices, the nudge is ever present for the industry to decarbonize. Steelmakers that are early movers towards decarbonization can capitalize on ESG metrics to gain a competitive edge.

Resource consumption in the steel industry



[80] Department of Energy

Challenges

The Indian steel industry faces multi-pronged challenges in its efforts to optimize resource consumption. There are challenges in energy usage, adoption of more efficient process routes, raw material, process optimization and logistics.

Considering the above, key roadblocks in achieving resource optimization presently faced by Indian steel industry which need to be addressed are summarized:

The energy usage challenge - steel is an energy intensive industry. Energy makes up 20-40% the cost of production of steel. Energy consumption in most Indian integrated steel plants is higher i.e., 6-6.5 Giga Calories per ton of crude steel compared to 4.5-5.0 Giga Calories World average[81]. Iron and steel have achieved considerable improvements in recent decades. However, it still reveals great potentials to further reduce energy use. These improvements could be achieved by saving energy during (primary energy) or after the manufacturing processes (secondary energy).

The challenge of shifting to cleaner process routes- a majority of the steel produced in the country is through the BF- BOF route. With the increasing focus on the environment, the share of steel through the scrap- EAF route is increasing. The energy required to produce 1 ton of steel from scrap remelting is ~70% less than through the BF- BOF route[82]. Steel produced through the scrap route is expected to rise further – from 16.82 million tons in 2017 to 22.36 million tons by 2023[83]. The national steel policy envisages the production of 35-40% steel from scrap in the total of 300 million tons by 2030. As such, the scrap demand is estimated to rise to 70-80 million tons per annum[84]. More effort is still required to enable scrap collection and processing centers to feed the estimated future demands of scrap in the country.

The DRI based reduction process emits less carbon dioxide when compared to the integrated steel producing process. Gas based DRI processes emit only one-third of the CO_2 per ton of steel of a BF – BOF route[84]. In the DRI route of steel making, lumps or pellets are reduced directly using Natural Gas. Increasing the share of production through the DRI (gas based) route will reduce the overall energy intensity of steel production. Development of technology to utilize hydrogen as a reductant in the DRI process is also ongoing. This will enable minimal carbon emissions if green hydrogen is used for reduction.

Raw material challenges – The rapid upward trend in steel output has put pressure on the availability of quality ore for steel production. In order to consume lower grade ore for steel making, beneficiation of ore is required. Iron ore extraction in India yields lump to fines in the ratio of 2:3 – 60% of the ore generation is in the form of iron ore fines[85]. For efficient utilization of ore produced; it is imperative to consume the iron ore fines.

Coking coal reserves in India stands at 34.5 billion tons however it is not of adequate quality to form good coking coal on account of high impurities. Currently ~85% of the coking coal requirements are imported. With a targeted production of 300 million tons of steel by 2030, the demand for coking coal is expected to rise to 161 million tons. In order to utilize local coking coal reserves, major R&D initiatives are required. Blending ratio for coal in countries such as USA are 40% where as in India it is only 10% at present[86].

> India needs to have policies which supports better utilization of its natural resources. Huge stock-pile of non-prime grade iron ore could be utilized by incentivizing beneficiation and pelletisation

Alok Sahay, Secretary General, Indian Steel Association

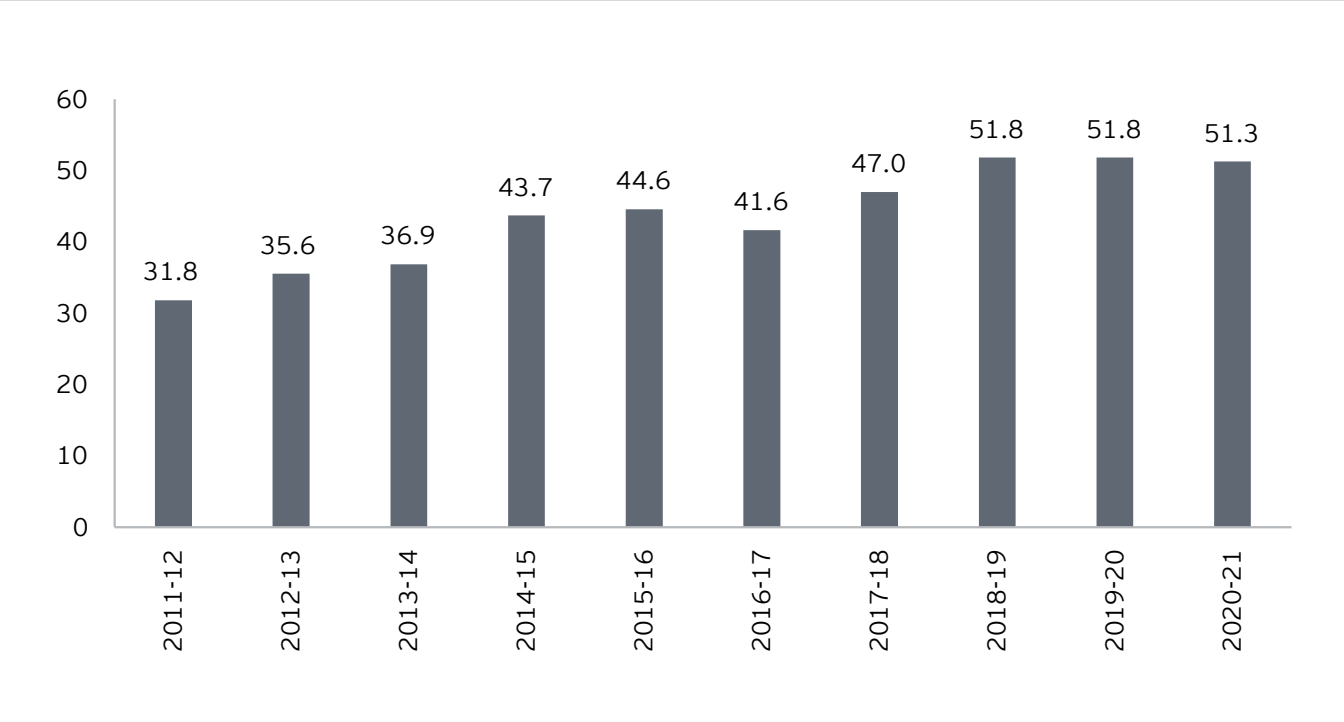
[81] Steel.gov.in
[82] [83] Metal Bulletin
[84] A review of ironmaking by direct reduction processes: Quality requirements and sustainability Comfort Ramakgala*, Gwiranai Danha
[85] https://ibm.gov.in/writereaddata/files/06062017101137Iron%20and%20Steel%202020_3.pdf6 India's pledge among most substantive: Climate expert | World News - Hindustan Times
[86] https://www.telegraphindia.com/business/india-s-steel-industry-faces-coking-coal-challenge/cid/1676853

Coking coal import

Coking coal imports have increased over the past 7 years till 2018. The imports have largely remained stagnant, however, there is a need to reduce dependency on imports.

Coal import data (India)[87]

Coking coal imports (MT)



Process optimization challenges – in order to realize the best efficiencies in the as-is state of production of steel, local and global optimization of all processes is imperative. Indian steel making has room for benefits from process optimization through the application of advanced analytics and digital solutions as the industry lags behind in the adoption of optimizing tools and digital solutions.

Challenges in inbound logistics - logistic costs in India are high, accounting for 14% of the GDP[88]. The road freight cost (per ton per kilometer) in India after adjusting for PPP is almost twice that in the USA[89]. In addition, the average speed of the freight vehicles in India stands at around 25-30Km/Hr. This is 50-60% lower than the speeds in the USA, adding to freight costs. While Indian steel is cost competitive on Ex Works basis, they lose out on FOB basis due to the high logistics costs. The high costs for logistics in India can be attributed to the following:

- Unfavorable inter-modal mix: road transport far exceeds rail transport, despite the latter being cheaper by 45%. Adverse rake booking policies and lack of inter-modal facilities for freight transfer stand as primary reasons.
- Inefficient fleet mix: Indian fleet mix comprises of smaller, more inefficient trucks – 16T and 25T trucks are the highest selling categories in India. In China 26-40T trucks lead the market. Freight costs on smaller trucks have substantially higher freight costs. Adding to this there is a lack of logistics hubs for consolidation and disaggregation resulting in higher point-to-point costs.
- Underdeveloped road infrastructure: poor road infrastructure leads to inefficient freight movement. There is a lack of 4/6 lane roads, coupled with inconsistent infrastructure there is congestion across key routes leading to added costs.

> India has the next decade to judiciously use its iron ore reserves, as post that, recycled steel will have a higher demand and a more preferred route of making steel

N.L.Vhatte, CEO - Vedanta ESL Steel Ltd.

[87] Coal.gov.i
[88] Niti Aayog
[89] https://morth.nic.in/sites/default/files/circulars_document/File2186.pdf

Solutions and interventions

Primary energy consumption solutions – some key takeaways of optimizing primary energy consumption are as follows:

Energy efficient Technologies

Several Technologies for efficiency across the value chain (Table below)

Fuel Substitution

- Energy sources of steel production processes needs to shift from coal to natural gas, hydrogen, electricity, biomass PCI/NG injection instead of coke
- Injection of waste oil and plastics in BF

Outgoing flow utilization

- Utilization of slag (cement) and dust (sintering)
- Utilization of mill scale
- By product gas recovery and conversion (COG,BFG and LDG)

Pre-treatment of feed

- Segregation slit wire for Sinter charging
- Stamp charging in coke oven
- Bell-less top system for burden distribution on BF
- Moisture removal by drying
- Desulphurization in torpedo cars

Technologies across the value chain for primary energy optimization[90]

Process	Technology	Improvement
Sinter	Sinter SSW (segregation slit wire) charging	Reduce coke breeze consumption by 10-15%
Coking	Multi-slit burner in ignition furnace	Reduce ignition energy by 25-30%
BF	Top combustion hot blast stove	Save energy in the hot stove by 1-2%
BOF	BOF bottom stirring	Reduce flux quantities by 10-12%
EAF	Contiarc furnace	Reduce energy losses by up to 0.80 GJ/t steel
Casting	Rapidfire edge heater	Save energy by 25%-28%
Finishing	Continuous annealing line	Reduce fuel consumption by 30%-33%

[90] Energy saving technologies and mass-thermal network optimization for decarbonized iron and steel industry: A review R.Q. Wang L. Jiang Y.D. Wang A.P. Roskilly

Secondary energy consumption solutions – some key technologies for waste heat recovery across the value chain are as follows:

Technologies across the value chain for primary energy optimization[91]

Process	Heat recovery method	Improvement
Sinter	Recover the sinter cooler's exhaust gas as steam	The system allows up to about 60% of exhaust heat from the sinter cooler to be reused
Coking	CDQ to generate steam	For a plant with 450000 t/year coke capacity, 450 GWh/year steam can be produced
Iron making	Hot stove waste heat recovery device	The recovery rate of hot stove flue gas sensible heat ranges from 40 to 50%
Steel making	Recover waste heat from the furnace gas duct	0.20 GJ/t energy can be saved when implementing heat recovery method
Rolling	Recover waste heat in a steel wires cooling process	Heat recovery rate is up to 10 KW

Digital as a solution for building resource efficiency: digital solutions utilize historical data to establish relationships between inputs, outputs and operating parameters and considers the "Total Cost of Ownership (TCO)" for the different materials. As a concept total cost of ownership considers the delivered cost of steel by a detailed study on an integrative impact of process parameters and quality of the raw materials to provide insights on recommended specs of RMs and process parameters for highest productivity and lowest cost. TCO based models use data generated from the plant, laboratories for optimization in an offline or in real time.

Such models are now possible by the increasing availability of data, increases in computing power, spread of mobile devices and automation. The modern AI-ML engines of the digital solutions possess capabilities to analyze large volumes of plants IT and OT data to establish relationships and build TCO optimization models for the consumption efficiency for the different materials.

These digital solutions can be leveraged across the steel making value chain and drive operational efficiencies by enhancing decision making across major aspects that impact material utilization in the steel manufacturing –

- **Sourcing related –** right quantities and quality of the different material integrated with
- **Consumption related –** optimal blending / recipe mix decisions to maximize yield and reduce consumption while maintaining desired outputs and this integrated with
- **Parameter related –** leverage relationships between parameters and material characteristics to fix parameters to achieve optimal cost for desired productivity

The following are an illustration of the typical business and operational benefits that may be realized by deploying digital solutions across the steel value chain -

- Optimizing raw material mix
- Increasing throughput and yield
- Optimizing energy consumption
- Predictive maintenance to reduce costs
- Enhanced quality and rejections reduction

The experiences of leading steel manufacturers in the Indian steel industry indicate that typical benefits of 3–4 % reduction in production costs driven through consumption and parameter optimization and 2– 3 % improvement in productivity may be realized through the deployment of digital solutions.

Digital solutions across the steel value chain

Digital solutions can be designed for the different production units of steel making, namely Sinter plant, Coke ovens, Captive power plants, Blast furnace and the Steel melting shop.

The stages of digital adoption in these production units are typically in multiple stages –**Descriptive (enhance visibility), Diagnostic (issues identification and root causes), Predictive (simulations for sensitivity analysis), Prescriptive (optimal state recommendations)**. The

[91] Energy saving technologies and mass-thermal network optimization for decarbonized iron and steel industry: A review R.Q. Wang L. Jiang Y.D. Wang A.P. Roskilly

descriptive and diagnostic capabilities are leveraged to enhance visibility across process, identify root causes for issues, enhance accountability and strengthen performance monitoring. The predictive and prescriptive capabilities are utilized in simulating the process to augment manual decision making with scientific methods and relationships to drive improvements for material consumption and productivity.

