IIM
Metallurgy
Materials Engineering
The Indian Institute of Metals – Delhi Chapter

MET INFO

NOVEMBER 2025

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An Inhouse Publication

For internal Circulation Only

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Visit to Sant Aluminium Pvt. Ltd., Bhiwadi

A team of IIM Delhi Chapter visited Foundry Division and Extrusion Division of Sant Aluminium Pvt. Ltd. (SAPL) on 25th Oct. 2025.

Set up in 2004, SAPL specializes in making various alloys as per customized needs of clients spread over diverse industries including air-conditioning, automobiles, furniture, utensils, ladders, architecture and other specialized uses.

Spanning over **300,000 sq. ft.** of covered shop floor area, **SAPL** is a leading name in the aluminium extrusion industry, with **four fully automatic extrusion lines** (**5, 6 and 8")**, having production capacity of 20**,000 MT per annum**. Advanced **toolroom** of SAPL is equipped with **extrusion simulation software**, enabling it to meet stringent customer requirements with precision and efficiency.

State-of-the-Art production facilities include:

- **Casting**: Fully automatic **Hot Top casting machine**, supported by **6 MT, 10 MT and 12 MT melting furnaces**.
- **Surface Finishing**: Advanced **die-nitriding furnaces** and Automatic die polishing machine ensure exceptional and smooth surface finish and durability.
- **Die Development**: In-house facilities feature **Haas VMCs, EDMs, and Wire Cut machines**, complemented by strategic partnerships with leading global die makers. Our expert **design team** delivers innovative, customer-centric solutions

25% of power requirement is met through captive solar energy unit. The company has necessary facilities for pollution control and water treatment.

SAPL has recently **entered the EV battery casing segment**, expanding its innovation footprint in sustainable mobility solutions.

IIM Delhi Chapter had extensive discussions with Shri Sanjeev Kumar, Managing Director, Shri Abhishek Aggarwal, CEO, and Shri Gurmeet Singh Thakkar, Head – Operation Excellence & Commercial.

Visit of Secretary General, IIM

Brig. Arun Ganguli (Retd.) Secretary General, IIM visited IIM Delhi Chapter on 27th Oct. 2025. Brig. Ganguli interacted with IIM Delhi Chapter Executive Committee

Members and was briefed about recent initiatives taken at IIM Delhi Chapter and future plans.

Brig. Ganguli highlighted various HO plans for extending more support to Chapters for enhancing activities of Chapters.

Molybdenum: A Brief History

For centuries, molybdenum was confused with lead and graphite until scientists finally isolated the element in 1781. It came into commercial use during World War I as a steel hardening agent. In the century that followed, hundreds of uses and functions of molybdenum have been uncovered, from corrosion resistance in stainless steels to an essential role in human health.

Molybdenum occurs in compound minerals called molybdenite, wulfenite, and powellite. By far the most common of these is molybdenite, a greasy, silver-gray mineral that leaves a mark on paper. Molybdenite was known and used in ancient times, but it was unclear if it was just another ore of lead or graphite. The element's name comes from "molybdos", meaning lead-like in ancient Greek.

It wasn't until the end of the 18th century that molybdenum was consistently distinguished from lead and graphite. It was not used commercially for another 100 years, until metallurgists found it could harden steel similar to tungsten in 1891.

Despite the discovery that molybdenum could harden steel, establishing demand for then-little-known element was a challenge. Efforts to design a lighter and more-fuel efficient vehicle without compromising durability led to development of superior performance molybdenum-alloyed steel. This became the reason molybdenum gained widespread acceptance as a beneficial alloying element in steel. Every component of the car's engine, power train, frame, and suspension that encountered stress was made from a molybdenum-containing alloy. By the mid-1920s, major automakers and steelmakers began using molybdenum in high quantity, and it also gained acceptance as a standard industrial alloying element.

Engineers expanded molybdenum's use into more demanding environments. It's role in aviation had already begun during World War I, when chromium-molybdenum steels were used in aircraft frames for their strength-to-weight advantages. Molybdenum's ability to retain strength at high temperatures made it ideal for early aircraft engines, particularly in hot exhaust components. By the early 1930s, it was alloyed into stainless steels, giving rise to Type 316, a grade with exceptional resistance to pitting and crevice corrosion. This new alloy was soon adopted in marine and chemical equipment as well as food processing.

While its industrial applications were growing, researchers were also uncovering molybdenum's biological importance. By 1932, several researchers had described the occurrence of molybdenum in plants and animals, as well as its possible functions. This began a journey of understanding its role as an essential trace element for most living organisms, and led to other uses, including fertilizer additives.

World War II renewed strategic demand for molybdenum in armor plate, artillery, and high-temperature steels. After the war, these materials transitioned into peacetime industries. Molybdenum became vital in tool steels and high-speed steels, where it formed stable carbides that preserved cutting edges at high heat. Through the 1970s, molybdenum was widely used in high-strength low-alloy (HSLA) steels, making gas pipelines, bridges, and heavy machinery stronger yet lighter. At the same times, molybdenum-bearing stainless steels became standard in nuclear power and pharmaceutical processing – anywhere corrosion resistance was essential.

Since the 1980s, molybdenum has supported advances in energy, transportation, and infrastructure. It became indispensable in superalloys for jet engines and gas turbines, in corrosion-resistant grades for oil, gas, and chemical processing, and in catalysts used in cleaner fuel production. Molybdenum disulfide gained wide use as a dry lubricant in aerospace and industrial machinery. As industries move toward higher performance and lower emissions, molybdenum plays a growing role in wind turbines, solar thermal power plants, and ultra-high-strength steels for automotive safety and weight reduction. It also remains critical in oil country tubular goods (OCTG) and hydropower infrastructure, where strength, corrosion resistance, and durability are essential.

Today, molybdenum is primarily mined as a by-product of copper mining, though some mines focus exclusively on molybdenum extraction. China is the world's largest producer and user of molybdenum and possesses the greatest known reserves. Chile, Mexico, Peru, and US are other major miners, and hold the largest reserves behind China. Molybdenum research is now a worldwide affair, so developments happen at a much quicker pace than in the previous century.

Though steel remains the largest market for molybdenum, applications continue to diversify. Now molybdenum plays a role in everything from lighting to semiconductors, energy production, fertilizers, infrastructure, architecture, and medicine. Its history continues to be written as new findings unfold with relentless speed -and its greatest impact may still lie ahead.

