IIM

Metallurgy
Materials Engineering

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The Indian Institute of Metals

Delhi Chapter

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IIM DELHI CHAPTER

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Annual General Meeting of IIM Delhi Chapter

The 73rd Annual General Meeting (AGM) of Delhi Chapter was held at our Chapter's premises on 31st May 2025.

Shri R K Vijayavergia, Chairman, welcomed the members present in the meeting.

Hon. Secretary, Shri K R Krishnakumar, presented the salient features of activities performed by our Chapter during 2024-25.

Hon. Treasurer, Shri R K Narang, presented the highlights of the audited accounts of our Chapter for the financial year 2024-25.

The following composition of the Executive Committee for the year 2025-26 of Delhi Chapter was unanimously approved by the AGM.

Office Bearers

Chairman	:	Shri Manoranjan Ram
Vice Chairman	:	Shri Deepak Jain
Hon. Secretary	:	Shri K R Krishnakumar
Jt. Hon Secretary	:	Shri M P Sharma
Jt. Hon Secretary	:	Ms Chandna Arjun
Hon. Treasurer	:	Shri R K Narang

Members

1 Shri K K Mehrotra
2 Shri R K Vijayavergia
3 Shri N K Kakkar
4 Dr. Ramen Datta
5 Shri N Vijayan
6 Shri G I S Chauhan
7 Shri B R Jain
8 Shri R K Singhal
9 Shri R K Sinha
10 Shri Neeraj Nautiyal
11 Shri Ashok Kumar
12 Shri Vijay Gupta

Special Invitee

Prof. S Basu

Hon. Secretary delivered vote of thanks after conclusion of the AGM.

Shri Manoranjan Ram
New Chairman of IIM Delhi Chapter

At the end of the AGM, Shri Manoranjan Ram, the new incumbent Chairman of Delhi Chapter, thanked all the members for reposing trust in him in discharging the activities of Delhi Chapter. He requested for co-operation and support of all the members to promote the activities of the Chapter.

Crude Steel Capacity and Production in South India

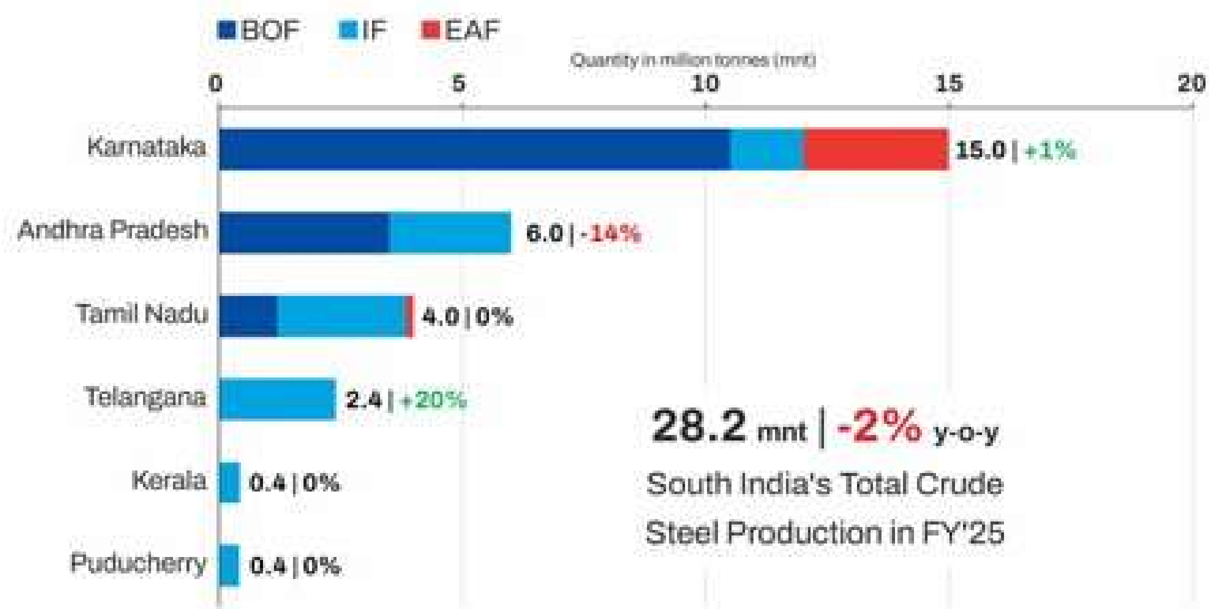
Crude steel production and capacity enhancement in India is progressing at a steady pace and the different regions of the country are witnessing rapid growth. South India has been witness to fast-paced industrial growth over the decades and the steel industry in the region has thrived as a result.

India's crude steel production in the last fiscal (FY'25) stood at 152 million tonnes (mnt), and South India -- comprising Andhra Pradesh, Karnataka, Tamil Nadu, Telangana, Kerala and Puducherry -- produced 28.2 mnt, a marginal decline from 28.8 mnt recorded in FY'24.

Karnataka was the top producer, recording total output at 15 mnt, followed by Andhra Pradesh at 6 mnt, and Tamil Nadu at 4 mnt.

Steel production and capacity in South India

South India's share in India's crude steel production was estimated at over 18% in FY'25. The region has one of the highest per capita steel consumption in the country, thanks to its burgeoning infrastructure and manufacturing sectors. Total crude steel capacity in South India is estimated at 44.16 mnt in FY'25, an increase of 27% y-o-y.