Total Cost of ownership for consumption optimization

Owing the continuous nature of steel production, the upstream processes have a strong influence on the downstream processes. For example, the output properties of coke and sinter produced in the coke oven and sinter plant respectively impacts the blast furnace performance such as coke rate, slag rate, productivity and consumption of materials. Similarly, the characteristics of coke and sinter are strongly impacted by the properties of the input raw materials – coking coals for the coke oven and the iron ore, fluxes and coke fines for the sinter plant. In this regard, the 'total cost of ownership (TCO)' considers the process impact of the raw material qualities and builds the process costs into the pricing for the different raw materials. The digital solutions for steel making leverage the historical data to establish relationships between inputs and outputs and optimize the total cost of ownership for the different materials.

The figure below provides an illustration of the relationships and impacts of the upstream processes and downstream processes in steel making.

The inter-dependencies of material aspects across process and impact on downstream processconsidered in digital solutions

	Sourcing / Procurement	Coke Making	Sinter Plant & BF	BF Operating parameters	Steel Making
	Mines / Suppliers	Coke Oven	Sinter Plant, BF	Blast Furnace	EAF, LRF & Casting
	Source Mix Optimization	Coal Blending optimization	Burden Mix Optimization	BF Parameter Optimization	FA Consumption Optimization
Aspects considered for TCO	Optimized TCO Cost Consistent Quality Enhanced Availability	Optimized Coke Cost Consistent Quality Increased productivity	Optimized Sinter & HM Cost Consistent Quality Increased productivity	Optimized operating parameter Increased productivity	Lean chemistry Optimized usage of FA Optimized killing cost
	Source of material Inventory levels Material quality	Coking coal Blend – Prime hard, Semi hard , Soft % Quality – TM, VM, FC, Vitrinite, CSN etc Coking speed, temperature	Sinter mix – Iron ore, coke, flux fines % IBM Mix (Lump, sinter, pellet), fuel & flux Quality – Fe %, Al2O3, CaO, SiO2 etc	O2, Steam, hot blast, cold blast, RAFT, heat load etc Coke rate, PCI rate, Slag rate	Ferro-alloy types & addition Opening chemistry Killing Aspects – C vs Si / Al
Outputs	Landed Cost TCO Cost Availability at plant	Coke productivity & cost Coke Quality – CSR, CRI, TM, VM, M10, M40	Sinter &HM productivity & cost Sinter quality HM cost, Si, temp & chemistry	HM productivity & cost HM temperature & Si HM Chemistry	Lean chemistry & FA cost Optimized killing
	Impacts downstream process costs	Impacts BF process & HM productivity	Impacts BF process & HM productivity	Impacts HM productivity and quality, SMS cost & Steel productivity	Impacts FG quality & market prices

Digital interventions work in synergy with the technology of the plant and optimal management of process to deliver efficiencies in terms of material consumption, yields, consistent quality with enhanced productivity.

The figure below provides as illustration of potential digital interventions across the different functions and processes –

Sinter Plant

- Prediction of Sinter RDI, RI, TI basis inputs and operating parameters
- Predictive and prescriptive recommendations for sinter plant operating parameters
- Optimized consumption of fuel (BF gas) in Sinter plant
- Optimized design and consumption of input mix for sinter preparation
- Predictions for impact of sinter properties on BF consumption and productivity
- Optimized procurement of raw materials (fines) basis requirement

Coke Oven

- Optimal design of blend between different coking coal types – prime hard vs semi hard vs semi soft vs soft
- Prediction for CSR, CRI basis input coals used
- Blend and parameter recommendations to optimize yield
- Prediction modelling for coking process time basis input coals and coke oven parameters
- Prediction for M10, M40 for coke basis inputs used
- Relationships between coke properties and BF performance such as slag rate, fuel rate etc
- Optimized procurement of coking coals in terms of quality and quantity

Blast Furnace

- Optimized burden mix preparation for the iron bearing materials
- Optimal range recommendations for the different blast operating parameters
- Prediction modelling for HM quality such as temperature, Si %, S, P etc
- Prediction modelling and simulations for hot metal productivity
- Prediction for slag volume, slag rate and fuel rate in blast furnace
- Optimized procurement for input raw materials in terms of quantity and quality

Steel Melting Shop

- Optimized ferro-alloy addition to achieve lean chemistry and higher usage of cheaper ferro-alloys
- Optimized killing process to enhance recovery
- Relationships between hot metal properties and convertor operations
- Optimized blow practice for convertors to optimize O2 consumption
- Prediction modelling for killing practice and recovery rates basis convertor process
- Relationship establishment between convertor operations and LRF consumption aspects
- Prediction modelling for defects in casting process

Procurement / Sourcing

- Total cost of ownership sourcing models for RM categories
- Bidding strategy / auction strategy tools
- Relationships between RM qualities, parameters and outputs
- Prediction for impact of quality on process
- Network / source mix optimization for RM categories

Policy intervention

With a 300 million targeted steel production by 2030, the government has several policies intended to aid the industry towards sustainable usage or resource and reduce emissions.

Vehicle Scrappage Policy

The vehicle scrappage policy is a government-funded program to replace old vehicles from Indian roads. The policy aims to make scrap available for steel making in light of increasing demand for EAF.

Policy to Support Logistics – LEEP

LEEP is designed to improve efficiency through infrastructure solutions like building multimodal logistic parks and the introduction of digital solutions like goods tracking. There is effort towards load matching using digital platforms to match freight with truck capacity. Increasing vehicle productivity is being targeted through effective packaging and loading. Warehousing performance is to be improved through network optimization and the implementation of advanced digitized tools.

PAT Scheme

Government of India set up the Perform Achieve and Trade Scheme (PAT) to reduce the specific energy consumption (SEC) in energy intensive industries. PAT is a component of the National Mission for Enhanced Energy Efficiency (NMEEE) which is one of the eight missions under the National Action Plan on Climate Change (NAPCC). In cycle 1 of the PAT that started from 2012-13 to 2014-15 the Iron and Steel sector achieved energy savings of 2.1 million TOE against the target of 1.486 million TOE. The total energy consumption for the Iron and Steel sectors in the year 2030 without the impact of PAT is estimated to be 126.4 million TOE, which may reduce to 123.9 million TOE considering the impact of PAT[92].

Despite several policies by the government towards efficient resource utilization in the Steel industry, there is still a lot of policy focus needed to steer domestic manufacturers to become competitive in the global landscape. With each region targeting to decarbonize the industry by 2050, precise and targeted guidelines and roadmaps will be required to meet the deadline. Policies need to keep in mind that the domestic industry is dominated by a few large players and several small (secondary) players in order to incentivize both towards adopting efficient practices in resource consumption.

[92] https://www.keralaenergy.gov.in/files/Resources/Iron__Steel_Sector_Report_2018.pdf

4

Achieve sustainable operations in steel industry

Context

Greener steel is about being in sync with the Sustainable Development Goals (SDGs) of United Nations. It is a broader range of environmental, social and governance (ESG) considerations to minimize the overall environmental impact of steel making.

While "visible mobilization" of investments and efforts on part of its members has been slow, the Paris Accord adopted by 196 parties in 2015[93] are being reflected in actions as many countries are announcing targets to significantly reduce CO_2 emissions by 2030 and/or becoming carbon neutral by 2050-2060. At the Climate Action Summit 2019, (update for COP 2021) more than 60 countries, including the EU and the UK, committed to full carbon neutrality by 2050. More recent COP26 Summit of November 2021, at Glasgow, India has pledged carbon neutrality by 2070 along with targets on renewables power generation of 500 GW and elimination of 1 Bn tons of carbon emissions from the total projected emissions by 2030. Carbon neutrality means that carbon dioxide emissions will be reduced altogether or fully offset by production industries.

The US, India and China are the main sources of atmospheric greenhouse gas emissions – China plans to reduce emissions intensity of GDP by over 65% from 2005 levels by 2030 and become carbon-neutral by 2060[94, 95] whereas India intends to reduce its emissions intensity of GDP by 33%–35% during the same timeframe[96].

Decarbonization is the most pressing issue facing the steel industry. Much like global, in India too, a typical integrated steel plant emission happens across the entire process from sinter plant to blast furnace and finishing mills. Every ton of steel produced emits on average 1.85 tons of carbon dioxide into the atmosphere[97]. Currently emissions from Indian steelmaking account for 12% of emissions from fossil fuels, but this is likely to increase to over 1/3rd by 2050[98]. Being one of the largest steel makers of the world[99], measures taken by India governments and steel companies will be closely surveyed by the custodians of climate change to determine the efficacy of new ways of reducing emissions, specifically from steelmaking as compared to other industrial manufacturing processes.

Depending upon the route of steel making adopted, quality of raw materials, discipline of following good management practices, investments in modernization of facilities, energy usage can be between 5.0 GJ/T -25 GJ/T of hot rolled coil, which is about 20%- 40% of the total costs of steel manufacture, making it extremely energy intensive. About 50% of a typically integrated facility's energy input comes from coal, 35% from electricity, 5% from natural gas and 5% from other gases. That said, there is has been systematic reduction of 0.35%-0.40% year-on-year on specific energy consumption for the last 10 years and by 60% over the last 50 years due to technological shifts and higher adoption and sophistication of the electric-arc furnace (EAF) route to steel making.

The steel making industry, by virtue of its capacity to impact environment health and consuming large quantities of natural resources, a systematic reporting of ESG metrics of climate change driven metrics like GHG emissions in tons of carbon dioxide equivalent (tCO_2e), estimate and report upstream and downstream emissions, Task Force on Climate-related Financial Disclosures (TCFD) aligned reporting on material climate risks and opportunities, is mandatory and likely to be tracked very closely in developed and developing markets including India. Firms with better ESG maturity scores are being seen to be less susceptible to systematic market risks, have a lower cost of debt, attract superior talent and create superior long-term value for their shareholders.

Therefore, greener steel goes beyond just decarbonization. It requires efforts from steel players to deploy all energy-efficient measures, adopt and invest in circular economy principles for production and design of steel, improve material efficiency and waste management, focus on steel value chain and its ability to impact scope 2 and scope 3 emissions along with the adoption of emerging low-carbon emission technologies for steel production. The use of high-strength steel leads to 25-40% weight reduction and a corresponding decline in energy consumption and emissions[100]. So, while the production of high-strength steel has higher emission intensity, the avoided CO_2 emissions from the uses of high-grade steel products primarily in vehicles are about six times higher than the CO_2 emissions from the production of the steel[101].

[94] "China's Xi targets steeper cut in carbon intensity by 2030", Reuters, https://www.reuters.com/article/climate-change-un-china-idUSL1N2IS0DY, accessed in January 2021

[95] "Climate change: China aims for 'carbon neutrality by 2060'", BBC, https://www.bbc.com/news/science-environment-54256826, accessed in January 2021

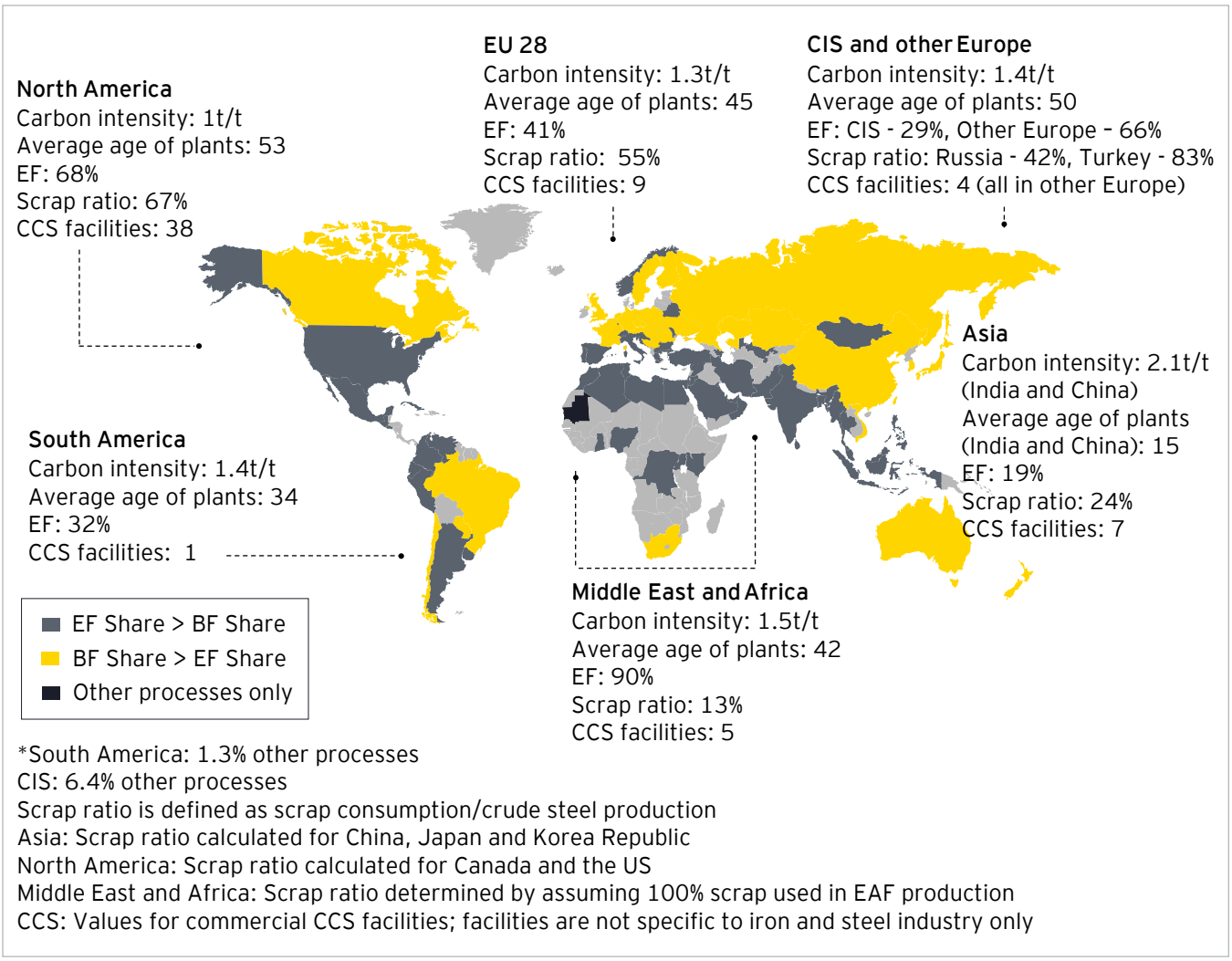
[96] Ministry of Environment, Forest and Climate Change