Source: Team Stainless Newsletter, August 2025

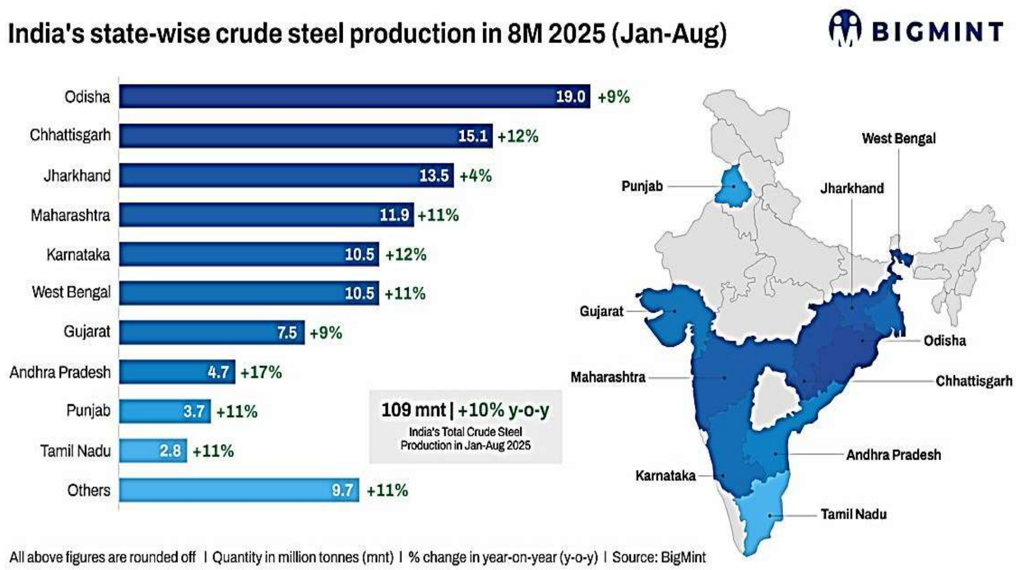
Crude Steel Output may Reach 165 million tonnes in CY'25

For the first time, India's crude steel production reached over 100 million tonnes (mt) in just eight months of a calendar year in CY'25. As per provisional data, India's crude steel production was 108.8 mt in January-August 2025 (8MCY'25), an increase of 10% y-o-y from 99 mt in the corresponding period last year. JSW Steel and RINL record impressive production growth. At current rate, crude steel output may reach 165 mt in CY'25.

Growth in crude steel production has outstripped GDP growth since the pandemic period and increasing urbanization and civic infrastructure development is creating demand for more steel. The government has announced an over INR 11 lakh crore infrastructure pipeline in this year's Budget. That apart, the surge in demand from the automotive sector, Indian Railways, defence and renewable energy sectors, as well as consumer appliances and engineering is driving growth.

State-wise Production

The state-wise data indicates a strong recovery in industrial activity and rising demand momentum.



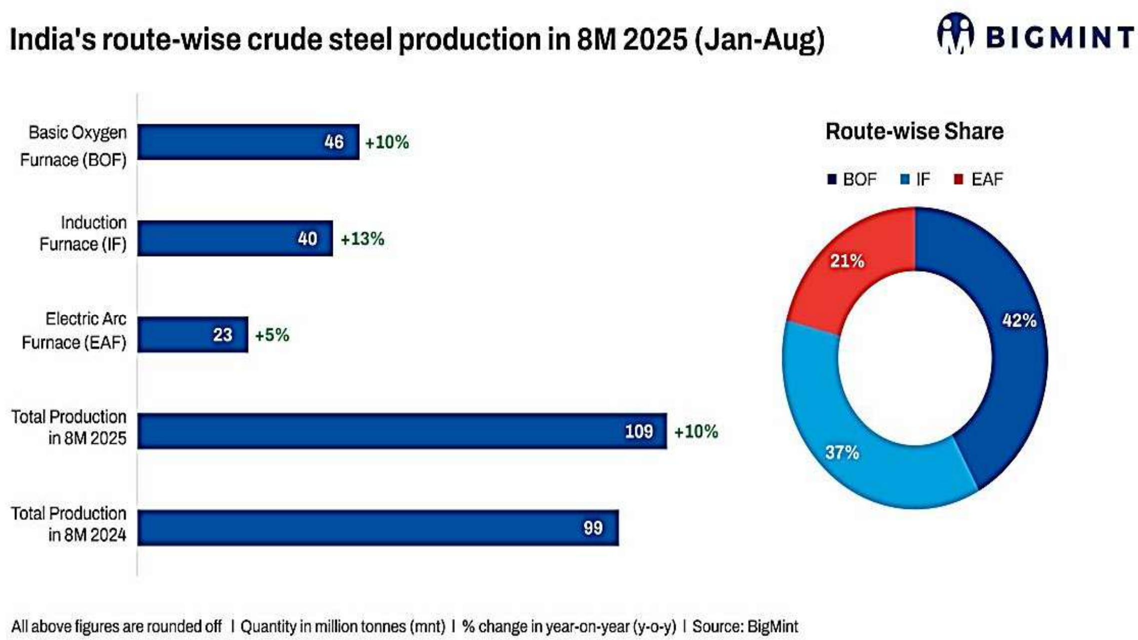
Odisha was the top steel producing state in the country in 8MCY'25, with production increasing to around 19 mnt, an increase of 9% y-o-y compared with 8MCY'24. As the largest mineral-bearing state of the country, all the major steel producers are keen to raise their stake in the state. Notably, Tata Steel's Kalinganagar expansion and acquisition and operationalization of NINL boosted production from the state.

Chhattisgarh saw crude steel production in 8MCY'25 rising to around 15 mnt, an increase of 12% y-o-y. The highlight has, of course, been the Nagarnar Steel Plant in Bastar which has raised production in quick time, reporting a 100% surge in hot metal production in FY'25.

Maharashtra, Karnataka and West Bengal witnessed an increase of roughly 11-12% y-o-y in crude steel output, thanks to capacity expansion by large and medium players. Moreover, JSW Steel's expansion in Karnataka and Maharashtra has boosted volumes.

Route-wise Production

As per provisional data, hot metal production edged up by 10% y-o-y in 8MCY'25 to over 45 mt, thanks to the increase in BF-based steel production. In comparison, EAF-based production remained largely stable y-o-y at around 23 mt. Interestingly, IF-based crude steel production increased at an even sharper rate than hot metal production. IF-based output edged up by 13% y-o-y to over 40 mt in 8MCY'25.



Therefore, the share of BF route in total crude steel production edged down slightly from previous years to 42%. While the share of EAF was largely stable at 21-22%, the IF-based route had a share of 37% of the country's crude steel output in 8MCY'25 compared to 36% in the year-ago period.