South India's route-wise crude steel production in FY'25

BOF: Basic Oxygen Furnace I EAF: Electric Arc Furnace I IF: Induction Furnace
Provisional figures I All above figures are rounded off I Note- A Financial Year (FY) starts from 1st April and ends on 31st March.
Quantity in million tonnes (mnt) I % change in year-on-year (y-o-y) I Source: BigMint

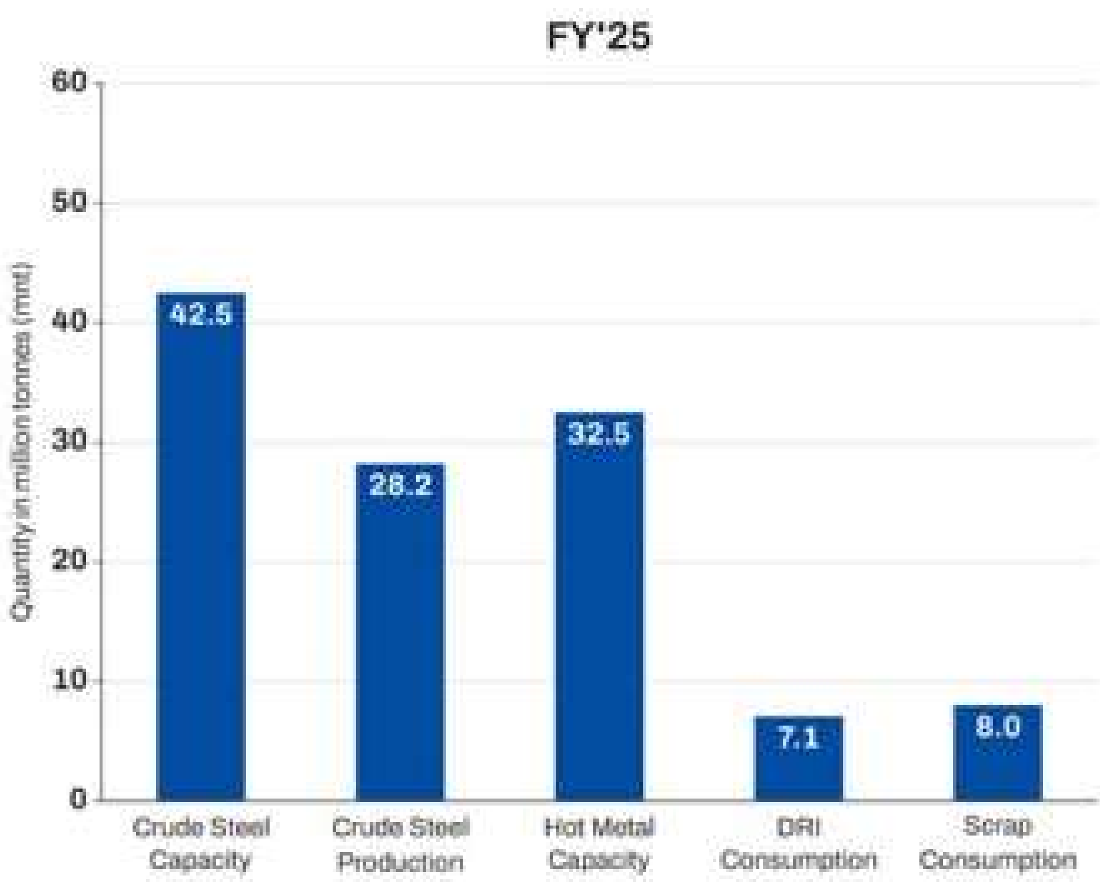
Currently, this growth is mainly driven by the BF-BOF route. The share of BF-BOF in total capacity stands at around 66%, at nearly 28 mnt-- mainly concentrated in Karnataka and Andhra Pradesh. While EAF steelmaking capacity stands at 3.63 mnt, IF-based capacity is 12.6 mnt.

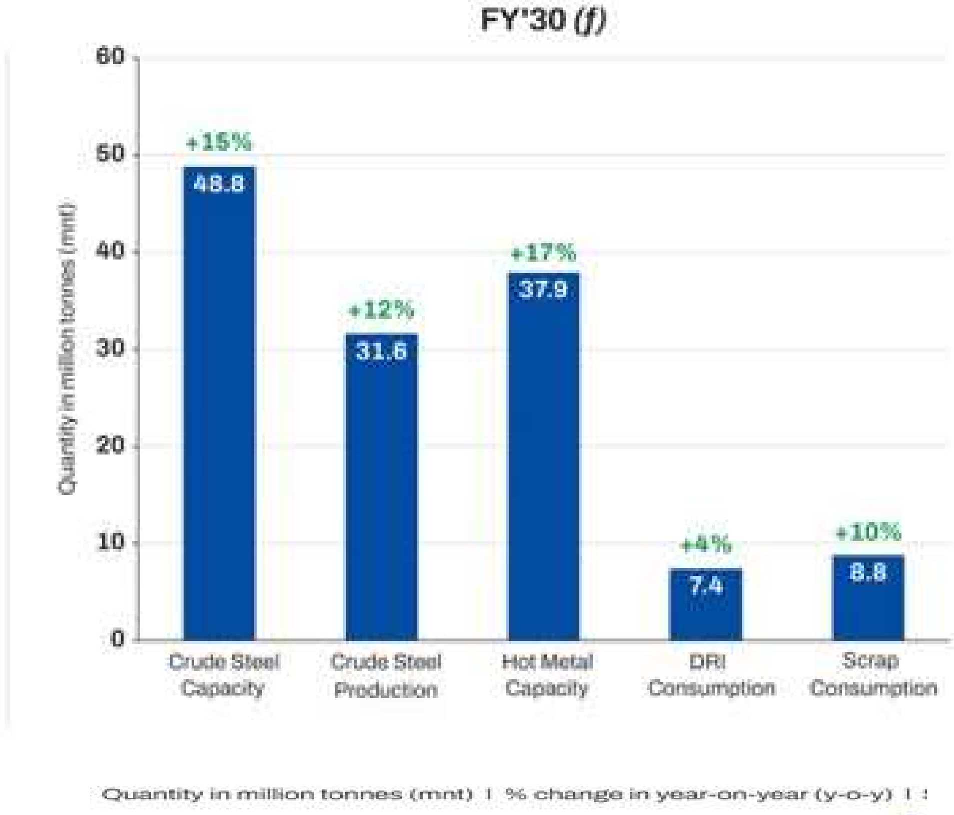
Of the total production of 28.2 mnt in FY'25, the BF-BOF route (across the six states mentioned) accounted for roughly 15 mnt, or about 54% of total output, while the IF-based route churned out nearly 10 mnt. The EAF route's contribution stood at 3.1 mnt.