[97 99 100 101] World Steel Association

[98] "Carbon emissions by India's steel sector to triple by 2050", The Economic Times, https://economictimes.indiatimes.com/industry/indl-goods/svs/steel/carbon-emissions-by-indias-steel-sector-to-triple-by-2050/articleshow/73927391.cms?from=mdr, accessed in January 2021

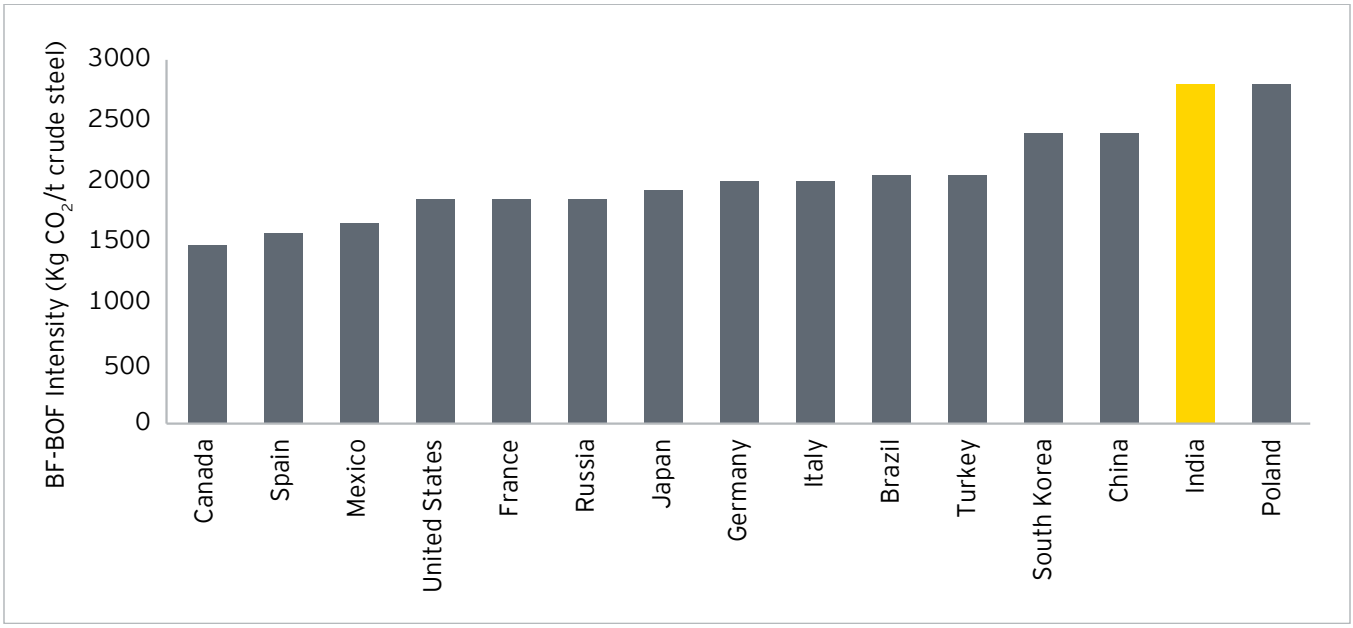
Decarbonization remains a critical challenge to meet sustainability targets. An analysis of the key sustainability metrics of major global steelmakers reflects that while some companies are continuously improving, others are still at the early stages of development. For our analysis, we divided steel companies into three broad ranges of emissions and energy intensity: low, medium and high. In the best-case scenario (LOW), production facilities may attain energy needs 0.1x of global average and emissions may be 0.2x of the global average. Companies in the high range were the ones largely using blast furnaces. For example, China, which had the second lowest energy intensity of BF-BOF steel production, has the third highest CO_2 intensity of BF-BOF steel production after Poland and India.

Carbon intensity and age of steel plants by region



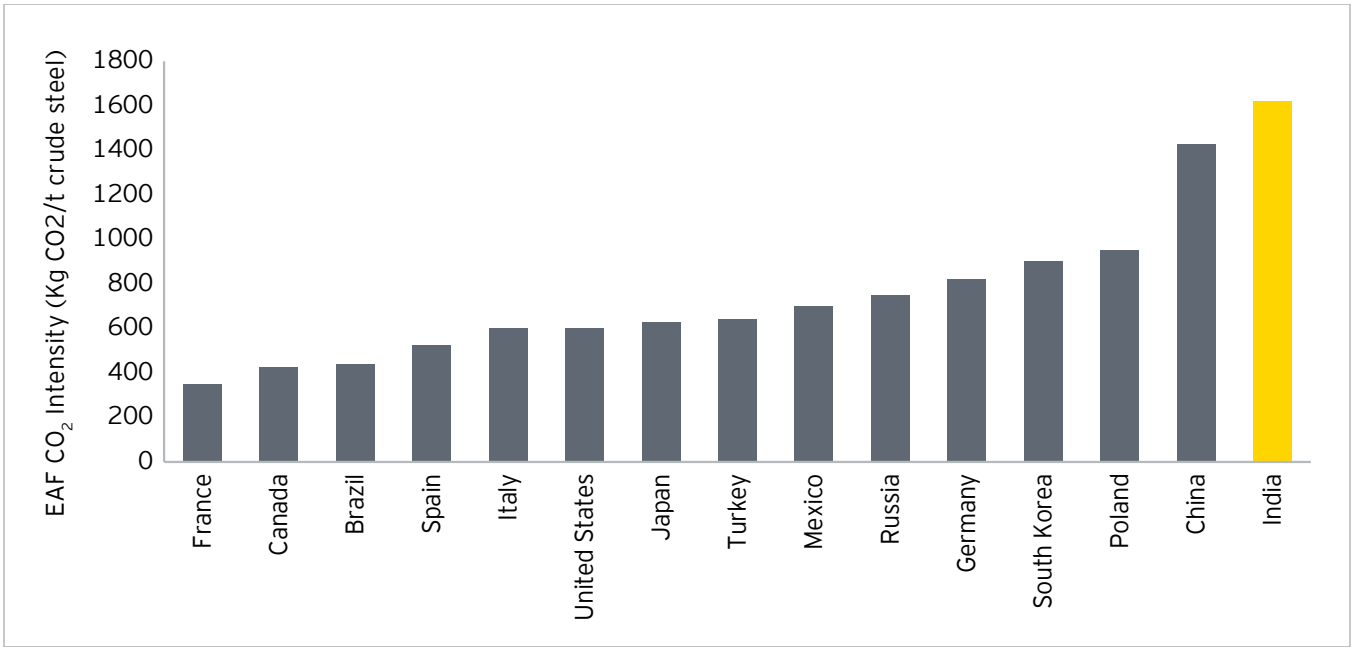
*South America: 1.3% other processes
CIS: 6.4% other processes
Scrap ratio is defined as scrap consumption/crude steel production
Asia: Scrap ratio calculated for China, Japan and Korea Republic
North America: Scrap ratio calculated for Canada and the US
Middle East and Africa: Scrap ratio determined by assuming 100% scrap used in EAF production
CCS: Values for commercial CCS facilities; facilities are not specific to iron and steel industry only

Intensity of CO_2 of BF-BOF global steel production country wise:



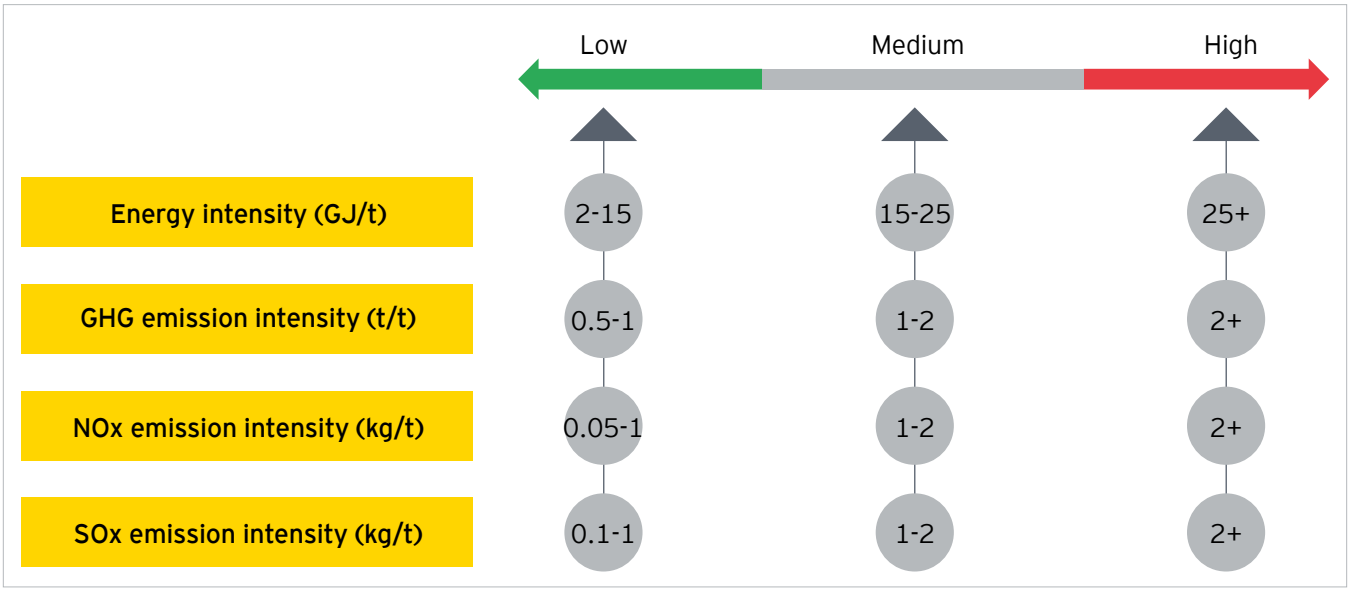
Source: Hasanbeigi, A. and Springer, C. 2019. How Clean is the U.S. Steel Industry? An International Benchmarking of Energy and CO_2 Intensities. San Francisco CA: Global Efficiency Intelligence.

Intensity of CO_2 of EAF global steel production country wise:



Source: Hasanbeigi, A. and Springer, C. 2019. How Clean is the U.S. Steel Industry? An International Benchmarking of Energy and CO_2 Intensities. San Francisco CA: Global Efficiency Intelligence.

Specific Emissions and Energy Intensity: range for Steel manufacturing



Key challenges and likely interventions

The government's aim to invest around US$1T in infrastructure growth over next 5 years indicates a strong outlook for the steel sector. Policy framework to raise steel capacity to 300mt by 2030 is directionally in line with expected growth of steel demand in the country. An investment of nearly INR 5.7 lakh crore will be required to achieve crude steel capacity to 250 MTPA from the current 142 MTPA.

Steel sector have mainly seen growth in areas where iron ore, water and cheap electricity availability is in abundance. Iron ore reserves in the country are highly concentrated in a few states. Four states namely Orisha, Chhattisgarh, Karnataka and Jharkhand accounts for around 97% of total iron ore reserves in the country.

As per 2019-20 data, about 55% steel is produced through the Electric Furnace route of which about 29% steel is produced through the Electric Induction Furnace (EIF) route and 26% from Electric Arc Furnace (EAF) route. About 46% steel is produced through the conventional integrated route of BF-BOF route as against the world average of around 70%. About 40% of the steel making assets in India are less than 15 years old.

For India, steel will be a 'hard to abate' sector. India has one of the largest (Over 30 Billion Tones) reserves of iron ore. To keep the industry globally competitive, India will maximize the use of its domestic reserves and will need coking coal for reducing iron ore to iron. Unlike sectors like automobile, cleaner technological pathways which use other reductants instead of coking coal are yet to prove themselves economically.

Hence the contradiction: on one hand there is a need for rapid sectoral growth and investments which maximizes the use of domestic iron ore to support the 5 Trillion dollar economy by 2024-25, there are real reasons for the abatement measures in India to be relatively slow and inefficient in the short to medium term, on the other.