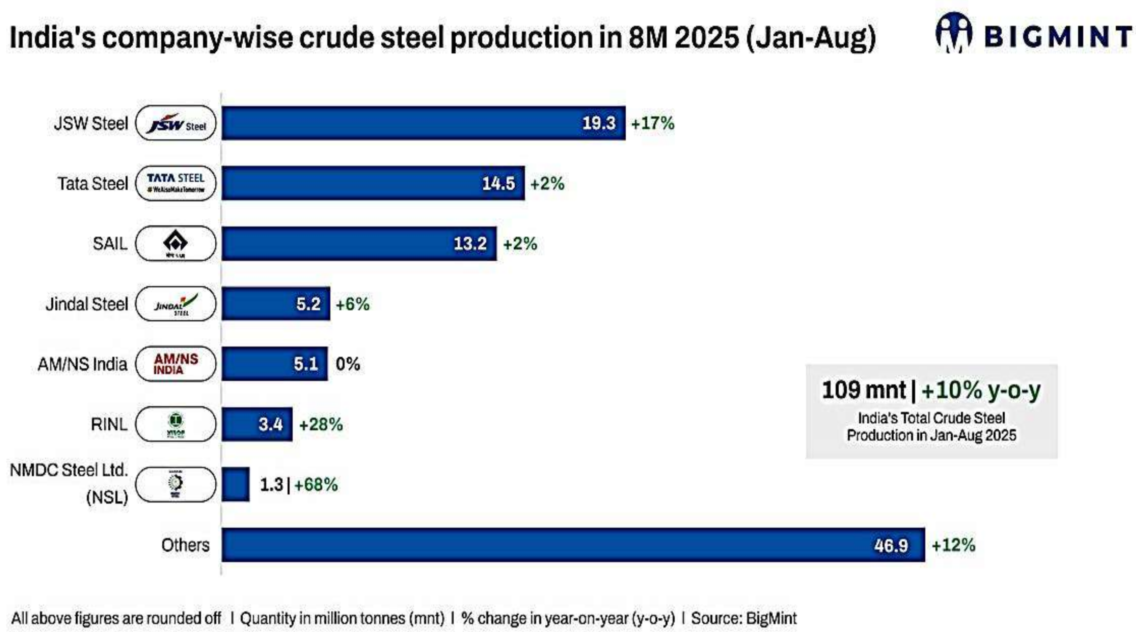
So, the overall share of the electric route in crude steel production increased to 58% of India's total production. This is because of the surge in IF-based production due to abundant raw material availability: iron ore production reached nearly 290 mt last fiscal; DRI output increased to over 55 mt; and domestic coal production rose to over 1 billion tonnes in FY'25.

Growing DRI production and an improvement in domestic scrap availability along with higher flexibility and lower upfront costs have encouraged the growth of IF-based steel output.

Top producers

JSW Steel emerged as the top producer in 8MCY'25, with output rising by 17% y-o-y to over 19 mt. This is because of the capacity expansion of the company's flagship Vijaynagar works. Further expansion of the Dolvi steel works in Maharashtra is underway.

Among the other top producers, Tata Steel and SAIL witnessed production edging up marginally y-o-y. The top achiever was surely NSL (Nagarnar Steel Limited), with crude steel output surging by nearly 70% y-o-y to 1.3 mt.



Notably, RINL recorded a sharp 28% rise in output at around 3.4 mt, thanks to the government's financial package and the restart of the company's third blast furnace in Visakhapatnam in July this year.

Outlook

At a 10% rate of growth as seen in 8MCY'25, crude steel output is expected to rise by around 15 mt y-o-y in CY'25. So, keeping in mind CY'24 production of roughly 150 mt, total output in CY'25 should be in the region of 165 mnt.

That said, the big steel players have lined up investments in states such as Odisha, Andhra Pradesh, Maharashtra and in several other states and it can be projected that the share of the BF-BOF route will rise going forward. Crude steel production is expected to reach around 220 mt by 2030, as per projections.

Source: BigMint Updates, 11 Sept. 2025

India's Steel Production and Consumption: Current Scenario

India's crude steel capacity currently consists of about 43 percent blast furnace/basic oxygen furnace (BOF) technology, 35 percent induction furnace (IF) configurations and 22 percent electric arc furnace (EAF) melt shops.

Average steel consumption rate of 105 kilograms per person estimated this year, represents an increase from 72 kilograms in 2020. The government forecasts the per capita figure will reach 160 kilograms (353 pounds) in 2030.

While the BOF producers rely largely on iron ore as a metallic feedstock, the IF and EAF operators tend to consume ferrous scrap (some of it imported) and direct-reduced iron (DRI).

In the first seven months of this year, iron ore consumption in India rose by about 10 percent, DRI use increased by 8 percent and scrap use at Indian mills was up by 15 percent compared with the same time frame in 2024. India's scrap usage is at 23 percent, well below the nearly 70 percent in the U.S.

Some of that scrap continues to be brought in from the U.S., Europe and other regions. India still has to rely on imports to meet 25 percent of our scrap requirements. From January through July this year, the 5.3 million metric tons (mmt) of ferrous scrap imported represents a 12.7 percent increase from the 4.7 mmt brought in during the first seven months of last year. India's domestic scrap generation has risen by 16.5 percent this year.

India's steel consumption continues to grow in 2025, though construction sector pace of growth has slowed, pinching demand and pricing for steel rebar.

It has been an exceptionally challenging year for rebar makers in India, with construction activities having stalled for almost three months now, which has put pressure on rebar prices.

A slowdown in heavy equipment sales this year in India, refers to restrictions on the announcement of new projects due to election rules, as well as a slowdown in ongoing central and state infrastructure projects as leading to a slowdown in equipment sales that also could be applied to rebar.

Steel mills in India also have active export markets, with the United Arab Emirates, Belgium and Italy among the larger volume buyers of Indian steel.

Investing in Green Steel

Taking the right decisions for the future is difficult, yet discussions today about the decarbonization of the steel industry are often limited to a technical viewpoint only.

Industrialized countries are trying to maintain primary steelmaking as a strategic sector under their regional control, whilst decarbonizing the enormous energy it consumes. Promising concepts to alleviate the resulting renewable energy shortage in the global north for this purpose is to establish efficient supply chains from the global south through either ammonia as an efficient hydrogen carrier molecule, or to relocate iron production and import HBI (hot briquetted iron).

Need for High Investment

The transition towards green steel requires massive investment in new infrastructure - Green electricity generation, hydrogen production, storage system etc. Upstream energy-related investments have an order of magnitude that is greater than that of the steel plant itself.

For example, the following investment volumes would be required for a green steel plant with a capacity of 2.5 million t/year and corresponding green energy supply:

Investment volumes for greenfield DRI plant including energy supply

(+/-25%)

Renewable electricity production	*5 billion US$*
Hydrogen production	*4 billion US$*
Energy storage	*> 1 billion US$*
Total energy supply investment	**> 10 billion US$**
Direct reduction plant	*1 billion US$*
Electric arc furnace or open bath furnace	*1 billion US$*
Rolling mill	*1 billion US$*
Balance of plant	*1 billion US$*
Total greenfield DRI steel plant	**4 billion US$**

When it comes to future energy supply chain investments, it is clear that energy companies and green investment funds will be in the driver's seat, and not steel producers. The former have much better credit ratings (typically A or AA), giving them access to capital and at much lower interest rates than for steelmakers. This difference in financial leveraging power is only further increased when interest rates remain high. The resulting high treasury bond yields make lenders even more wary of non-investment grade bonds from steelmakers. Additionally, the energy sector offers much more stable returns and free cash flow due to the nature of their business model and generally present bigger market capitalization, allowing them easier access to equity for large investments on top of higher borrowing capacity at better rates.