Some of the leading producers are JSW Steel, RINL, SAIL, BMM Ispat, AP High-Grade Steel, Kalyani Steels, etc.

Raw material requirements

As the BF-BOF route dominates steel production in certain key hubs in South India, the usage of iron ore and metallurgical coal is widespread. Ferrous scrap consumption has gradually increased with the development of IF-based facilities, as well as EAFs of some leading producers in the region. Scrap consumption in steelmaking stood at 8 mnt in FY'25 across the six states covered. This is an increase of around 11% y-o-y compared with 7.2 mnt in FY'24. Scrap usage in IF steel production stood at 5.8 mnt, while use in BOFs and EAFs in the region stood at 1.4 mnt and 0.4 mnt, respectively.





South India's metallic mix scenario FY'25 Vs. FY'30

On the other hand, sponge iron consumption was assessed at 7.1 mnt in FY'25. While total DRI usage in IFs in the different states of the region was 5 mnt, another around 2.2 mnt was consumed by EAFs.

Outlook

It is estimated that the crude steel capacity of the six states of South India is likely to reach around 49 mnt in FY'30, an increase of over 10% compared with FY'25. Capacity expansion will mainly be driven by the BOF route, while simultaneous expansion will happen in the IF and EAF routes. Likewise, crude steel production is expected to increase by over 12% to reach nearly 32 mnt in FY'30.

Estimates show that scrap consumption is likely to rise by 10% to around 8.8 mnt by FY'30 on higher consumption across routes. Given the strategic advantage of growing low-emissions steel production in the region, ferrous scrap usage is likely to gain a further boost in the years to come.

However, estimates show that sponge iron consumption in South India is expected to remain largely flat till FY'30 in tandem with the gradual increase in domestic scrap availability.

Source: BigMint Updates, 23 May 2025

Stainless Steel Melt Shop Production in 2024

The world stainless association has released figures for the full year of 2024, showing that stainless steel melt shop production has increased from 2023 to 2024 by 7% to a total of 62.6 million metric tonne

Stainless steel melt shop steel production [000 metric tonnes]

Region	Quarter				12 months		+/- %
	1/2024	2/2024	3/2024	4/2024	2023	2024	y-o-y
Europe	1,563	1,625	1,506	1,394	5,997	6,088	1.5%
USA	509	518	482	441	1,824	1,950	6.9%
China	8,655	10,152	9,898	10,736	36,676	39,441	7.5%
Asia w/o China and S. Korea	1,842	1,776	1,776	1,928	6,880	7,322	6.4%
Others	2,076	1,761	2,029	1,954	7,163	7,820	9.2%
Total	**14,644**	**15,833**	**15,690**	**16,453**	**58,539**	**62,621**	**7.0%**

Others: Brazil, Indonesia, Russia, S. Africa, S. Korea

Source: worldstainless

Global Molybdenum Production and Usage in 2024

Global production of molybdenum was at 639.7 million pounds (mlbs) in 2024, a rise of 2% from 625.4 mlbs in 2023, as per the figures released by the International Molybdenum Association (IMOA). Global usage rose 3% to 648.4 mlbs from 630 mlbs the previous year.

China remained the largest producer of molybdenum in 2024 at 294.8 mlbs, up 5% from 281.8 mlbs in 2023. South America remained the second largest producer at 174.7 mlbs - a rise of 4% from 168.5 mlbs the previous year. North America saw production rise 1% to 114.5 mlbs from 113 mlbs the previous year. Other Regions saw a decrease of 10% in production to 55.7 mlbs from 62.1 million pounds in 2023.

Global production in Q4 2024 saw a 3% rise to 164.3 mlbs when compared to the same quarter of the previous year. North America saw the largest rise, 9%, to 31.3 mlbs, while South America saw a 4% rise to 44.3 mlbs and China saw a 2% rise to 74.8 mlbs. Other Regions saw production decrease 4% in Q4 to 14 mlbs, when compared to the same quarter of the previous year. When compared to the previous quarter (Q3, 2024), North America saw a 15% rise, Other Regions 2%, China 1%, while production in South America fell by 5%.

China, the largest user of molybdenum, saw the biggest increase in usage, 10%, to 305 mlbs in 2024, when compared to 2023, while usage in the USA remained largely static. Europe, the second largest user of molybdenum, saw a 2% decrease in usage to 122.3 mlbs, while Other Regions saw a 1% fall to 92.1 mlbs. Japan saw the largest percentage decrease in usage, 7%, to 44.1 mlbs in 2024, while CIS saw a 3% reduction to 20.8 mlbs.

In Q4 2024 global usage fell 3% to 160.6 mlbs when compared to Q3, 2023, with a fall of 5% in Europe, 7% in USA, 10% in both Other Regions and CIS and 2% in Japan. China was the only region to see a rise in usage, 1%, when compared to the same quarter of the previous year. When compared to the previous quarter (Q3, 2024), global usage fell by 2%, with a fall of 3% in China and Japan, 5% in USA and 6% in CIS. Usage in Other Regions remained mainly static, while Europe saw the only rise, 2%, in usage.