- The unavailability of commercialized cleaner technological steel making pathways (Less than 0.3 T Co_2/Tone of CS) other than Scrap based EAF
- Mix of technological routes and fragmentation of steel making in India
- Exports of finished steel to its and customer pressure for abatements: Total exports of 8 MTPA
- Relatively unstructured and underinvested scrap supply chains: Import of 7 MTPA of scrap.
- Lack of clear government policy and support
- Current measurement and reporting on ESG and sustainability metrics
- Risk of stranded assets
- Expected cost of transitioning to the new technologies

There is no single solution to lowering CO_2 for steelmaking,

and a broad portfolio of technological options is required, to be deployed alone, or in combination as local circumstances permit. In India, the planned trajectory of carbon reduction is likely to be gradual as compared to Western counterparts. Many blast furnaces are still less than 15 years old and it is uneconomical to replace these such steelmaking assets so early in their lifecycle. This is going to more complicated as there are many small capacity enterprises in the country which are less efficient, produce more pollutants and find it challenging to attract significant investment to upgrade technologies.

For India to make credible commitments to significantly reduce carbon emissions, there is an urgent need to create a detailed roadmap for increasing consolidation, increasing share of EAF and investing in robust recycled steel supply for steelmaking. A realistic assessment and options based of adoption of clean technologies balancing risk, capital cost and quality considerations in the need of the hour.

Our analysis suggests that the industry construct of India and its associated maturity on the green journey, India should attempt the following:

- **Basis net zero target for GHG emissions by 2070 set up an Apex committee for drawing up a policy driven framework for the journey of India Steel Industry**
  - A comprehensive framework which encompasses all the steel industry participants needs to be drawn up. The framework will address the needs of the Indian Steel industry at large to ensure that the approach taken by India is balanced and not biased in any which way towards a particular section of the industry. Along with alternative fuels and carbon capture technology, the government has to create supportive policies and markets that encourage companies to switch. The latter includes carbon taxes, offsets and emission trading schemes.
- Guiding and supporting the implementation of the most relevant and effective Decarbonization Pathways relevant to India.
- Developing a policy structure for meeting addressing financing requirements of this journey. Inclusion of banking and finance industry to start playing an active role in the journey. Current estimates are that in comparison with conventional steel, it would cost INR 9000/T to INR 27000/T more per ton to produce green steel through the primary (iron ore) route. This difference mainly results from higher operational costs, in particular for the low CO_2 energy and feedstock supply (electricity and hydrogen). If the full additional cost of green steel falls on the steel producer, it will be unable to compete on price with conventional steel. If the cost is passed through to the end-consumer product, the extra cost with green steel could be under INR 25000- INR 30000 more for the price of a car and under INR 1800-INR 2200 more for the price of a washing machine. Supportive policy efforts can help to bring about these new markets for 'green' products, generating demand from end-consumers for

(slightly) more expensive but more environmentally friendly products. If the extra cost of producing green products is not passed to the end consumer because of competitive pressures from traditional steel makers or because of low demand from consumers for green steel, then it may be necessary to provide temporary financing for the extra costs and simultaneously take measures to support the business case for clean products.

- **Accelerate ongoing retrofits and process changes for addressing energy and emission efficiency**

Efforts to improve energy efficiency have been on the rise over the past decade in India. In all routes to steel making, energy currently constitutes 20-40% of steel production costs. Steelmakers have taken steps to adopt energy efficient processes and the average energy intensity on a per ton basis has decreased by 1.5% between 2009-2019.

To gain more sustainable improvements in energy efficiency, integrated Blast Furnace (BF) based steelmakers in India are continuing to invest in incremental process improvements on current assets like waste heat recovery, optimization of TRT (top pressure recovery turbine) for power generation, enhancing proportions of coal dust injection (CDI) in BF, etc.

Plans are now to commission newer smelt technologies, which can drastically reduce energy consumption but also the usage of carbon bound reducing agents. The investment and long payback period on newer energy efficient technologies are likely to be offset by improved productivity and cost-control achieved over the longer term.

Similarly, for the steel makers, currently on the EAF route, optimization of waste gas usage, Direct Reduced Iron (DRI) feedstock composition control, power usage optimization for arcing operations, running DRI operations on optimal metallization ratios are important sources of building energy and overall process efficiencies.

- **Rapid spend and absorption new tech on EAF based steel making through partnerships and focused R&D**

For integrated steel players, considering a transition to scrap based EAF production, ease of and affordable scrap availability, end-product quality will be important determinants of the strategy and technological choice between the options as below:

- EAF with full scrap (Scrap-)EAF
- Primary steel through DRI with natural gas as the primary reductant followed by EAF (NG-DRI/EAF)
- Primary steel through DRI with green hydrogen as the primary reductant followed by EAF (H2-DRI/EAF)

The ratio of steel made in India through the EAF route vs that of Bf BOF favours India, a lot depends on the inputs materials added to EAF in order to sustain the higher quality and grades of steel that India also aspires for being

a leader for in the future. The technologies of EAF based steel making for scale, size, productivity and quality is fast developing around the world lead by Japan and US.

- **Reduce reuse recycle remanufacture: the case for structural revamp of reverse supply chains**

National Steel Policy 2017 (NSP-2017) aims to develop a globally competitive steel industry by creating 300 Million TPA Steel production capacity by 2030 of which 35-40% is estimated to be from EAF/IF route. Although, scrap is the main raw material for secondary sector the primary sector too uses scrap in the charge mix of BOF to the tune of 10%-15% to improve efficiency, minimize cost of production and other process needs. The availability of raw materials at competitive rates is therefore imperative for the growth of the industry and to achieve NSP-2017 target. Thus, the availability of right quality of scrap, in adequate quantity is one of the critical factors for the future growth for both EAF/IF sector and primary sector.

The Ministry of steel, Government of India has drawn up a Scrap policy in 2019 which deals with scrappage associated with policy deals with automobile, household, structural, railways, industrial waste but excludes specific industries like ship breaking which are covered under separate act / policy. The current supply of scrap is 25 MTPA from the domestic unorganized scrap industry and 7 MTPA from import of scrap. When the production of steel rises to 250 MT, as is envisaged in the National Steel Policy, then the requirement of scrap shall rise to 70-80 MT. This shall require about 700 scrap processing centres, that is 700 shredders.

IN the effort to "organize the scrap industry", the ministry has laid out clear guidelines on QEH&S (Quality, Environment, Health and Safety) norms e.g. The collection and dismantling centers shall comply with relevant health and safety legislation/regulation and environmental norms as laid down by MoEF&CC / SPCB for such operations and Hazardous & Other Wastes (Management & Transboundary Movement) Rules, 2016 as also list of statutes/Licenses that the such processing centers will have to comply with in order to operationalize such facilities.

The policy is also clarifies the role of the Ministry of Steel, Players, Auto OEMs, State Governments to ensure that the recycling industry gets all the support and guidance needed to become healthy industry. There is some more work needed e.g. issues related to quality of scrap and ensure that international standards, wherever acceptable are followed and domestic standards of quality of scrap are formulated, Ministry of Finance issues of the steel scrapping industry, related with financing, indirect tax issues and other direct tax incentives for promoting investments in projects on waste management, development of competitive markets and transparency for recycled materials through e commerce e.g. India MART etc.

Scrap availability from the world's largest graveyard with respect to ship breaking is the Indian sub-continent, Alang in Gujarat, India, oversees ship dismantling for almost 50% of the world's vessels will reach about 2 MTPA in 2022 and will be governed by Director General of Shipping as National Authority for Recycling of Ships under section 3 of the Recycling of Ships Act, 2019.

> Carbon tax in new form can be delayed but can't be stopped. While some major integrated steel producers in India are working towards achieving carbon neutrality, most small and medium mills are yet to plan for a sustainable production

Pankaj Satija, Managing Director, Tata Steel Mining Ltd.

What is to be done

Reduce

India has to invest extensively in R&D for development of new grades of automotive grade advanced and ultra high strength steel to reduce weight and reduce overall emissions of vehicles used in India

Reuse

The amount of steel scrap availability in the country is increasing everyday. India stands to make huge gains by not just recycling steel but also by reusing the by products. The valuable by products of steel production including slag, dust and process gases in other industries like cement concrete etc

Recycle

India will need to develop and commit to the adopting the life cycle analysis to measure an explain the tru environmental impact of steel. LCA approach will evaluate the complete environmental implication of a products manufacture, usage and end of life stages among other things

Remanufacture

India is becoming a global hub of manufacturing of wind turbines, industrial machinery (incl farm machinery), trucks, car engines, electrical motors and domestic appliances. The assets or products can be restored to as a new condition via this process. We need to incentivize, formalize and adopt such process in India

Institutionalize carbon capture and storage and top gas recycling for DRI and BFs

CCS could potentially be applied to all major point sources in the steel sector. Past studies have tended to focus on the blast furnace as the major point source of CO_2 on a conventional integrated steel plant, either using retrofitted CO_2 capture technology or by developing a new type of blast furnace. The European ULCOS program represents a good example of the latter – proposing a radical new top gas recycling blast furnace design.

Direct reduction plants can offer an easier route to CCS, as some plants incorporate CO_2 separation into their designs and emit a concentrated stream of CO_2 during normal operation. In these plants additional carbon capture equipment is not required.

Tata Steel has recently commissioned a 5-tonne per day (TPD) carbon capture plant at its Jamshedpur Works, making it the country's first steel company to adopt such a carbon capture technology that extracts CO_2 directly from the blast furnace gas.

As most carbon capture projects are still at an early stage of development, affordable cost of deploying these technologies will materialize only over next several years. Moreover, scaling up of operations will require investments in transportation and storage with the associated improvements in technologies of geological storage capacity and reduced risk of leakage. Potential sites must undergo site characterization to ensure that the site can safely store CO_2, to avoid any regulatory compliance issue.

This technology promises and much and early pilots linking the steel industry have been successful. India could be well served to explore this route to decarbonization for BF and DRI routes to steel manufacturing.

Renewables for power usage and electric vehicles for steel logistics

On its target to produce 300 MTPA of steel by 2030. In this context, from mines to the last-mile customer, about 800 MTPA-850 MTPA tons of raw material would require logistics. Anticipating the needs of the future, the

government has already started working on infrastructural readiness of mega projects in logistics like Sagarmala, Bharatmala and Dedicated Freight Corridor. The GHG emissions associated with such logistics if all road logistics would be a sourced from conventional fossil fuels would be about GT of CO_2, perhaps the largest GHG emissions for any industrial sector.

Tata Steel has tied up with an Indian start-up to pursue its aspiration of deploying EVs for steel transport. The company has contracted to deploy 27 EVs, each with a carrying capacity of 35 tons of steel. It plans to deploy 15 EVs at its Jamshedpur plant and 12 EVs at its Sahibabad plant.

"This is a definitive step toward our commitment to the environment. This initiative is also aligned to the government's larger climate agenda and will surely serve as a cornerstone and a way forward for the industry to follow," said Peeyush Gupta, Vice President Supply Chain, Tata Steel.

Prepare for hydrogen intrusion in the industry: hydrogen based DRI and EAF using renewables

Efforts and plans for investments in are on globally and in India to make green hydrogen the most affordable fuel option by bringing down its cost to initially under $2 per kg. India can potentially set an even more aggressive target of achieving under $1 per kg within a decade. In the medium to long term Primary steel through DRI with green hydrogen as the primary reductant followed by EAF (H2-DRI/EAF) can be a very cost and green friendly way of steel manufacturing. This is technology is technologically very promising but about 10-15 years away from its full commercialization. An early commitment to experiment with, learn and scale and adopt this route to suit Indian environment may be the best pathway in the medium term.

Increase compliance with ESG standards to meet shareholders' expectations

Many investors are demanding ESG compliance from companies to enable them to have a sustainable portfolio. In the future, more governments and investors will be enforcing carbon abatement strategies on firm, e.g., several countries and regions, including Canada, Mexico and the EU, have implemented policies such as Emission Trading System (ETS) (cap and trade system) and carbon tax regimes.

ESG aligned steel makers will have a lower financing cost, better management of resources, a better capacity to absorb and recover from economic shocks and reduced operational risks. This also helps develop more resilience to any drastic change in a country's environmental and related norms. Steel makers should therefore start preparing for the new normal of integrating non-financial frameworks of ESG into investment decisions.

In recognition of the above, some steelmakers are taking small steps e.g. they are including the impact of carbon emissions in assessing the profitability of capital investments. For instance, JSW Steel has adopted a shadow internal carbon price of US$20/t CO_2, while Tata Steel has marked US$15/t CO_2[102].