In short, decarbonization projects at this scale require the financial resources of players outside the steel industry. It is therefore up to the energy sector and possibly also governments to set the tone on whichever national and global green energy strategy is the most beneficial to them, whilst steelmakers will most likely have to play the hand they are dealt.

Return on Investment

Steel can be decarbonized via multiple routes. If it is to be produced 'CO_2 lean,' the coal feedstock in its production process must be replaced with non-fossil-based alternatives. Pioneering projects use green hydrogen for this purpose. However, the steel plants are often located in regions with an uncompetitive hydrogen infrastructure in terms of availability and costs. That goes in particular for heavily industrialized countries such as Germany, Japan, Korea, and many regions of China.

Given their capital-backed decision power, investors will always choose the option that generates the highest risk-adjusted return. Energy generation facilities are often situated in remote locations in the global south, in countries with high risk-profiles, where high profit margins are essential to justify them. Steelmakers do not have the financial firepower or profit margins to bear such risks compared to the energy sector.

Consequently, steelmakers face an uphill battle to secure capital willing to be allocated to remote, high-risk regions for the production of hot briquetted iron (HBI), for instance, which companies rely on to decarbonize steel production via the direct reduction route.

An alternative could be ammonia, as it would not only provide the steel industry with a reductant, but it also has a large existing market for fertilizer and chemicals, as well as a growing market for co-firing in power plants in the Asia Pacific region. The offtake market is diversified and much bigger, consistently offering producers the flexibility to sell to the highest bidder, whereas HBI production is a much narrower and much more rigid value chain. Ammonia production has an inherently lower risk profile and has at least the same or better profitability. Capital will thus most likely be drawn to ammonia as its higher risk-adjusted return acts as gravity for investment.

In summary, the responsibility for global and regional decarbonization strategies will likely extend beyond the steel sector itself. This is due to the significant financial and infrastructural resources needed, which are better handled by players with larger budgets, such as those in the energy sector. Additionally, these entities seek to maximize returns while minimizing investment. Among the options, ammonia presents more opportunities for utilization, has existing infrastructure, and involves lower risk compared to alternatives like hot briquetted iron (HBI).

Source: SMS group #Connect update, Sept. 1, 2025

E-Waste Collection: Informal Sector

With million tonnes of consumer electronics and appliances disposed of in the recent years, e-waste collection, recycling and extracting expensive and scarce metals and elements may assume more important in the years to come. While hundreds of millions of mobile phones are in use in India, with TRAI pegging the number of mobile broadband connections in excess of 93.9 crore, India constitutes only about 4%, of global electronics consumption.

As global electronics' supply chains stay fragile, local manufacturing capacity is being encouraged. A ₹1,500 crore mineral recycling scheme has been announced in early September.

Recycling elements such as copper, aluminium, nickel, cobalt and lithium, has shown growing importance. "Extended producer responsibility" (EPR) framework has been introduced for appliances and electronics, to be collected by the original manufacturers, for harvesting materials expensive to procure from the open market.

A 2023 report by the Indian Cellular and Electronics Association pointed to a key hurdle in creating a "circular economy" for such products — where metals and elements from so-called end-of-life products can be reintroduced into supply chain — viz., *domination of informal sector*. These set-ups focus on repairing products by harvesting parts from used goods and operate outside any formal framework that can eventually lead to recycling being a viable source of key raw materials for manufacturing firms.

There is a need for repairing products more and prolonging their life as a measure in e-waste management.

Inventorying is critical as western countries count a product sold as potential e-waste soon after sale unlike in India, where gadgets may go through multiple owners before wearing out beyond repair. Presently, inventory has been entrusted to State Pollution Control Boards, but there is no uniform method suited to India, and international figures of e-waste generation are always different.

Recycling from e-waste, however, has been improving year on year. In India, gold, copper, aluminium and steel are majorly recovered. While the current proportion of recycled precious metals and rare-earths in domestic supply chains is “negligible,” with the right policy push, India can meet 70% of its rare earth materials requirements.

Source: The Hindu, 30th September 2025

EPR Framework to Address Critical Mineral Recycling

Feedstock availability for the critical mineral recycling scheme will be addressed through formalization of collection under the extended producer responsibility (EPR) framework, integrating the waste into the recycling ecosystem to boost prospects for local critical mineral recyclers. The scheme was approved in September and the application process started this month. Under the EPR framework, e-waste and battery waste management rules obligate extraction of specified end-products. The capacity to process black mass is limited in the country, due to which it is being exported without extracting valuable critical minerals.

The Centre expects incentives under the scheme to bring in more recyclers, especially upstream entities such as dismantlers, crushers and shredders into the formal system. Many private recycling companies are already running scrap collection systems efficiently.

E-waste, spent lithium-ion batteries (LIBs) and catalytic converters in end-of-life vehicles are categorized among feedstock under the scheme.

The annual generation of e-waste in the country is estimated at 1.75 million tonnes, and of spent LIBs at about 60 kilo tonnes. Over next 4-5 years, the availability of these waste products is going to increase manifold.

Source: The Economic Times, 24th October 2025

JSW Steel Plans Scrap Recycling Unit in Chennai

JSW Steel plans to open a scrap processing facility in Chennai to source and recycle scrap from various sources, including automobile and white goods manufacturers, and use in its steel-making plants.

The company is looking to set up the facility in Chennai to supply scrap to its units at Vijayanagar in Karnataka and at Kadapa in Andhra Pradesh, which is under construction. The facility will be in addition to a similar metal recycling plant being built by the wholly owned subsidiary, NSL Green Steel Recycling, at Raigad, Maharashtra.

In 2022, JSW Steel announced plans to invest ₹175 crore to establish a metal recycling plant in a joint venture with New Zealand's metal recycler, National Steel Holdings, in Maharashtra. It invested ₹23 crore in 30.5 acres of land, about 4 km from its existing 10 mtpa integrated steel plant at Dolvi. In 2023, National Steel Holdings divested its entire stake in NSL Green Steel Recycling to JSW Steel. The company sourced about 2.25 million tonnes of scrap in the western region last fiscal, and it is growing at a steady pace.

Currently, JSW Steel is sourcing only ready-to-use scrap in the Western Region, and once the Chennai unit starts operations, the company plans to process other grades of scrap.