Source: International Molybdenum Association Latest News, April 2,2025

E-waste: A Treasure to be Recovered

When electronic devices reach their end-of-life, they become an important resource in the "urban mine."

Huge economic potential

The digital transformation has changed and continues to alter the way we live, work, learn, socialize, and do business. Electronic devices play a central role as they interconnect people, applications, and machines. This trend extends beyond computers and mobile phones to include smart appliances, e-bikes, e-scooters, health monitors, sensors, smart furniture, wearable tech, toys, tools, and devices like LEDs and solar panels, to name but a few.

Global E-Waste statistics

Electronic waste is the downside of this development as all of these products come to the end of their useful life when they are replaced by rapid innovations. This results in fast-growing amounts of waste electronic and electrical equipment, or WEEE for short. In 2022, the world generated 62 million tons of e-waste, an average of 7.8 kg per capita. The composition varies by type of equipment, but e-waste consists primarily of metals and alloys (50% to 60%), plastics (25%), as well as composite materials, glass, and concrete. Among the metals, steel is the most used, followed by aluminum and copper, although WEEE also contains notable amounts of zinc, lead, tin, cobalt, antimony, gold, silver, and palladium, as well as platinum group metals. Much more impressive than the mere quantities are the associated values. The Global E-waste Monitor (*https://globalewaste.org/)* estimates that e-waste contains 19 billion US dollars' worth of copper, 15 billion in gold, 14 billion in nickel, 8 billion in palladium, and 1.4 billion in tin every year. So, recycling electronic devices should be a no-brainer to transform the inevitable waste created by society using appropriate technology.

However, only a small part of these metals is recovered. The main reason is the low collection rate. Only 22% of this WEEE mass was documented as formally collected and recycled in an environmentally sound manner. The large majority is collected outside formal e-waste management systems, shipped to countries with no developed e-waste management infrastructure, or simply used as landfill. This can have a severe impact on the environment and people's health as WEEE contains harmful materials.

E-waste recycling technology

When properly collected, the recycling of WEEE remains a complex metallurgical challenge. The complexity arises from the diverse and functional combination of metals and other materials, making recycling and recovery more challenging compared to conventional metal scraps. High recycling rates can only be achieved with a profound understanding of the metallurgical processes in combination with extensive experience in plant engineering. Ideally, digital twins and simulations are used to determine the best process route and the design of the various plants.

Over recent decades, SMS have developed numerous processes to offer tailored solutions for recycling WEEE, more specifically circuit boards that contain valuable elements. SMS provides pyro- and hydrometallurgical solutions, as well as combinations of both, designed to effectively address the challenges of recycling complex metal-containing waste. WEEE recycling solutions range from standalone technologies that produce copper-rich alloys consisting mainly of valuable metals such as copper, cobalt, nickel, gold, silver, platinum, and palladium as an intermediate product, to complex plants producing all relevant metals as well as slag and energy. The larger plant concepts can be complemented with rectangular copper anode refining furnaces, which also allow the recycling of various copper scraps. The current design offers an annual capacity of 3,000 to 120,000 t of WEEE concentrates.

Source: SMS Group Connect Update- May 2025

Transforming Copper Scrap into Premium Products

Copper plays an essential role in our modern world. With an anticipated copper supply gap and the need to preserve precious natural resources, it is crucial to transform copper scrap into high-quality copper. Recycling solutions should ensure high recovery rates while maintaining a minimal carbon footprint.

Copper possesses a number of properties that contribute to its high value and versatility, mainly heat conductivity, electrical conductivity, formability, and toughness. Without copper, there would be no use of renewable energies such as solar power. Cars could not run without copper. The weight of the copper components installed in a typical passenger car today consists of approximately 9 kg to 23 kg, which is equivalent to a half mile of copper cabling. Copper and copper alloys are utilized in electric and hybrid vehicles in even greater quantities: up to 91 kg of copper and copper alloys can be found in fully electric vehicles. The ever-growing power requirements and increasingly small dimensions of computers and smartphones would be equally inconceivable without copper's fast signal transmission capability. It is also ideal for semiconductor chips that need ultra-thin, ultra-compact wiring.

Parallel to these developments, copper has become scarcer on the global market. Experts even see a gap emerging between copper supply and demand in the years ahead. There is a growing call for high-quality copper from recycled material.

Great demand for high-quality copper recycling

Worldwide, around 10 million t of copper scrap is recycled every year. Due to the high value and extensive range of applications of copper, copper scrap recycling is part of the circular economy.

The advantages of secondary copper production are considerable. Recycling saves up to 85% of the energy required for primary production, which results in a reduction of approximately 2.1 t of CO_2 per t of copper. Consequently, recycling copper scrap significantly conserves natural resources while lowering carbon emissions. It reduces energy consumption and minimizes environmental impact compared to mining new copper. It also provides economic benefits, cuts waste, and ensures a stable supply of high-quality copper for industrial use.

Copper scrap is categorized into various grades based on the purity and form. Common qualities include bare bright copper (Millberry), #1 copper to #3 copper, and insulated copper wire. Consequently, there are several options for recycling processes within both primary plants and secondary plants that treat only scrap material.

The quality of available copper scrap plays an essential role in determining the most efficient secondary copper processing route. The process involves collection, sorting, cleaning, shredding or baling, melting, refining, casting, and manufacturing. The smelting and refining of copper scrap is challenging due to the inherent impurities, the heterogeneity of scrap materials, and the tendency of copper to oxidize during processing. Additionally, these processes are energy-intensive, must comply with strict environmental regulations, and are influenced by fluctuating market prices. These factors collectively complicate the efficient and profitable recycling of copper scrap.

Melting, refining, and casting in one unit

For copper scrap recycling, SMS group has developed a new generation of tilting refining furnaces, enabling the production of anode copper, fire-refined, high-conductivity (FRHC) copper, or even copper granules for copper foil manufacturing.