> **Technology will move towards enabling reduction in CO_2 release but no single technology will be prevalent. Hydrogen, Bio-fuels and many others are being explored but as yet it is not clear if there will be no clear winner or loser as far as technology is concerned**

Dr. Edwin Basson, Director General, World Steel Association

[102] https://www.jsw.in/groups/sustainability-framework-measuring-success-climate-change; https://www.tatasteel.com/tata-steel-brochure/sustainability.html

A comparison of emerging and new technology production methods for greener steel:

Emerging Commercial Technologies	Incremental prod. costs	Potential CO_2 reduction	Commercial horizon	Benefits	Challenges
Scrap-EAF	-	80%	Commercial	High potential of CO_2 reduction; technology readily available; useful in case of low supply of high quality coal	High scrap supply required; energy needs of EAF can add to emissions
Smelting reduction	-	4-20%	Commercial	Lower operating cost; Possible elimination of sinter/pellet and coke plants	High calorific value export gas generated; Lower economic scale of operations
BF/BOF with biofuel	-	20-50%	Commercial	Easier to implement by altering the input mix in blast furnace	High quantity of biofuel required; Increased storage and transportation cost; High moisture content of biofuels
BF/BOF with carbon capture	+30-50%	30%	5-10 years	Can easily be integrated to BF-BOF; Advantage from R&D going on since long time	Large infrastructure investment for storage and transport; Difficult to capture all CO_2 emissions
BF/BOF with hydrogen	-	-	~ 10 years	Potential to reduce emissions both in coke plant (reduced amount of coal required) and blast furnace	Difficult to replace reducing agent by hydrogen beyond a point to maintain operations
Natural gas DRI (NG-DRI/EAF)	-	40%	Commercial	High energy and emissions savings	Adequate and afford-able supply of natural gas critical to determine profitability
Blue hydrogen DRI (H2-DRI/EAF)	+35-55%	-	10-20 years	Flexibility; scalability of producing blue hydrogen in some areas	Production cost of blue hydrogen: ~ US$2/kg compared to black hydrogen: ~ US$1.7/kg; Does not address emissions from pellets
Green hydrogen DRI (H2-DRI/EAF)	+60-90%	80-95%	10-20 years	Increased flexibility as hydrogen and HBI can be stored	High green hydrogen costs: ~ US$5/kg compared to black hydrogen costs of ~ US$1.7/kg
Iron electrolysis	Not determined	~90%	20-30 years	Largest potential in CO_2 reduction	Still at an early stage of development, only been tried at a lab scale

Sources: BNP Paribas, BHP, IEA, ArcelorMittal, EY analysis
Note: Potential CO2 reduction for scrap-based EAF, smelting reduction process considered as compared to blast furnace
Estimates majorly for transition to low-emissions steelmaking in Europe
Incremental production costs (OPEX and CAPEX) compared with average annual net income of steel industry
Values compared for crude steel production

5

Research and Development led product innovation

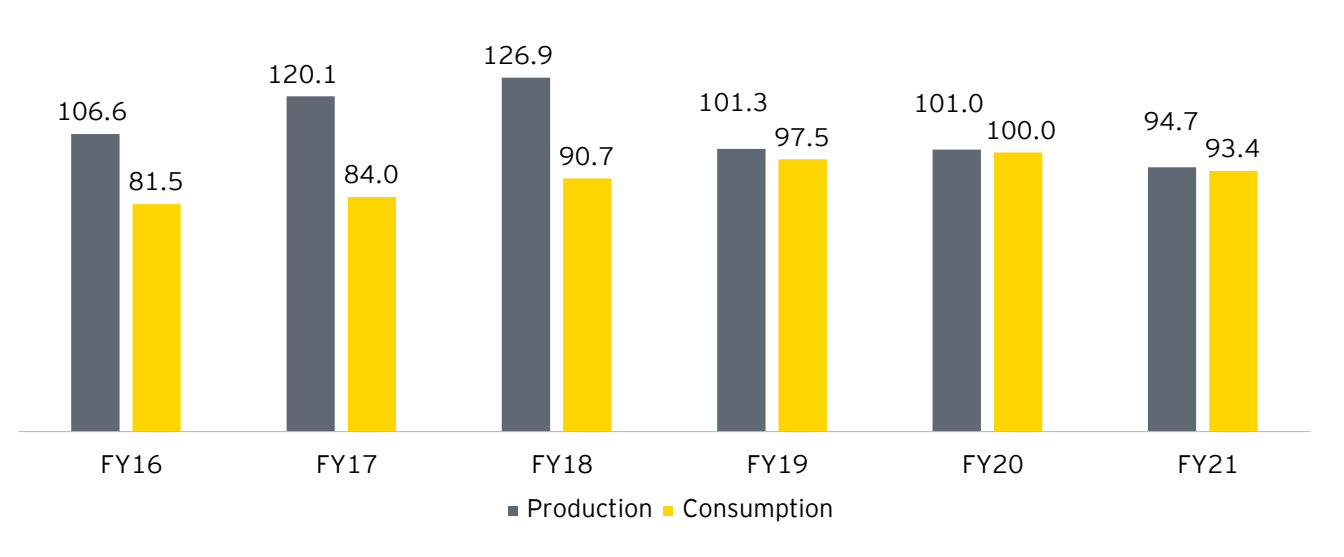
Context

India is targeting to become a 5 trillion-dollar economy in this decade. The steel industry needs to be the backbone of that growth story. It is predicted that the industry shall grow at an average of 8% for the next 10 years and by 2030 the production of Indian steel would be around 300 MT as compared to 94 million we stand today.

The total installed capacity in India for steel production today is ~142 MT, which was used to produce 102 MT of crude steel. However, most of the installed capacities in India is with a moderately dated technology and barring the top 10 major steel making companies, the expansion in limited and concentrated mostly around certain basic grades of production.[103]

Comparison of finished steel production and consumption in India (MT) (FY2016 to FY2021)

India's steel production was a in growth trajectory till FY18 and from then on its been sliding down from FY19 to FY21 due to various factors. Steel consumption went up till FY20 but then came down due to COVID-19.



Source: Ministry of Steel, Annual Report 2020-21

[102] https://www.ibef.org/industry/steel.aspx

The problem with the current technological landscape is two folds: one production efficiency with respect to global standards specially related to specific consumptions of inputs, and second, they are not technologically updated and produce innovative products like the latest variants of high-performance steel which the downstream industry wants. Added to this, India also has a limited downstream processing capacity which prohibits us to generate value from the crude steel which is being made in India.

Domestic consumption

The consumption of steel in India is increasing at a rate of 17-18% per year, but mostly the demand is for long products. As per the sector wise demand, the consumption is primarily driven by construction industry, followed by capital goods, automobiles, and consumer durables industry. The construction industry mostly uses steel products which are not very technically challenging to produce, unlike certain other relatively high grades required for railways, automobiles, or defense industries for high end applications.

Specification and grades: high grade steel definition

As per the World Steel Association, there are over 3,500 different grades of steel, encompassing unique physical, chemical, and environmental properties. Different types of steel produced based on the properties required for their application, and various grading systems are used to distinguish steel types based on these properties.[104]

Steel can be broadly categorized into four groups based on their chemical compositions: **Carbon, Alloy, Stainless, and Tool Steel**. These four groups are based on the carbon content and percentage composition of other alloying elements e.g., manganese, silicon, nickel, titanium, copper, chromium, and aluminium) in varying proportions to modify its properties depending on the usage. The wide ranges of tensile strength, yield strength, and hardness are largely due to different heat treatment conditions and broadly following are the characteristics on which segregation can be done across various categories:

[104] https://www.thoughtco.com/steel-grades-2340174

Comparison table of different steel grades (compositions, Characteristics & Application)

Different types of steel have different characteristics and therefore different application.

Key characteristics	Carbon Steels	Alloy Steels
Composition	Three main categories: 1) Low Carbon Steels/Mild Steels (up to 0.3% carbon), 2) Medium Carbon Steels (0.3-0.6% carbon), 3) High Carbon Steels (more than 0.6% carbon).	Contains alloying elements (e.g. manganese, silicon, nickel, titanium etc) to manipulate properties, such as hardenability, corrosion resistance, strength, formability etc
Application	Mainly use in large-scale construction and other applications	Applications include pipelines, auto parts, transformers, power generators and electric motors.
Tensile Strength (MPa)	276-1182	758-1882
Yield Strength (Mpa)	186-78	366-17933
Percent Elongation (%)	10-32	4-31
Hardness (Brinell 3000 kg)	86-388	149-627

Source: efunda, Steel Grades and Properties-ThoughtCo.com

Classification of Steel: grades definition of Advanced High-Strength Steel (AHSS)

Normally, high grades of steel belongs to certain grades of alloy and tool steel or sometimes a combination of tool steel and alloy steel. In simple words contemporary high-grade steels are generically used for all steels with low- to medium-alloy content, which exhibit high strength and hardness, coupled with good formability and weldability. They also demonstrate exceptionally low temperature notch toughness and crack resistance despite the high strength. Such specific properties are a result of careful selection of both chemical composition and heat treatment.

There are different ways to classify high grade steels, based on:

- Metallurgical designation- provides details about composition, processing, and microstructure of the steel.
- Strength designation- strength of the steel. HSS and AHSS are generally used to designate all higher strength steels.
- Formability designation- ability to be formed into simple and complex shapes by different manufacturing processes. The important parameters that characterize the formability are high work-hardening exponent and total elongation.

The most used classification is based on the metallurgical

	Stainless Steels	Tool Steels
	Three groups based on their crystalline structure **Austenitic:** 18% chromium, 8% nickel and >0.8% carbon. **Ferritic:** Nickel, 12-17% chromium, > 0.1% carbon **Martensitic steels** 11-17% chromium, > 0.4% nickel, max 1.2% carbon.	Tool steels contain tungsten, molybdenum, cobalt and vanadium in varying quantities to increase heat resistance and durability
	Austentic Steel - food processing equipment, kitchen utensils, and piping. Martensitic - knives, cutting tools, dental and surgical equipment.	Flat Products) plates, sheets, coils, and strips_- automotive parts, appliances, packaging, shipbuilding, and construction. Other Products include valves, fittings, and flanges and are mainly used as piping materials.
	515-827	640-2000
	207-552	380-440
	12-40	5-25
	137-595	210-620

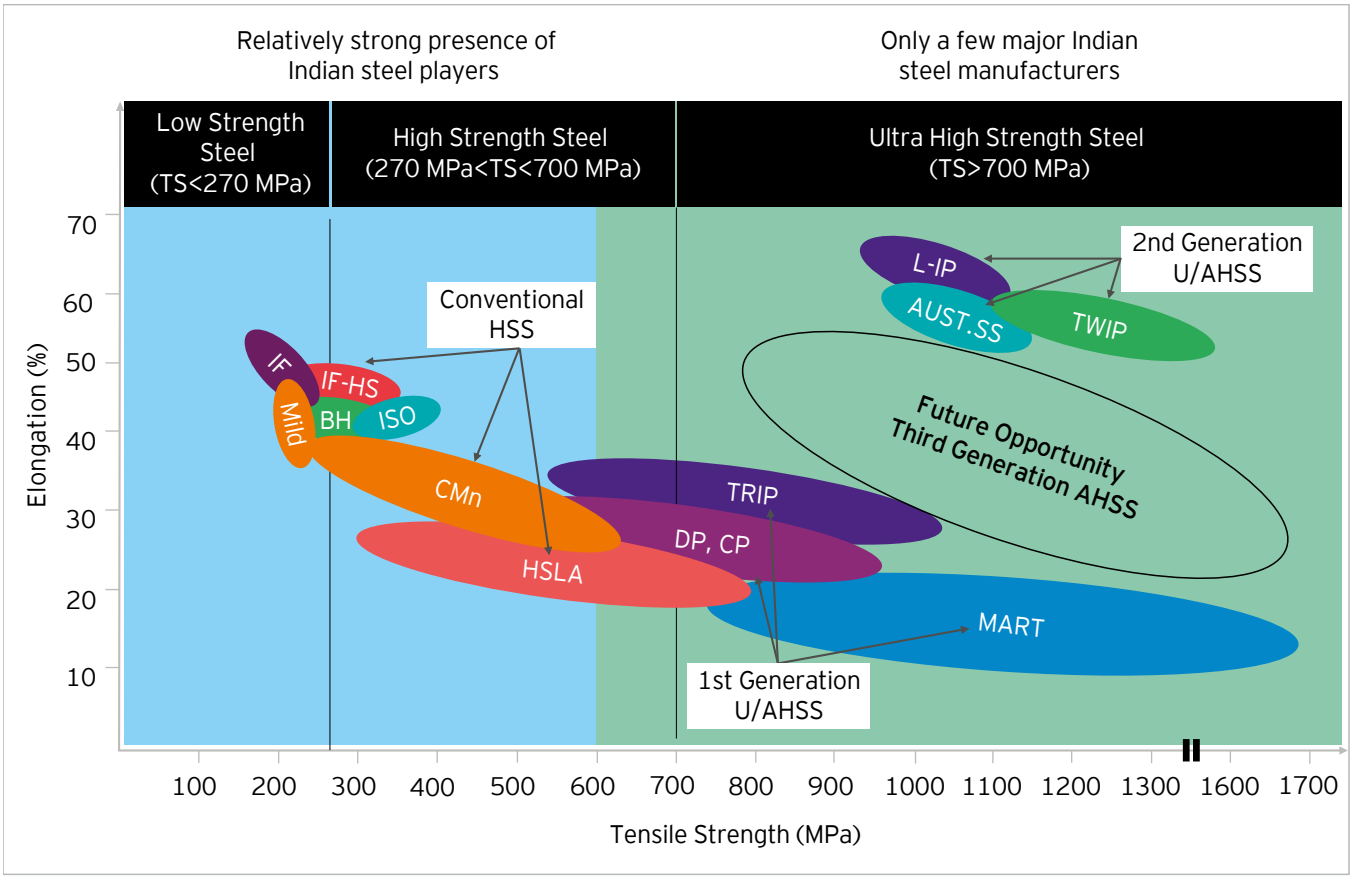
designation providing some process information. Common designations include lower-strength steels (interstitial-free and mild steels); conventional high strength steels, such as bake hardenable and high-strength, low-alloy steels (HSLA); and Advanced High-Strength Steels (AHSS) such as dual phase and transformation-induced plasticity steels. Additional higher strength steels include press hardening steels and steels designed for unique applications that have improved edge stretch and stretch bending characteristics.