JSW Steel's strategic vision is to reduce its carbon footprint by increasing the usage of steel scrap in its steel-making. The recycling plants will supply scrap to JSW Steel's plants in the form of baled or bundled scrap.

Green Hydrogen

The company has started production of green hydrogen at the 3,800 tonne-per-year pilot project set up at Vijayanagar in Karnataka. The hydrogen will be transported through a pipeline to the steel mill. The green hydrogen project, a JV with JSW Energy, will use 25 MW of renewable energy and is part of the company's larger decarbonization strategy to produce "green steel" by using green hydrogen in its direct-reduced iron (DRI) unit. Plant will produce low carbon emission green steel, which will be sold under the green steel brand *Green Edge*. An international agency shall certify the carbon emission reduced and certificates can be issued to customers.

Source: The Hindu Businessline, 23rd October 2025

Forging India's Metals Security

India's metals trade pattern demonstrates a structural asymmetry; exporting low-value bulk while importing high-value niche inputs, exposing vulnerabilities that constrain downstream industrialisation and compromise resilience.

The country today stands at an inflection point in the Metals & Metallurgy Industry (MMI) constituting HSN:72-83, where trade imbalances have grown from episodic fluctuations into a structural liability. Illustratively, India's metals deficit reached $14.15 billion in 2024, making up (-)5.4 per cent of the overall trade deficit of $261 billion. In last two decades, India has become a net importer, from being an exporter in 2004 with $1.96 billion surplus.

India possesses abundant ores but has failed to convert this advantage into durable industrial strength, with persistent deficits in copper, nickel, tin, and lead offsetting only modest surpluses in iron and steel articles and occasional gains in aluminum.

Structural Crossroads

The country's MMI trade trajectory underscores widening product-level vulnerabilities. Copper (HS:74) exemplifies the sharpest decline, shifting from a modest surplus of $0.36 billion in 2004 to a deep deficit of $8.36 billion in 2024, aggravated by the closure of Sterlite Copper and import dependence on Chile and Africa. The FTAs India has entered into have also contributed as a conduit of re-routing and rampant dumping of metals, undermining domestic industry potential.

Likewise, Nickel (HS:75) has remained structurally negative, deteriorating from $(-) 0.26 billion in 2004 to $(-) 1.10 billion in 2024, with no overseas acquisitions to offset domestic scarcity. Iron and steel (HS:72), once India's flagship export, fluctuated dramatically, recording a $9.52 billion surplus in 2021 before collapsing into a $(-) 7.33 billion deficits by 2024. Aluminum (HS:76) briefly moved into surpluses in 2021 but returned to deficit by 2024.

The structural crossroads reflect multiple vulnerabilities cutting across resources, technology, and policy. Smaller categories such as tin, zinc, and lead persistently show deficits, reflecting limited refining, weak recycling, and shallow value-addition, compounded by resource scarcity, high energy costs, outdated smelting technology, fragmented recycling systems, poor R&D intensity, policy volatility, infrastructure bottlenecks compliance pressures, and sub-scale production.

Despite abundant iron ore and bauxite, India exports significant volumes in raw or semi-finished form, while higher-value steels and alloys are imported. This shallow value addition highlights fragility in industrial depth. The market is fragmented, with many small-scale players, some medium firms, and only a few large enterprises, producing oligopolistic behaviour where scale, productivity, supply-chain control, energy efficiency, and market access determine competitiveness. Recycling remains embryonic.

India's trade balance ($billion)

HSN	Particulars	2004	2014	2024
	Metals and metallurgy	1.96	-1.09	-14.15
72	Iron & steel	0.78	-2.21	-7.33
73	Iron or steel products	1.22	3.46	4.97
74	Copper	0.36	0.23	-8.36
75	Nickel	-0.26	-0.48	-1.1
76	Aluminum	-0.04	-0.97	-0.34
78	Lead	-0.14	-0.4	-0.38
79	Zinc	-0.12	-0.06	-0.05
80	Tin	-0.03	-0.17	-0.41
81	Other base metals	-0.06	-0.24	-0.54
82	Tools & implements	0.14	-0.07	-0.34
83	Miscellaneous base metals	0.1	-0.17	-0.28

India exports significant volumes of iron ore and bauxite in raw or semi-finished form, *while higher-value steels and alloys are imported. This highlights fragility in industrial depth*

Aluminium scrap, lead-acid batteries, and e-waste are handled mainly by informal operators lacking scale, technology, and safeguards, with poor collection systems, low material recovery rates, absence of standardized protocols, weak regulatory enforcement, and minimal investment in modern recycling infrastructure, resulting in environmental hazards, resource leakages, and missed opportunities to build a robust secondary supply base.

As a result, India misses a reliable secondary supply-base that could buffer against global volatility and reduce dependence on imports.

Innovation in metallurgy is sparse, underpinned by weak institutional capacity. Alloy research, lightweight composites, and green metallurgy remain underfunded, while unpredictable policies on tariffs, royalties, and mining approvals deter long-term investment. This leaves India reliant on eternal supply chains dominated by China, Indonesia, and the Democratic Republic of Congo, embedding risks of volatility and geopolitical leverage.

Meanwhile, India's appetite for metals is rising rapidly, driven by infrastructure, renewable energy, electric mobility and aerospace. While iron ore and bauxite reserves offer a natural anchor, integration into higher-value chains is essential.

Green steel, low carbon aluminium, and scaled recycling could create a circular economy, while production-linked incentives and trade agreements can embed India more deeply in global value chains.

By contrast, China illustrates the power of scale, scope, sophistication and orchestration. It produces over half the world's steel and aluminium, dominates copper smelting and nickel processing, and secures overseas mining stakes to lock supply chains. Unlike India, which exports ores and imports alloys, China has built a fully integrated value chain from extraction to engineered exports, supported by R&D and green metallurgy pilots, positioning itself as architect and price-setter of the global metal's economy.

Way Forward

Reducing India's trade deficit in metals and metallurgy requires a strategy that fuses resource security with industrial depth and sustainability. The recent Carlsberg Ridge acquisition, granting India a 15-year exploration contract for polymetallic sulphides, exemplifies how seabed initiatives can address shortages of copper, nickel, cobalt, and other critical minerals. Alongside earlier allocations for polymetallic nodules and cobalt-rich crusts, such initiatives diversify supply sources, reduce import dependence, and create strategic autonomy in the mineral space.

Moreover, India should expand domestic smelting and refining capacity in copper, aluminum, and nickel, supported by PLI-style incentives for speciality steels, lightweight alloys, and advanced materials. Building industrial clusters in port-based corridors that co-locate smelters, alloy plants, and recycling hubs can replicate integrated ecosystems seen in China. Simultaneously, organized recycling of copper, aluminum, and e-waste, underpinned by recovery targets and extended producer responsibility, can integrate circularity and ease pressure on imports.