Tilting refining furnaces (TRF) and elliptical tilting refining furnaces (ETRF) perform the task of melting, refining, and casting copper scrap in one flexible unit. By combining the tilting refining furnace with a casting wheel, high-quality anodes are produced. The type of furnace employed depends on the desired production capacity. The TRF is designed for large capacities of up to 500 t, whereas the ETRF handles capacities up to 100 t. The copper scrap is charged in the form of bales or loose scrap via the charging doors. Depending on the desired product and quality, different grades of copper scrap (grades 1 to 3, e.g., birch or cliff) can be used. The units can also be offered “H2-ready,” enabling CO_2-reduced copper production.

Additional equipment such as top blown rotary converters (TBRC) or basic rotary refiners (BRR) can be added for recycling slag, lower-grade copper scrap, and e-waste. The flexibility of the TRF/ETRF process ensures that the copper quality is adequate for the partial replacement of cathodes for a fire-refined semi-product.

An example of modern copper scrap recycling plant is the secondary copper smelter for Ames Copper Group, a joint venture of Prime Materials Recovery Inc. and the Cunext Group, located in North Carolina. The new facility is designed for an annual capacity of 50,000 t of anodes. The entire system consists of a TRF, which handles the melting, multistage oxidation and reduction stages, one anode casting wheel, and a gas cleaning system.

Maximum recycling rates are attained by combining plant technology and automation, designed to optimize metallurgical processes, aiming to achieve the highest copper content with the lowest impurities in the copper anode. It employs two core applications: simulation and optimization. The simulation controls the copper scrap refining process, calculating the mass and impurities concentration of anode copper at the end of the refining steps. The calculation happens in seconds and evaluates more than 100 potential operation points, choosing the best fit – both at the batch start and during operation. AI support also ensures the system's self-learning capability. It dynamically adjusts parameters such as air blowing, oxidation, reduction, and purification rates, to meet the desired copper purity and composition.

The optimization algorithm maximizes copper yield and minimizes impurities by finding the optimal combination of fluxes based on input parameters such as copper scrap weight, composition, feed temperature, and gas rates. This enhances production efficiency, yield, quality, and throughput, and reduces production costs. Comprehensive metallurgical expertise coupled with innovative furnace design and process control system can make big difference.

Source: SMS Group Connect Update- May 2025

Zinc-Ion Batteries

Growing concerns over the drawbacks of lithium - such as limited global availability, environmentally harmful extraction methods, and challenges in disposal and recycling – are providing a push for alternative solutions. In 2018 , viability of zinc-ion batteries was explored at Stockholm University.

Enerpoly, a deep-tech company specializes in the development of patented zinc-ion battery cells and packs for stationary energy storage. Their technology offers significant advantages, including a reduction in cell costs compared to lithium iron phosphate (LFP) batteries and a 70 percent decrease in carbon emissions.

What is a zinc-ion battery?

A zinc-ion battery is a rechargeable electrochemical battery that utilizes Zn^{2+} ions as the charge carrier. During charging and discharging, these ions move between the electrodes to enable efficient energy storage. The battery features a zinc metal anode, a host material on the cathode, and a water-based electrolyte optimized for high ionic conductivity and extended battery lifespan. A key technological focus is the suppression of zinc dendrite formation and hydrogen gas evolution, which enhances battery safety and longevity.

Additionally, the patented cathode material further improves the overall performance, making the technology more reliable and efficient.

Zinc-ion technology may allow to leverage the supply chains of primary AA and AAA alkaline batteries to develop rechargeable energy storage solutions. Alkaline batteries have been the dominant single-use battery technology for the past 70 years.

Another key factor is the ability to utilize abundant and locally sourced materials within Europe to ensure a secure and sustainable supply chain. Zinc and manganese dioxide were selected as core materials that unlocked a promising electrochemical potential that would align well with the requirements of the stationary energy storage market, offering competitive energy density and lifetime. Zinc-ion batteries offer a sustainable and reliable energy storage solution that addresses critical market needs, such as grid stabilization, backup power, and support for critical infrastructure.

One of the key advantages of zinc-ion technology is its inherently safe chemistry, which eliminates the risk of fire or thermal runaway. This significantly reduces production and installation costs by reducing the need for complex safety systems. The non-flammable and non-toxic nature of the battery also makes it ideal for deployment in urban-dense environments, essential infrastructure, and even hazardous or potentially explosive areas where safety is paramount.

Zinc-ion batteries are highly cost-effective and offer one of the lowest levelized costs of storage among all battery technologies. This affordability opens up new opportunities for energy storage in applications that were previously considered economically unfeasible. These batteries are maintenance-free, reducing both logistical challenges and long-term financial burdens.

Another major advantage is the full local manufacturability. Zinc-ion batteries can be produced globally using existing supply chains, which strengthens energy security and minimizes risks associated with geopolitical trade issues, such as import tariffs. By prioritizing responsible sourcing and recyclability, the zinc-ion technology aligns with sustainability goals, meeting the environmental standards expected by end users.

Several key trends currently shape the energy storage landscape in Europe. Firstly, there is a growing demand for lower-cost energy storage solutions, as measured in euros per kilowatt-hour (€/kWh). This is essential for enabling medium- to long-duration energy storage, which plays a critical role in stabilizing the grid and integrating renewable energy sources.

Secondly, there is a strong movement toward the localization of production. European countries are increasingly focused on developing domestic supply chains to enhance energy security and reduce dependency on imports. This trend is driven by both geopolitical considerations and a desire for greater control over critical materials and technologies. *Enerpoly* has established a mega - factory in Stockholm, which will be supported by a fully European supply chain, and is targeting 100 MWh of annual production at this facility by 2026.