Generally, HSLA and AHSS is used to designate all higher strength steels. The principal difference between conventional HSLA steels and AHSS is their microstructure. Conventional HSLA steels are single-phase ferritic steels with a potential for some pearlite in C-Mn steels. AHSS are primarily steels with a multiphase microstructure containing one or more phases other than ferrite, pearlite, or cementite – for example martensite, bainite, austenite, and/or retained austenite in quantities sufficient to produce unique mechanical properties. Some types of AHSS have a higher strain hardening capacity resulting in a balance between ductility-strength which is superior to simple conventional steels. Some other types of AHSS have ultra-high yield and tensile strengths and show a unique bake hardening behavior.[105]

[105] https://matmatch.com/resources/blog/advanced-high-strength-steel-stronger-lighter-safer-cars/

Mapping of Steel Grades (Current & Emerging) in Indian perspective[106]

Steel grades are evolving around the world and even in India. Demand of downstream industry especially Automobiles is driving this change and 3rd Generation AHSS development.



High grade steel: India's dependence on imports

India, at an overall level, has become a net exporter for last 4-5 years, however at a composition level, India is a net importer for alloy and stainless steel. In fact, India ranks way below Japan, US, Korea, and Europe when it comes to the production of high-grade steel or specialty steel. India meets 15% of its annual demand for specialty steel through imports. On one side, the domestic stainless-steel industry has a low-capacity utilization due to low price imports, we are also dependent on import of most of the super duplex, super austenitic and high alloyed varieties of stainless steel for stringent end use applications. Out of India's total steel imports of 6.7 MT, nearly 60% can be attributed to the imports of specialty steel. This import constitutes steel grades used in coated/plated steel products, specialty rails, high-strength-wear resistant steel products, electrical steel, wires, and alloy steel products amongst others.

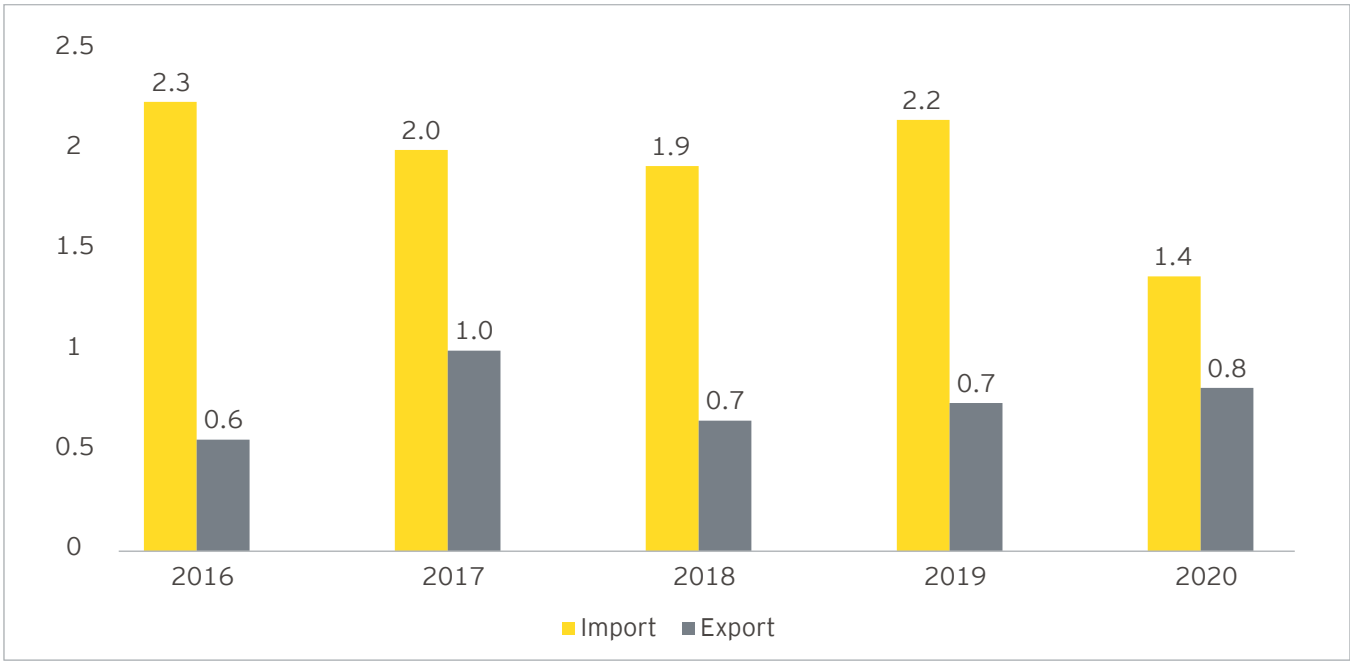
> **India plans to install 500 GW of energy through renewable sources by 2030. At 40GW per year, it translates to quadrupling the existing rate of capacity installations. With the demand for high grade steel increasing, the Indian steel industry has to gear up to meet the requirements**

R.V.Sridhar
Executive Director & CEO – Coated Steel, ArcelorMittal Nippon Steel India

[106] Cora, Ömer Necati & Koç, Muammer. (2014). Promises and Problems of Ultra/Advanced High Strength Steel (U/AHSS) Utilization in Auto Industry. 10.13140/2.1.4725.0883.

Comparison of Import and Export of Alloy Steel in India (MT)

India is heavily dependent on import when it comes to stainless and alloy steel. Most High grade steel are under these two types where, even though the domestic demand is high, production is low.



Source: Ministry of Steel, Annual Report 2020-21

Key challenges pertaining to high grade steel manufacturing in India

- **Scale of high-grade steel in domestic market:** Key grades for railways, automobiles, and specialty applications for Military, Defense, Aerospace or advance manufacturing have a very limited demand. In fact, most of these industries are all still at nascent stages in India. Thus, smaller steel players are not very interested to enter this segment. This demand is being catered by current big Indian players only at this point of time and there is limited collaboration of these players with small scale mills.
- **Higher investment with long lead times Due** to Atmanirbhar Bharat Initiative[107] and government focus to discourage end user from imports, it is expected that high grade steel will be used for a variety of applications in the near future. However, a single order quantity for any specific grade of material is relatively small. These order quantities are generally below the minimum order quantity (MoQ) required to run a sustainable business. With little or low multi-use potential for some of these specific grades of material, the order volumes remain below sustainable production levels. Thus, in relation to commercial application and production, Indian companies (especially mid and small size players) are not able to recover the investment which are associated with developing indigenous capabilities for these grades.
- **Technological capabilities** Historically, technological transitions in the highly competitive steel sector have been driven by purely commercial factors; this has come primarily in the form of increased efficiency (and thus decreased cost), as well as improved quality. When it comes to steel technology, whether its process or material engineering, India has majorly been depended on its foreign collaborations. R&D is required to develop specific grades of alloys even through it is cost

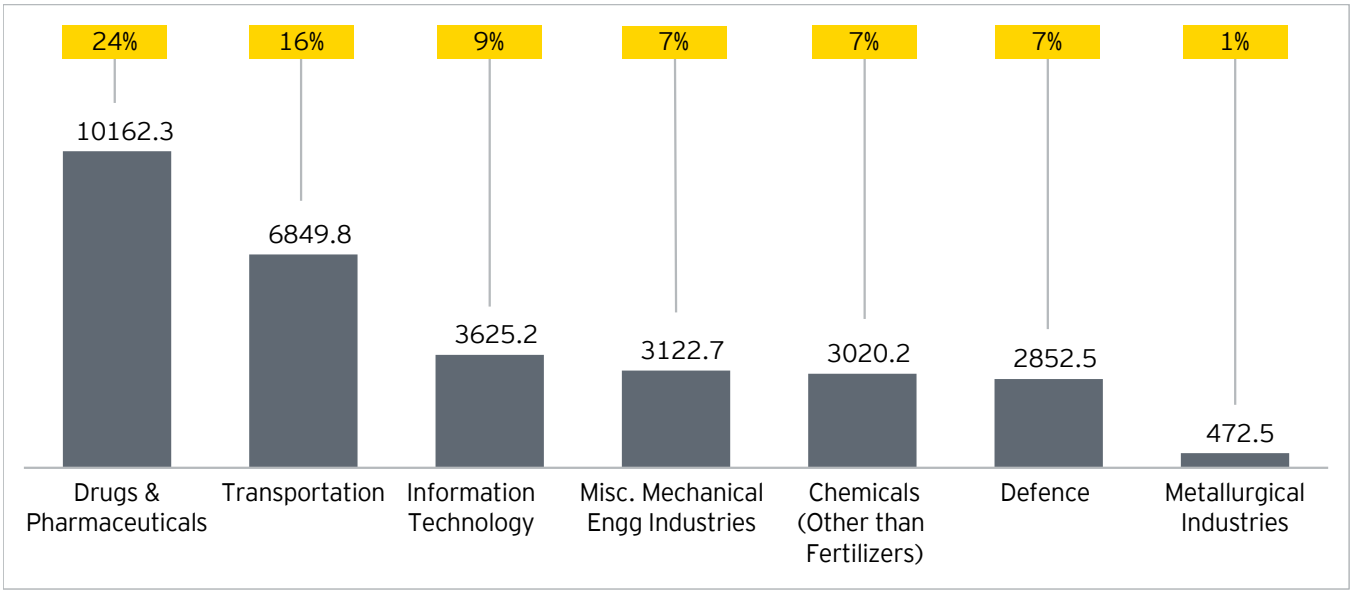
[107] https://www.business-standard.com/about/what-is-atmanirbhar-bharat-mission

prohibitive. Barring some major players, companies are reluctant to invest in R&D for these new materials. Instead, the industry often looks to license the technology, which have end-use restrictions and thus cannot be accessed without government interventions. The government has dedicated institutes like SRTMI, DRDO where different technologies related material development is being developed which is being shared with the industry. Otherwise, the innovation is limited to the big 4-5 players in steel, who have technical tie-ups with their foreign partners. JFE, Kobe, Nippon, Thyssenkrupp, POSCO all have different tie ups with JSW, TATA, JSPL, AML, ESSAR etc. who limited the development to themselves.

- **Finance and capital** steel industry is a highly capital-intensive industry. For every 1 Ton of crude steel, an approximate investment of INR 8000 to 10000 crores is required (for a Green Field Project)[108]. This is a major deterrent for any private player to invest in this sector. Added to this, the high rate of interests in India, unfavorable political landscape, and huge volatility in the global steel market are other reasons why the sector does not have many investments in India. Small and medium sized mills minimize the risk by producing low grade, easily sellable steel with equipment and technology which are already established and running. As the steel landscape shifts very rapidly even in India, based on global cues, existing plants are less adventurous when it comes to expansion or investment in modern machinery and technology.
- **R&D spend:** R&D and product innovations are weak links in the steel industry in India. Levels of R&D expenditure in Metallurgical industries is very low as compared to other industries like Pharmaceutical, Transportation and Information technology industry groups. While the top 5 industry groups have more than 7% R&D expenditure out of the total R&D spend in India, the Metallurgical industry ranks very low (12th rank across industry groups) in terms of spend. Interestingly, the Metallurgical industry is the only industry in India where contribution from private and public sectors is almost equal. However, it is not only funds but also paucity of ideas which is responsible for low spends on R&D in steel industry.

R&D expenditure (in INR crores) by industry groups (2017-2018)

Overall the spend on R&D in India is low across all sectors barring Pharma. But when we look at metallurgical industries is as low as 1% and that too consolidated among a few players.