Lastly, innovation and green transition must complement these efforts. Hydrogen-based steelmaking, renewable-powered aluminum smelters, and sustainable metallurgy can open access to ESG-sensitive markets. By combining domestic reforms with strategic ISA's approved seabed explorations in Indian Ocean, India can transform from a resource-constrained importer into a globally competitive, investment-attractive alternative to China.

Source: The Hindu Businessline, 25th October 2025

Rolling Thinner Gauge Hot Strip

Rolling thin-gauge hot strip presents both opportunities and challenges. Higher prices are paid for thin strip dimensions due to the increased challenges and risks associated with their processing. Disruptive cobbles, unscheduled roll changes, and downtimes are a significant concern.

To address these challenges and for improving process stability in hot strip mills, fast mechanical actuators and control elements, mechatronic packages and sophisticated process models, well-designed strip-guiding systems, and advanced strip steering control modules to ensure straight transfer bars are required.

Rolling low-carbon thin-gauge strips at high speeds within the austenitic temperature range brings with it metallurgical and process challenges. The use of a coilbox helps to maintain a nearly constant strip temperature during rolling, whereas without a coilbox, temperature losses at the strip end require process acceleration to reach the final rolling temperature. Coilbox provides a heat balance above the transformation temperature, ensuring consistent mechanical properties of thinner gauges. Sophisticated and holistic process models for temperature, profile, contour, and flatness, as well as advanced control systems for thickness and mass-flow, help stabilize the rolling behaviour and enable the production of thinner strips or higher-strength steel grades.

When it comes to thin-gauge rolling of high-strength materials, in particular, the stability of the rolling process is a challenge.

Producing strip with a final thickness of below 0.25 mm is a demanding task for a fully continuous pickling line and tandem cold mill (PL-TCM). The challenges of the continuous process include avoiding frequent strip breaks as well as taking into account the higher demands with regard to production planning and process control and the increased maintenance involved.

The main challenges in rolling thin gauges are avoiding strip breakage, ensuring fast rolling speeds, and maintaining the reproducibility of rolling conditions. Essentially, these are guaranteed by reliable mechanical equipment, automation systems for smooth operation with almost no operator intervention, perfect mass flow and flatness control, precise adjustment of the draft distribution and emulsion parameters, special handling provisions for thin strip in automation mode, as well as high-level maintenance and process knowledge.

The skills and competencies required to operate a PL-TCM for such applications include ongoing operator training, a particular focus on equipment maintenance, and ensuring stable work roll quality with roll grinding procedures. Design aspects such as achievable flatness results, cooling systems, and emulsion system stability to keep the work roll and strip temperature within set limits are important too. The careful selection of measurement devices is also relevant in this context.

When rolling thin gauges, the interstand flatness plays a more important role in the rolling process. Excessively high edge tension, in particular, can cause strip breaks. The technological models calculate the setup values for the actuators together with the parameters for acting on dynamic disturbances, such as roll force variations, and ensure the requested flatness in the mill. All this emphasizes the role of automation in dealing with sensors and actuators, providing for perfect thickness and mass flow control, and the specialized strategy for handling thin strips during transfer to the tension reel.

The technological tasks involved in rolling thin strips at high speed focus on the adaptation of the emulsion conditions, roll roughness, and tensions. The characteristics of the emulsion used and the influence of various parameters have to be considered. Establishing a stable working point and addressing chatter issues is also essential. If all these measures are implemented, strips with a thickness of under 0.25 mm can be handled with special care and the highest yield levels can be maintained.

India's Electrical Steel Landscape

- *Domestic demand to grow at 7% CAGR, mirroring GDP rate*
- *CRGO supply hinges on imports, with domestic production falling short*
- *CRNGO supply adequate, but Chinese dumping risks remain*

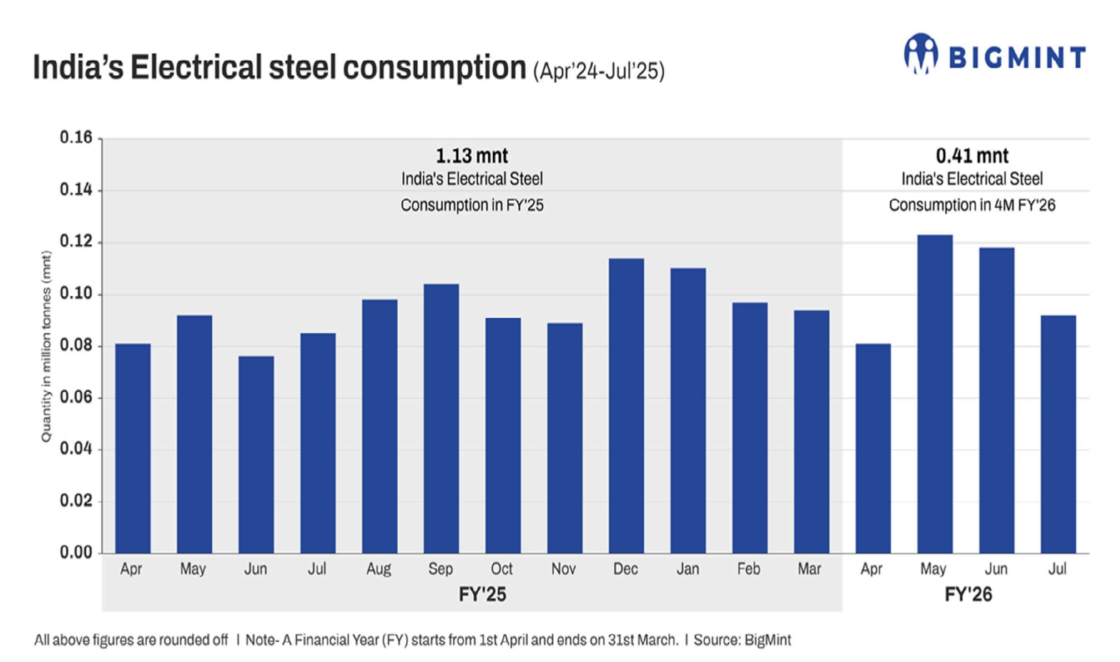
India's growing electrical steel segment has generated immense buzz, given the accelerating transformation of the power sector, both to increase capacity and to raise renewable energy adoption. While capacity additions in the electrical sector are ongoing to meet rising demand, market participants cite that India still suffers from heightened dependence on imports and an acute supply shortage.

Overview

A type of specialty steel, electrical steel is so called because of its suitability for electromagnetic applications. Silicon is the primary alloying element, as against carbon, which is kept at a minimum to avoid brittleness and energy loss. Given that the percentage of silicon in the alloy is comparatively high, traditionally around 3% but reaching up to 6.5%, electrical steel is also known as silicon steel.

The addition of silicon increases the alloy's electrical resistivity and enables higher permeability of electrical currents, resulting in a reduction in core losses and improved energy efficiency.