Another trend is the rising interest in alternative battery technologies that rely on abundant and readily available materials. These alternatives offer significant supply chain benefits, such as lower price volatility and improved sustainability through more responsible sourcing practices.

Safety is also becoming a central concern. Across the energy storage value chain, stakeholders are placing greater emphasis on reducing fire risks, which accounts for added safety-related costs in the design and deployment of storage systems.

Finally, the global standardization of large-scale battery energy storage systems, driven in part by major manufacturers in Asia, does influence how projects are developed in Europe. These standards are informing practices related to overall system design, system interoperability, integration and procurement.

The need for energy storage in Europe is becoming increasingly evident. This trend is largely due to the rapid expansion of renewable energy sources, which is outpacing the deployment of sufficient energy storage capacity needed to balance supply and demand effectively.

However, there are significant challenges hindering the growth and scalability of energy storage. There is a clear need for stronger policy momentum at both the EU and national levels to recognize and support the critical role of energy storage in ensuring grid stability, enabling renewable energy integration, and achieving broader decarbonization goals.

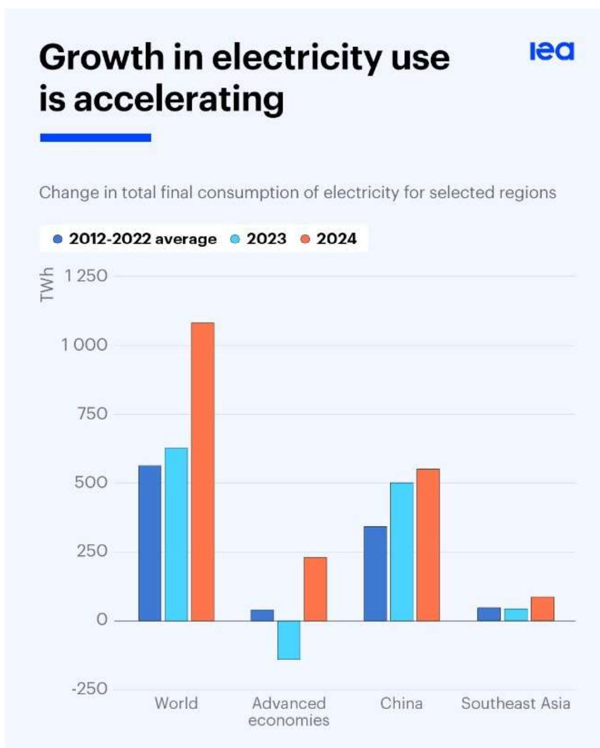
Source: ees newsletter, April 2025 (electric energy storage)

Global Electricity Consumption in 2024

Global electricity demand is growing quickly today. There are some key questions: How much electricity does the world currently use? Where does it come from – and is this changing?

According to Global Energy Review, which provides the first global assessment of trends across the energy sector in 2024, power consumption rose unusually fast last year. It surged by nearly 1,100 terawatt-hours, or 4.3% – nearly double the annual average over the past decade.

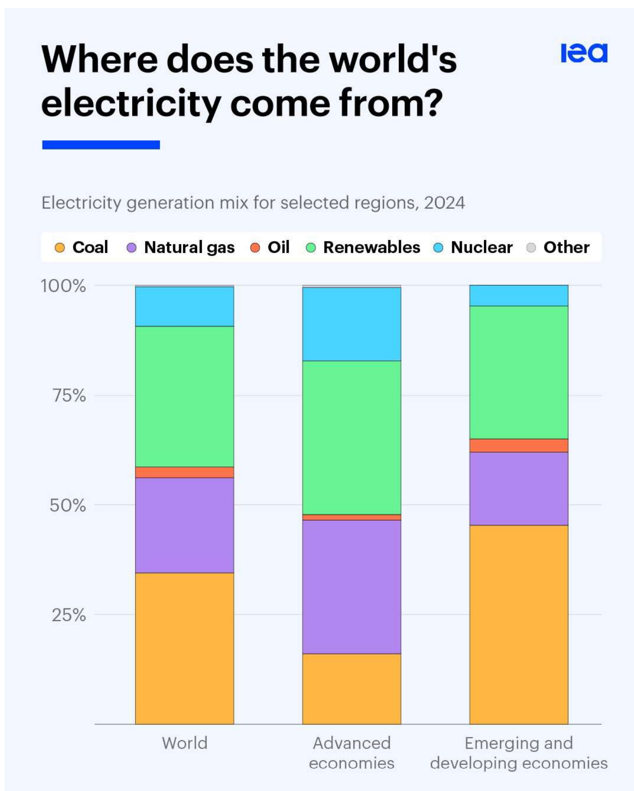
The jump was driven by record global temperatures, which boosted demand for cooling in many countries – as well as by rising power consumption from industry, the electrification of transport, and the growth of data centres and artificial intelligence. As a result, electricity use in advanced economies increased after years of stagnation or decline in many of them. This came on top of robust rises in electricity demand in China, India, Southeast Asia, the Middle East and other emerging and developing economies.



When many people think about energy, electricity comes to mind. The bedrock of modern societies and economies, it powers essential services such as lighting, air conditioning, refrigeration and communications systems.