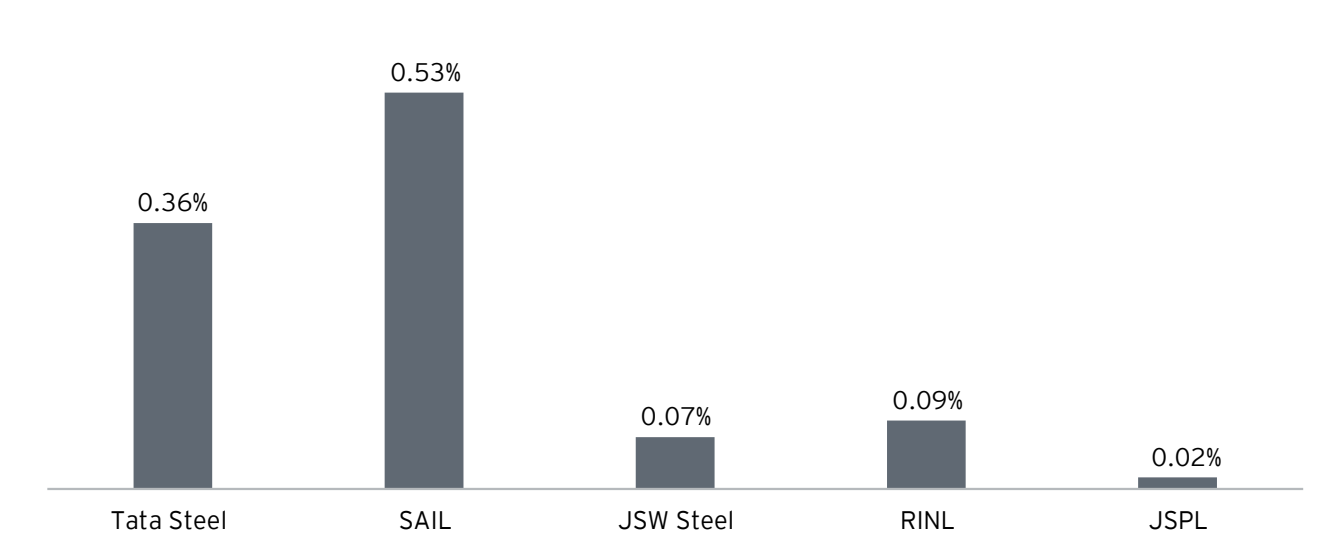
Source: Data collected and compiled by NSTMIS, DST, GoI- 2017-2018

[108] REPORT OF THE WORKING GROUP ON STEEL INDUSTRY FOR THE TWELFTH FIVE YEAR PLAN (http://mme.iitm.ac.in/shukla/wg_steel2212%281%29.pdf)

The actual investment on R&D by the large steel companies in India varies from company to company in the range of 0.02-0.53% of their sales turnover. It is also important to note that the current focus on R&D from a spend perspective is related to incremental technology development to address the present and short-term needs of production units. In fact, barring some commendable product development efforts, contributions towards disruptive technology development have not been noteworthy. The actual investment on R&D by large steel companies in India is considerably less than their global counterparts.

Comparison of Research and Development spend as % of their turnover for the Top five steel makers of India (FY2021)

Even leading steel producers are not very keen when it comes to spending on R&D. Compared to these, their counterparts in other parts of the world spend more than 1%.



Source: Annual reports-FY21, EMIS

In comparison to the global R&D scenario with respect to steel companies' particularly, in China, Japan South Korea, and US, companies have large outlay of funds earmarked for R&D and have visible tie-up with external laboratories and academic institutions. Annual R&D investment in these companies is high which is up to 1% of their sales turnover.

These issues are plaguing the Indian Steel industry and making the high-grade steel production not competitive in the global market.

High Grade Steel – opportunities for Indian Steel players

Product innovation: shift towards high grade steel in domestic consumption and exports market

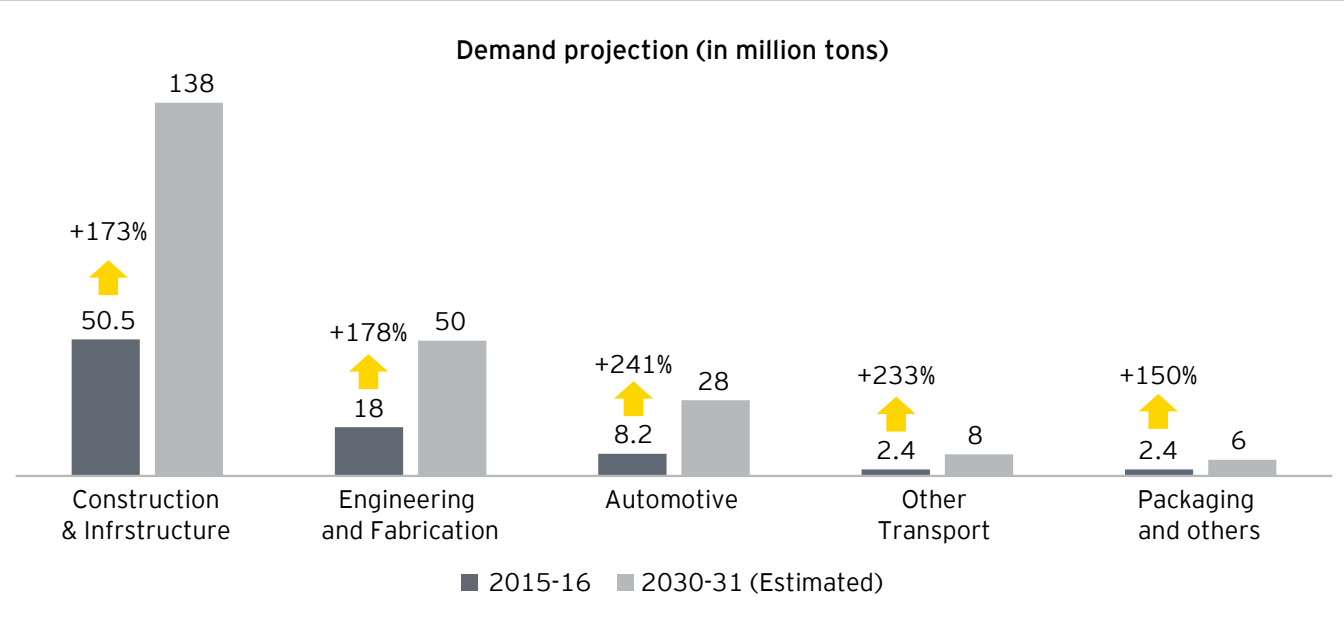
Steel companies are facing an increasingly competitive global market where a differentiated and technically more advanced product can reach higher value segments. Today countries across the globe are trying to re-imagine the use of steel. Apart from our standard uses of infra, tools and utensils, engineering material etc. today steel is being used in food processing and storage, fashion, art, hygiene, aviation, medicine etc.[109]

In recent years, demand for alloy and special steel, or value-added steel, with superior quality to meet stringent application norms of various market segments, has been growing. Based on the projected demand, from a domestic consumption perspective, there is a huge demand potential across key user segments.

[109] Metinvest Holdings, https://metinvestholding.com/en/media/article/10-udiviteljnih-sposobov-primeneniya-stali

Industry wise demand projection of Steel for 2030-31 in comparison with actual demand of 2015-16

Steel demand is going up as India moves to become a 5 trillion dollar economy. The growth in the sector shall be driven by infrastructure and construction.

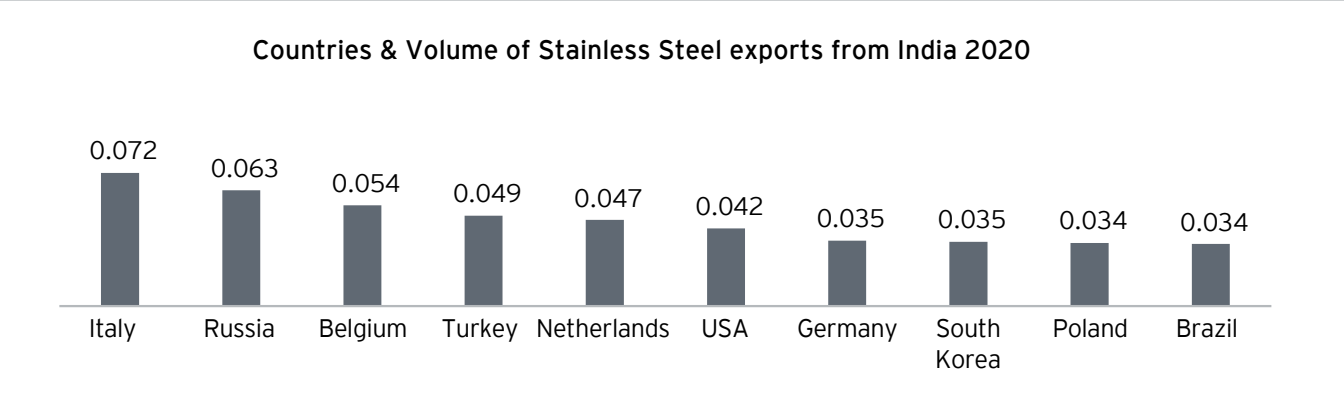


Source: EY analysis, Ministry of Steel, MECON

In India, major steel manufacturers are diversifying their portfolio of products to make high grade steel. JSW, TSL, JSPL, AML are all making steel which is also getting exported to across Europe for special application like modern day electric vehicles, high sped railways, advance building materials, and marine vessels. But the overall share of these materials when compared to the larger picture is very small. India is not the most preferred supplier and there is a major gap between the top exporter and India, especially in high grade steel which is a major opportunity for the country.

Comparison of Stainless Steel export from India to Top 10 countries by Tonnage (MT)

When it comes to Stainless Steel, India exports to many European countries, but the volumes are extremely low when compared to total demand.



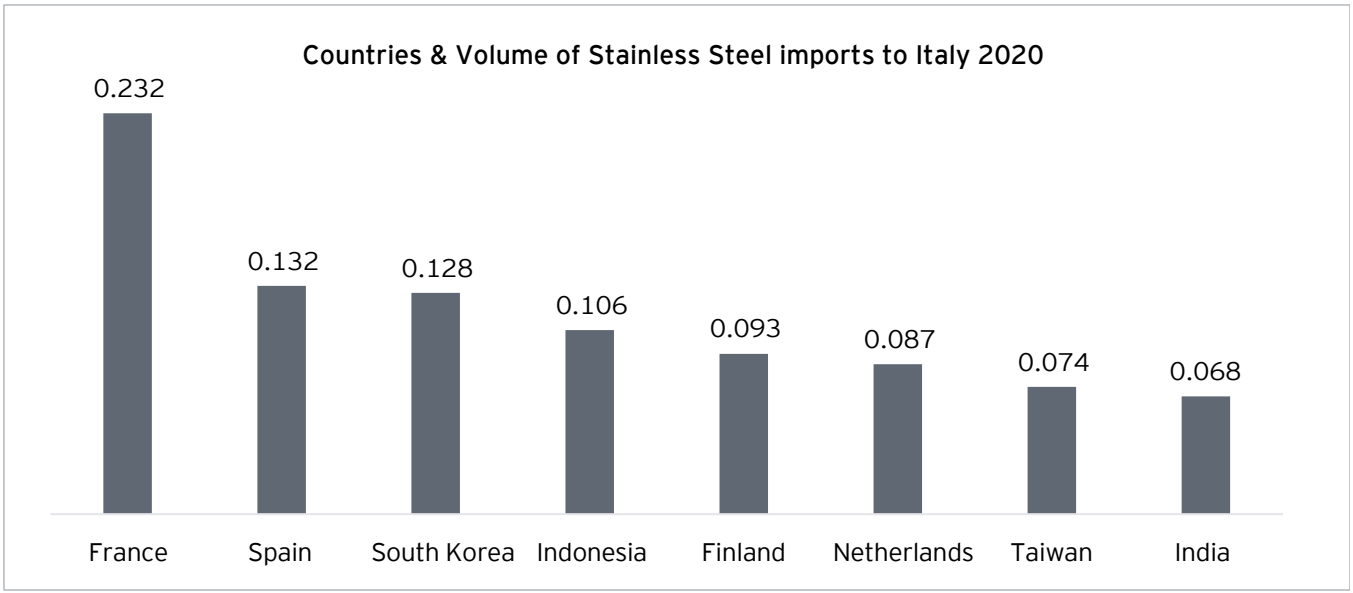
Source: Official Website of the International Trade Administration, USA (https://www.trade.gov/steel)

As evident from the above graph, the top countries to which India exported stainless steel were all in Europe but the volume of export was very low. If we just take Italy for example, we shall find that in 2020, it imported around 1.3 million metric tons of Stainless Steel out of which roughly only 5% was catered to by India. Countries like Spain, Indonesia and Taiwan have a better share of the wallet when it comes to supply to Italy, which was India's highest export partner when it came to stainless steel.[110]

[110] Global Steel Trade Monitor, https://www.trade.gov/data-visualization/global-steel-trade-monitor

Comparison of Stainless Steel Import to Italy from Top 10 countries by Tonnage (MT)

Italy was the country where India exported maximum stainless steel in 2020, but India features 8th in the list among importing countries in Italy, and ranks lower than Indonesia, Spain and Taiwan.



Source: Official Website of the International Trade Administration, USA (https://www.trade.gov/steel)

In summary, that there is a major potential for Indian Stainless and Specialty Steel from reducing the import dependence, increased domestic consumption as well as expanding the volume in export market. The additional impetus required is in form of both government policies (both local and bi-lateral) and the industry (mid-size to take a leap towards having a stronger presence though product innovation to develop new products and process innovation to make better quality at a more competitive price.

Usage and applications of high-grade steel across different sectors

Aero space and Défense Sector- Steel has been a major construction material in aviation to build strong parts like the landing gear due to its strength but at the same time it has been not the material of choice for the body due to its weight. However, new types of carbon steel now is also been used as the skin of some high-speed airplanes. New generation airplanes and supersonic jets are exploring the usage of carbon steel and steel composites because of its resistance to heat and an added protective layer. Modern day material scientists and engineers are trying to develop types of steel which are strong but at the same time be thin and light. This grade of steel is finding application across different industries ranging from aerospace and defense to high end automobiles and even in construction.

Construction and Infrastructure Sector: Steel fibres have been long used to augment or even substitute rebars in reinforcing concrete. Addition of steel fibres increases the flexural strength of the composite from 25% to 100% - depending on the proportion of fibres added and the mix design. Catastrophic failure of concrete is virtually eliminated because the fibres continue supporting the load after cracking occurs. Modern day building science is finding more uses of SFRC in developing more complex building structures.