Ferro silicon is the key feedstock for electrical steel.



Grade-wise classification & applications

Primarily, there are two grades of electrical steel: cold-rolled grain oriented (abbreviated as CRGO or GOES) and cold-rolled non-grain-oriented (CRNGO, CRNO, or NOES).

The key difference between the two is that CRGO is processed to have its grains aligned in a specific direction, while the grain orientation of CRNGO is more randomised, leading to uniform magnetisation in all directions. CRGO is also more expensive to produce and is limited in supply. It is ideal for use in static applications such as transformer cores in the power and distribution segment and inductors. Meanwhile, CRNGO is considered to be more suitable for rotating equipment, including motors and generators.

Demand-supply scenario

Global demand for CRGO stands at 3.2-3.5 mt, while production is approximately 4 mt. Production capacity is estimated to be within 5-7 mt, with the lions share in the hands of only 10-12 companies, who fiercely guard their technology. India sources its CRGO mostly through imports, with self-reliance still a remote possibility. China is the largest consumer of this grade, followed by the US and India.

India's CRGO demand is estimated at around 300,000 t per annum (tpa), but production capacity is around 50,000 t. In a 2024 report, GTRI pointed to domestic production meeting only 10-12% of demand. However, another senior executive from a major electrical steel producer suggested that Indian capacities are able to meet a higher 33-35% share of consumption.

As for CRNGO, global production capacity is pegged at 8-10 mt, with both output and demand coming to around 5-6 mt. Indian production capacity is considered to be at 750,000 t, with annual demand at 700,000 t.

India seems to have adequate CRNGO production, while domestic CRGO supply fails to meet demand. Additionally, the 0.23-mm and 0.27-mm sizes of CRGO are largely used in transformers. For CRNGO, the 0.35-mm and 0.50-mm sizes fetch the most demand.

Sectoral demand perspective

The energy sector has been the primary driver of the expanding electrical steel landscape in India. Infrastructure growth, rising electrification, increased renewable energy use, strong consumer demand, the emergence of artificial intelligence and need for data centres, shift to automation, EVs, and green steel adoption are all leading to robust investments in India's power sector.

However, again, imports of finished products threaten India's electrical steel demand. For example, in the transformer sector, cheap motor imports persist, while the home appliances segment is also reliant on foreign product inflows.

The same dynamics are reflected in the automotive industry, which is expected to be a major consumer of electrical steel in the days ahead. However, in India, electrical steel use in the automotive industry is still in its early stages, due to large-scale imports of finished components and equipment -- 40 crore motors were imported last year.

As such, MSMEs have an excellent growth opportunity to capitalise on, with these businesses being tailor-made for MSMEs, asserted the above source.

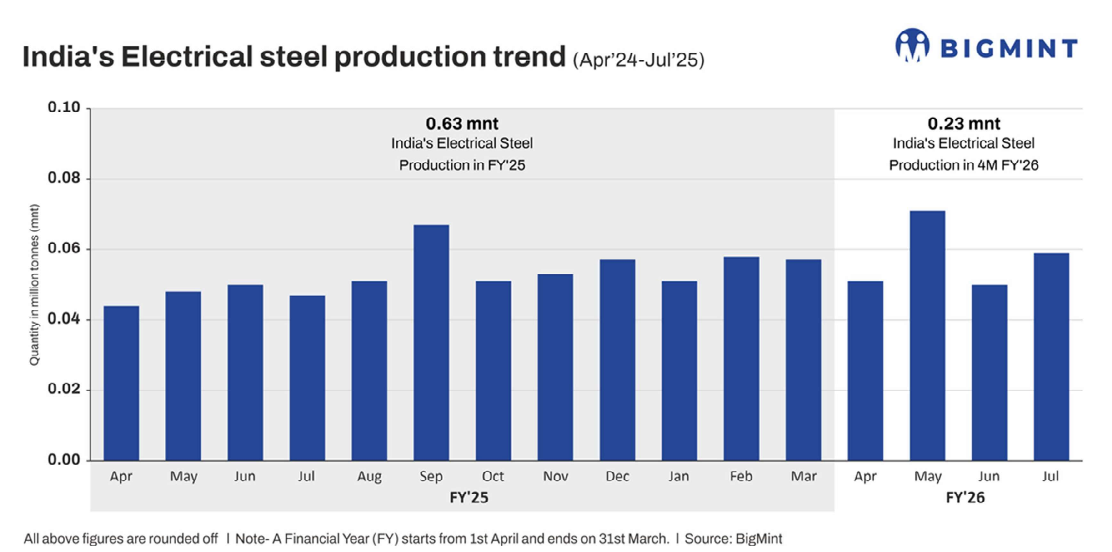
Capacity expansions

JSW Steel, the leading electrical steel maker in India, has been steadily increasing production in collaboration with Japanese partner JFE Steel Corporation. In August, they announced an INR 5,845 crore expansion of their CRGO manufacturing capacity to 350,000 t.

The company had earlier also acquired thyssenkrupp Electrical Steel India, previously the only large-scale CRGO manufacturer in the country.

Additionally, SAIL and John Cockerill India have joined hands to set up an INR 6,000 crore plant for CRGO and CRNGO, with production of 1.5 mt per annum.

The Indian government has also improved ease of doing business for potential CRGO producers as per the second round of the PLI scheme for speciality steels. Stating that the technology to make CRGO is unavailable with Indian steelmakers, the Ministry of Steel has reduced the investment and capacity creation thresholds to INR 3,000 crore and 50,000 t, respectively, to incentivise production growth.



Domestic consumption growth

India's electrical steel consumption has been steadily increasing in recent years, with FY'25 volumes at 1.13 mt, up by a robust 24% y-o-y. Even FY'24 recorded a 21% y-o-y increase at 0.91 mt. Meanwhile, consumption in the first four months of this fiscal year (4MFY'26) has reached 0.41 mt already, showing a 24% rise y-o-y.