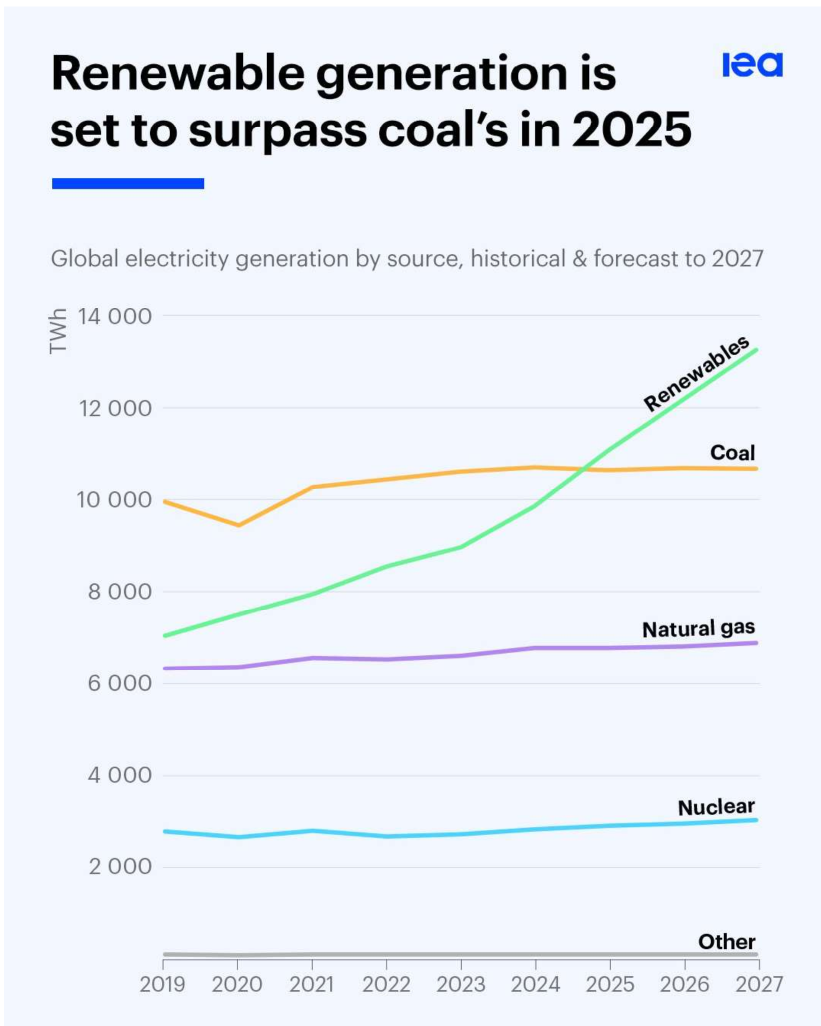
Global power mix is evolving. Fossil fuels still generated nearly 60% of global electricity in 2024. Coal remained the world's largest source, a position it has held for more than 50 years. In 2024, it accounted for 35% of total generation, primarily due to its prominent role in powering several large emerging and developing economies. Natural gas was the second-largest source of electricity, marking more than two decades in which it has provided over 20% of global electricity.

However, over 80% of the growth in electricity generation last year came from renewables and nuclear power. Together, these low-emissions sources contributed 40% of total generation for the first time, with renewables (including solar PV, wind and hydropower) supplying 32%.



Given record investment in renewables and strong international interest in expanding nuclear power, electricity generation from these sources is set to keep growing in the years ahead. According to the forecasts for the next few years, renewables are set to surpass coal-fired generation this year, pushing coal's share of the power mix below 33% for the first time in the past century.

Current trends also indicate that low-emissions sources are expected to expand quickly enough to meet all of the growth in global electricity demand, in aggregate, through 2027.



Source: IEA Energy Snapshot, 14 April, 2025

Coal India Eyes Lithium Mining JV with Argentina's YPF

Coal India Ltd. is exploring a 50:50 joint venture with Argentina's YPF for lithium exploration, mining and commercial use in the Latin American nation.

A non-binding agreement was signed two months ago and once lithium blocks are identified and finalized, a binding framework will be established.

Coal India is looking to diversify into lithium, a critical component in energy storage solutions including mobile phone batteries and electric vehicles (EVs). India is entirely import-dependent for lithium, both in raw and processed forms.

YPF SA (Fiscal oilfields) is a majority State-owned Argentinian energy company engaged in oil and gas exploration, production, refining and marketing.

Lithium Footprint

If the deal materialises, Coal India would become the second Indian PSU to enter Argentina's lithium sector, following the Mines Ministry-owned KABIL (Khanij Bidesh India Ltd.).

In January last year, KABIL became the first Indian entity to acquire five lithium blocks in Argentina's Catamarca district, where non-invasive exploration is currently underway.

Source: The Hindu Businessline, 2nd April 2025

How We Can Eliminate the Need for Mined Minerals by 2050

As demand for EV batteries grows rapidly, responsible, resilient supply chain must be is in place to meet this demand. Today's linear supply chain relies on newly mined minerals, the extraction of which is associated with social and environmental harms. Furthermore, just a few countries dominate the supply chain, making it vulnerable to changing geopolitics and trade alliances.

A circular battery economy — one in which end-of-life (EOL) batteries are reused, repurposed, or recycled — can help address these issues.

Outline below are three approaches that can help realize the benefits of a circular battery economy.

1. Get the most out of mined minerals

It will take some time to build the infrastructure to support a robust circular battery economy, so in the short term we will need to continue mining to meet growing demand for batteries. But by focusing on how to get the most out of these minerals, we can greatly reduce our need for mining. This can be done by implementing the following six strategies:

i. **Shift to new battery chemistries:** Deploy different battery chemistries that require fewer critical minerals.
ii. **Increase energy density:** Store more energy per kilogram through better battery engineering.
iii. **Employ battery recycling:** Ensure all batteries are recycled at end of life so their materials can be used in new batteries.
iv. **Reuse EVBs and extend their lifetime:** Use and reuse batteries longer to avoid the need for frequent replacements and provide a greater flow of service from a smaller stock of batteries and their minerals.
v. **Increase vehicle efficiency:** Make cars more efficient — lighter weight, sleeker, and with better tires and accessories — and right size them for purpose to allow for smaller batteries for the same vehicle range.
vi. **Change mobility patterns:** Reduce the demand for motorized transportation and induce mode-shifts to public transit, electric micromobility, cycling, and walking through better urban planning, smarter transportation infrastructure investments, and logistics efficiency.