Apart from SFRC, special grade steel structures are also finding rapid use in construction especially in high-rise buildings. Demand for special alloys which are stronger than conventional materials but thin and light are in demand. Though these alloy structures are way more expensive today, they bring down the overall cost of construction by a substantial margin and help in construction of green and sustainable structures.

Automotive Sector: Electrical steel is vital for its use in

> **As India moves towards a USD 5 trillion economy and builds world class infrastructure, use of stainless steel is bound to multiply. Known for its longevity, formability, and strength, stainless steel is the most cost effective material on a lifecycle costing basis. Since it's made from recycled scrap using the EAF route, the metal is a most sustainable choice among other alternatives. I'm confident that India will rapidly grow her per capita consumption of stainless steel in sync with her global counterparts**

Abhyuday Jindal, Managing Director, Jindal Stainless Ltd.

the stators and rotors in the motor of an electric vehicle. In recent years, steel has increasingly been favored over aluminium as the metal of choice in EV construction, largely because of its lower cost and superior strength. Materials like Advanced High Strength Steels are playing a vital role in lowering vehicle weight while still offering high passenger protection. Electrical steel, which is manufactured to contain specific magnetic properties, is a key component in transformers and generators. This material is also vital for its use in the stators and rotors in the motor of an electric vehicle. Here it has a critical influence on the efficiency of the motor, minimizing core energy losses and boosting the vehicle's range.

Motors used in industrial machinery typically operate at between 5,000-8,000 RPM, but the electric motors in modern vehicles can reach speeds four times higher than this. This generates significant heat, which can increase core losses and negatively impact vehicle performance. At this many revolutions, the motor components undergo extreme mechanical stress and here electrical steel can be relied upon for its high durability.

In addition, there is huge market today for Ultra-thin steel (0.00175mm thick) foils and stirps being used in motors, transformers, batteries and many other applications in automotive, aerospace, energy exploration, industrial and medical markets. Material engineers are exploring new avenues to improve the usability of steel in different sectors and finding ways to improve the nature of steel to be more adaptable to different application. Snapshot of some of the potential alternatives and its advantage over the current state.

Table of Sector wise use of steel- Current Product, Alternative Product under development and Advantages

Evolution of steel products is a process happening in all sectors. New types of steel products are replacing old ones or completely changing the industry landscape. All this innovation is getting driven by demand.

Sector	Current State	Alternative Products
Building Construction	1. Mostly done with Brick and Mortar 2. Slow adaptation of Structural Steel but Limited to urban areas	1. Structural Steel 2. Pre-Fab Units
Infrastructure	Use of Steel limited in RCC as TMT Bars	1. Steel Fibre re-enforced concrete 2. Ultra High Carbon Steel Sections
Aviation	Aluminium composites for body and special steel for landing and stress parts	1. New Age Carbon Steel 2. Ultra Thin Steel Sheets with carbon Fibre
Defence	Multiple grades of speciality steel for speciality use	1. HCS 2. UHCS 3. Nitrogen Steel 4. High Grade Armor Steel
Automobiles	1. HSLA & ALSS are the primary materials to make Automobile bodies 2. Cast Ion for engine blocks 3. Carbon Steel for Other parts	1. New Age AHSS 2. Electrical Steel
Packaging	1. Plastic 2. Tin 3. Aluminium	Thin and Ultra Thin Stainless Steel

Source: EY Internal research, www.steelforpackaging.org, www.sciencedirect.com, www.princeton.edu

> **End-use sector is a catalyst for the steel industry to produce high grades of steel. While some major players with international partnership are making advanced grades of steel in India, the small and medium players are focused on grades which are in high demand. But this situation is likely to evolve with the demand patterns changing & democratization of technology for producing value added steel in India**

Dr. Edwin Basson, Director General, World Steel Association

	Use Alternatives	Advantages
	1. Increased per capita consumption of steel 2. Increase reach of structural steel in rural parts 3. Move towards complete pre-fabricated units using structural steel	1. Increase per capita consumption of steel 2. Decreases construction Time 3. Environmentally sustainable buildings 4. Reduces cost of construction 5. Improves longevity of buildings
	1. SFRC to be used in place of RCC 2. UHCS structures can be used for bridges for support	1. Reduction of weight of structures 2. Higher post crack flexural strength 3. Better crack resistance 4. Improved fatigue strength 5. Higher resistance to spalling 6. Higher first crack strength. 7. Easy to shape without compromising on strength or durability
	Ultra thin steel re-enforced with carbon fibre can substitute Aluminium Composites	1. Better resistance to heat at super-sonic speeds 2. Increased Life
	1. Develop composites with carbon fibre and Kevlar to make body Armor and helmets 2. Use for tanks and land equipment 3. Use in structural development	1. Corrosion resistance 2. Better holistic capabilities 3. Better mechanical properties 4. Lighter Armor 5. More Strength
	1. New age AHSS can bring down the weight of the vehicle by 25-40% 2. Electrical steel is a soft magnetic material. In such materials an external magnetic field generates a magnetic flux density that is many times higher than would be the case in air.	1. Electric cards are the thing of the future. Steel needs to be re-engineered for lighter but stronger bodies. 2. Electrical steel improves the performance of the electrical motors required in the EVs
	Thin and Ultra thin steel can become a direct substitute for both Tin and Aluminium	1. Strength is better than Tin and Aluminium 2. Formable 3. Long lasting 4. Helps to preserve food longer 5. No need to add preservatives to the foods kept in steel cans 6. Bio-degradable/Reusable -Thus environmentally friendly

With better demand prospects and mega expansion plans in the pipeline, there is a need to sharpen the focus on alloy and special steels as it guarantees better premium to both steel makers and consumers. These products are mainly finished steel and are termed so depending on their treatment or their end use across different sectors.

The way ahead

While there are number of initial steps that have been undertaken by major Indian steel players for R&D, policy intervention by government and industry -user collaboration, there is a persistent need to not only have sustained R&D investment by Indian steel companies but also engage and develop a deeper level of collaboration across different stakeholders within the steel ecosystem. This collaboration across the stakeholders need to operate across three levels:

- Policy
- Sector
- Organization

Policy level interventions:

Policy framework: At a policy level, focus on integration of science and research labs, universities, government level agencies and industry level partnerships through a policy framework to promote advanced R&D activities to enable innovation is critical. Though initial steps have been taken in different forms, there is a need to align technology, research, and innovation with an integrated policy that will allow the stakeholders to identify areas of greatest impact.

Establishment of Nodal Agency: With the inputs from different stakeholders, the policy framework needs to address dimensions of technological upgradation, product innovation, skill development and productivity across a broad spectrum of steel industry and support sustainable development in India focused on higher grade steel and leverage India's strong manufacturing base to translate innovation into competitive products and services. This will enable enhanced co-ordination across multiple agencies and would make it easy to identify the areas of greatest impact and synergies across the ecosystem. This policy framework would also require a formal governance structure to ensure active engagement of all the stakeholders across the steel ecosystem and supported by a structural review to achieve the desired objectives This can be governed by establishment of a "nodal agency" to provide a structural review and policy support.

Helping others to join Alloy-Club- The government is pushing hard for an Atmanirbhar Bharat or Make in India. This is huge advantage to help high-grade steel development in India. With Make in India and Source from India, the manufacturing industry would look inwards for special metals and alloys. This would generate a steady and high demand which is missing in India currently. The government should help through policies, tax benefits and other interventions which would excite the smaller and medium scale mills to also start producing high grade steel. Once this happens, the market would open up, making pricing more competitive which would force all the companies to better their efficiencies and technology. It is very important to thus create a level playing field when it comes to high grade or special steel, for the same to grow in India.

Sector level

A consortium of leadership groups across steel companies, user sectors research labs, **Academia** to create a roadmap on sector specific strategies to be adopted for technology and product innovation. In India, especially in the Steel Sector we find such collaboration very rare. If we look at Japan, Europe or US this is one of the major differences we can point out in terms of sector-level collaboration.

These collaborations help companies to look deep into the future and be ready for it, bring in path breaking technologies and products and at the same time have a steady flow of talent into the plants. Unfortunately, this kind of collaborations use to be present in India before, especially when the first few steel plants were commissioned, they had a tie up with IISc, Bangalore, IITs, REC, IIT Roorkee) and IIEST, Sibpur for technology and product innovation. However, over a period, this has faded.

This collaboration needs to be re-kindled with funds and support from both the industry and the government. Different collaborations may be made to focus on different areas. Even premier private colleges should aim at opening Metal Technology Centres to develop Material Engineering and Steel Technology. Foreign Research Students who show potential can be given special grants to peruse their research in India. These kinds of steps would help develop research in steel in India.

Case in Point: Tata Steel-Academia Collaboration[111]

- National Institute of Technology, Trichy signed a memorandum of understanding with Tata Steel Ltd to promote joint ventures for the development of innovative technologies in steel making.
- With Harvard University, Tata Sons, Tata Communications, Tata Steel, and JLR have established a six-year research alliance, which will bring together the capabilities of Harvard's scientific research enterprise with those of the Harvard Business School. Some of the initial areas of interest are soft robotics, advanced materials, and sensor technologies. Tata Steel has also tied up a five-year alliance with the Indian Institute of Technology Madras, in Advanced Materials. Tata Sons will provide support through participation in the technical and governing bodies of the collaboration. The vision is to set up a self-sustaining research centre in Advanced Materials Technologies for the Tata group.

Organization level

Based on the specific requirements at an organization level, steel companies can explore technological collaboration with certain foreign players across the value chain. The objective would be to ensure seamless transfer of technology from foreign players to India and foreign players leveraging Indian steel industry's bulk capacity and manufacturing capability for distribution of products in the Indian market and export from India to have a win-win proposition for both the partners. It becomes important for Indian companies to explore this option (more critical for mid-size and MSME companies) as learning curve for technology and product innovation need to be very steep as upfront R&D costs are significantly high. In addition, the approval process is also relatively long which can have significant impact on balance sheet for a mid-sized and SME steel player. This collaboration will only create innovative and competitive products for the marketplace, it will drive growth for both the partners.

Perspective: International Tie-Ups, Technology Transfers and JVs

In the past, many countries have shared their expertise with India for expansion of steel ecosystem to accelerate its growth drive and achieve the status of the Indian Steel Industry today. Japan and Russia have been key strategic partners for India.

-Japanese companies are increasingly collaborating with Indian counterparts to enable them to produce quality steel and increase its usage. Two Japanese firms have already partnered with Indian steel manufacturers in this regard. JSW Steel has entered into a collaboration agreement with Japan-based JFE Steel in a bid to get access to the latest technology. India has chosen Japan as its partner country for making Indian steel ecosystem bigger both in terms of quality and quantity.

-JSW Steel USA Ohio Inc, a US subsidiary of JSW Steel, has signed a long-term agreement with local steel producer Allegheny Technologies Inc. to convert JSW's locally produced carbon steel slabs into hot rolled coils.

-Tata Steel has also signed up with leading steel manufacturers of Europe to form JVs, namely Thyssenkrupp AG to make high grade speciality steel.

- With the new PLI scheme being announced by the GoI, there has been a high level of interest from Russian Steel Companies to invest in India and come in with the latest steel making tech to make high grade steel.

[111] https://timesofindia.indiatimes.com/home/education/news/nit-trichy-tata-steel-tie-up-to-develop-innovative-technologies/articleshow/66352424.cms
https://www.business-standard.com/article/companies/tata-sons-group-companies-to-partner-with-academic-institutions-fund-r-d-116082900528_1.html

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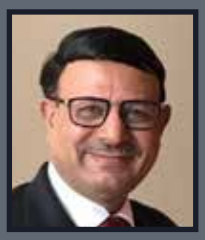

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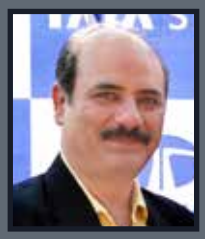

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Notes

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About CII

The Confederation of Indian Industry (CII) works to create and sustain an environment conducive to

the development of India, partnering industry, Government and civil society, through advisory and consultative processes.

For 125 years, CII has been working on shaping India's development journey and, this year, more than ever before, it will continue to proactively transform Indian industry's engagement in national development.

CII is a non-government, not-for-profit, industry-led and industry-managed organization, with about 9100 members from the private as well as public sectors, including SMEs and MNCs, and an indirect membership of over 300,000 enterprises from 288 national and regional sectoral industry bodies.

CII charts change by working closely with Government on policy issues, interfacing with thought leaders, and enhancing efficiency, competitiveness and business opportunities for industry through a range of specialized services and strategic global linkages. It also provides a platform for consensus-building and networking on key issues.

Extending its agenda beyond business, CII assists industry to identify and execute corporate citizenship programmes. Partnerships with civil society organizations carry forward corporate initiatives for integrated and inclusive development across diverse domains including affirmative action, livelihoods, diversity management, skill development, empowerment of women, and sustainable development, to name a few.

With the Theme for 2020-21 as Building India for a New World: Lives, Livelihood, Growth, CII will work with Government and industry to bring back growth to the economy and mitigate the enormous human cost of the pandemic by protecting jobs and livelihoods.

With 68 offices, including 10 Centres of Excellence, in India, and 8 overseas offices in Australia, Egypt, Germany, Indonesia, Singapore, UAE, UK, and USA, as well as institutional partnerships with 394 counterpart organizations in 133 countries, CII serves as a reference point for Indian industry and the international business community.

Confederation of Indian Industry

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