Import scenario, dumping threat

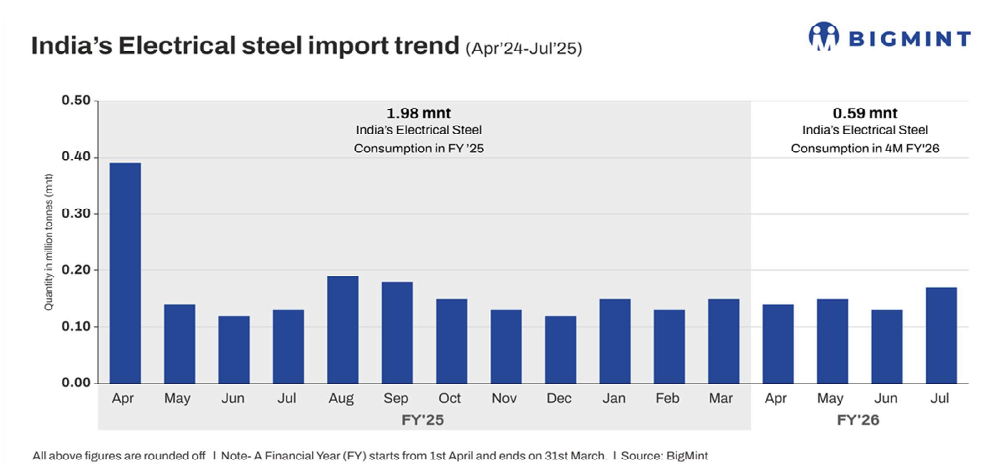
In the past five years, annual electrical steel import volumes have consistently remained above 1 mt, with strong y-o-y growth in most years. In FY'25, imports jumped by 40% y-o-y to 1.97 mt, though arrivals had fallen by 13% y-o-y in the preceding year. FY'22 and FY'23 witnessed y-o-y spikes of 10% and 19%, respectively.

Imports are sourced primarily from China, South Korea, Japan, Taiwan, and Russia. On average, South Korea has been the leading supplier to India, consistently shipping over 0.55 mt every year. However, last fiscal year, China superseded South Korea (0.57 mt) by exporting over 0.67 mt to India, a rise of 123% y-o-y. This has given rise to concerns of dumping.

Mounting imports have caused irreparable damage to the domestic industry. With reference to fully processed CRNO, from a consumption point of view, India has got today nearly 50,000 t per year of extra capacity. Due to predatory pricing of imports from China, Japan, and Vietnam, some of this capacity is idle.

The CRGO sector has also been suffering equally. Indian production manages to meet only around 35% of demand, but that is because domestic output has few takers amid surplus supply of cheap overseas material. Indian producers' financial losses have swelled, even keeping capacity expansions in check.

In October 2024, India initiated an anti-dumping investigation into Chinese CRNO imports based on complaints from domestic subsidiaries of South Korean and Taiwanese producers, including POSCO Maharashtra Steel and CSCI China Steel Corporation India. However, both CRGO and CRNGO have been kept outside the purview of the three-year safeguard duty on flat steel imports.



Demand outlook to 2030

India's electrical steel demand is only going to rise as energy transition and power generation accelerate. An expanding power sector, the government's push to integrate 500 GW of renewable energy by 2030, and the Bureau of Energy Efficiency's mandate for a star-label upgrade for transformers, effective January 2025, are expected to boost demand for this specialty steel.

The other major contributor is EVs and green energy. EVs use high-performance CRGNO in motors, while renewable energy systems (like wind turbines and solar inverters) use both variants. The auto sector would, however, benefit from the development of high-grade CRNGO with lower energy loss and better magnetic properties.

The government's tightening of energy efficiency standards for appliances, motors, and transformers is also expected to boost demand, as well as setting up of smart grids and digital transformers. This may push manufacturers to shift to premium-grade electrical steel with ultra-low core loss, despite higher costs incurred.

Source: BigMint Updates, BigMint Bureau, 18 Sep 2025

SSAB Achieves Near-Zero CO_2e Emissions Steel

SSAB produced Zero™ steel produced using HYBRIT technology to be used in GE Vernova's tower production.

SSAB Zero™ steel produced with hydrogen-reduced iron from HYBRIT® technology is claimed to be the world's first near-zero CO_2e steel. The product will be available for use in GE Vernova onshore wind towers.

SSAB Zero steel is produced at SSAB's Montpelier, Iowa facility using recycled scrap metal, fossil-free electricity, biocoal and renewable natural gas. By adding hydrogen-reduced iron to the SSAB Zero manufacturing process, this steel now meets the requirements of near-zero steel, set out by the IEA.

SSAB Zero steel will be deployed in GE Vernova wind towers across the United States.

SSAB Zero is designed for end-use applications such as automotive, mining, agriculture, construction, heavy equipment, transportation and energy.

Source: SSAB Press Release September 23, 2025

Overseas Technical Presentations

Asian Battery Conference and International Secondary Lead Conference

The mega biannual event "**Asian Battery Conference & International Secondary Lead Conference**" took place at Kota Kinabalu, Malaysia during 01-05 Sept. 2025. The events were attended by large contingents from ILZDA members. About 1000 delegates participated in the two conferences. Mr L. Pugazhenthy, Executive Director, Indian Lead ILZDA made a technical presentation " **Lead Recycling in India – Present & Future Perspectives**" which was well – received by the delegates. There was also an exhibition along with the conference

70th Annual Session of the International Lead & Zinc Study Group

The 70th Annual Session of the International Lead & Zinc Study Group (ILZSG) took place at Lisbon, Portugal during 8-10 Oct 2025; normally these meetings are attended by participants from the various member-governments of ILZSG. ILZSG has members from 26 governments involved in mining & extraction of Lead & Zinc. The presentations give an idea on the prevailing situation with regard to Lead & Zinc in various countries. Mr L. Pugazhenthy, Executive Director, ILZDA made a technical presentation "**Zinc & Lead Scenario in India - An Update**" Mr K Sridhar, Secretary, ILZDA also participated in this meeting.

Know Your Members

Prof. N S Harsha Gunda

Academics

- B. Tech in Metallurgical and Materials Engineering from IIT Madras.
- Masters in Materials Science and Simulation from ICAMS, Ruhr University Bochum, Germany.
- Ph. D. in Materials Science from the University of California, Santa Barbara, USA.

Experience and Expertise

Prof. N S Harsha Gunda obtained his Ph.D. in 2019 from the University of California, Santa Barbara (UCSB), working in Prof Anton Van der Ven's group. During his Ph.D., he used first-principles statistical mechanics to analyze phase stability in Ti-Al alloys during oxidation. Following his Ph.D., he joined Oak Ridge National Laboratory (ORNL) as a postdoc, working on computational alloy design for automotive applications using high-performance supercomputing and machine learning. He has also worked as a postdoc at Ohio State University (OSU) on analyzing the formation of LPT phases in NiCo-based superalloys.

Prof. N S Harsha Gunda joined the Department of Materials Science and Engineering at Indian Institute of Technology, Delhi, in December 2023 as an Assistant Professor. His research is focused on applying state-of-the-art computational techniques such as Density Functional Theory (DFT), Molecular Dynamics (MD) and Machine Learning (ML) for alloy design. He focuses on developing advanced materials such as high-entropy ceramics, superalloys, and materials for EV applications and extreme conditions. He is passionate about creating open-source software for materials applications and pushing the boundaries of computational materials science by including the latest AI/ML techniques.

Prof. N S Harsha Gunda was awarded the prestigious Prime Minister's Early Career Research Grant in 2025 for his proposal on discovering new high-entropy Diborides for structural applications. He has more than 10 scientific publications in various reputed international journals.

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