These strategies will not only help meet near-term EVB demand but may actually eliminate the need for new minerals by 2050**.**

It is often said that critical minerals are the new oil — meaning that critical minerals will power our future, drive our global economy, and require ever-increasing extraction the way that oil has done in the past. This also implies that the drive to maintain strategic access to them will lead to the same geopolitical conflict and environmental impacts as oil. This concept misses a key point: minerals only need to be extracted once, while oil needs continuous extraction**.**

If all six solutions are employed mentioned above, we'll only need to mine a cumulative 125 million tons of battery minerals to reach mineral self-sufficiency. This may seem like a lot, but it is 17 times smaller than the amount of oil we extract and process for road transport every year. And, at today's commodity prices, it's about 20 times cheaper.

2. Implement policies and market-based solutions to account for the true return on investment of battery recycling

The economics of EVB recycling are challenging. High capital requirements, the need for significant feedstock (at a time when most of the available battery recycling material is production scrap), and a volatile critical minerals market can result in a low return on investment (ROI) on recycling infrastructure. However, when evaluated using a triple-bottom-line accounting approach, one that considers social, environmental, and financial impacts, EVB recycling's ROI is greater than that of mining.

3. Invest in domestic EVB recycling and midstream manufacturing to strengthen the supply chain's resilience, increase energy security, and boost the economy.

Global demand for lithium-ion batteries — and the resulting demand for the minerals that go into them — is growing rapidly. At the same time, there will be a considerable increase in EVBs reaching end of life in due course. If recycled, these EOL batteries can help meet supply gaps

Access to information can help make a circular battery economy a reality

If we continues to rely on a linear EVB supply chain, we'll miss out on battery circularity's many social, environmental, and economic benefits. By adopting the approaches outlined above, we can hasten instead of impede the transition to electrified transportation, while reducing negative impacts and risks in the supply chain, increasing our energy independence and security, and boosting our economy.

Source: RMI Spark 17 April 2025

Changing Steel Logistics

Steel logistics is a complex ecosystem where expertise makes all the difference. Logistics professionals navigate intricate supply networks, balancing multimodal transport, strict regulations, and time sensitive deliveries. Their deep industry knowledge enables them to handle oversized loads, hazardous materials, and compliance requirements with precision. This expertise extends to mastering multimodal transport, seamlessly coordinating rail, road, and waterways to ensure efficiency and resilience.

Each transport mode has its own set of challenges: rail offers high capacity but faces risks of delays, road transport is flexible but fragmented, and waterways provide sustainability benefits but have limited availability. Managing these flows requires logistics teams to address unexpected disruptions, aim at cost efficiency for each journey, and comply with strict regulations while meeting increasing customer expectations.

Rail transport, in particular, faces unique constraints beyond delays. Wagon availability, network congestion, last-mile connectivity, and infrastructure limitations all impact efficiency. Logistics teams must be able to anticipate these challenges and integrate them into their planning, ensuring that steel shipments remain on schedule despite fluctuating conditions.

In addition to their technical expertise, steel logistics teams excel at crisis management. Steel production follows a strict schedule, where delays can cause costly disruptions. Logistics professionals anticipate and resolve problems in real time, rerouting shipments and maintaining constant communication with all stakeholders. Their ability to interpret data, use historical knowledge, and make quick, informed decisions ensures production lines remain uninterrupted. integrated AI-driven analytics into its logistics operations allows leveraging big data platforms to improve forecasting and optimize its supply chain. Combining AI insights artificial vision with predictive maintenance facilitates improving safety, ensuring greater efficiency, and minimizing environmental impact across the transportation network.

Before digitalization, decisions were based on field experience and instinct rather than historical data. With digital transformation, these skills are now enhanced by technological tools that capture field data in a centralized platform.

When assisted by reliable data, decision-making becomes easier and more accurate. Embracing Industry 4.0 technologies, deploying IoT sensors and AI-driven predictive maintenance all lead to optimizing logistics operations. Integrating data from multiple sources, helps achieving increased efficiency, reduced downtime, and improved overall supply chain performance.

From problem solvers to pioneers: The digital evolution of rail logistics

As digitalization reshapes the steel industry, logistics teams are moving from reactive problem solving to proactive optimization. They are no longer simply executing shipments but designing intelligent transportation strategies. Using AI-driven forecasting and real-time tracking, they analyze historical data, traffic conditions, infrastructure availability, equipment status, regulatory constraints, labor availability, and market demand trends to predict potential bottlenecks and smooth out rail traffic flows. This enables them to anticipate risks and adjust logistics plans accordingly, optimizing routes, scheduling, and resource allocation to improve efficiency and reduce delays.

Looking at other industries that are progressing in their digital transformation can provide valuable learnings for steel logistics. Agribusiness and building materials, for example, share key similarities with steel: they are large-scale industries that rely on complex logistics networks, handle massive transportation volumes, and require seamless coordination among multiple stakeholders. Both have leveraged digitalization to optimize rail freight and related operations, as well as address emissions challenges. They offer insights that the steel industry can apply as it accelerates its own transformation.

Paper-based processes and phone calls are giving way to integrated digital platforms that centralize tracking, scheduling, and predictive analytics. Deploying IoT-enabled tracking solutions to increase visibility across their multimodal supply chain improve resilience and response time to disruptions. Rather than replacing human expertise, these technologies act as force multipliers, increasing visibility, simplifying workflows, and enabling smarter resource allocation.

Collaboration is also evolving. The future of steel transport depends on interconnected networks where rail logistics teams, railway operators, and customers not only share real-time data but also synchronize their actions to anticipate and prevent disruptions. By aligning schedules, proactively identifying potential bottlenecks, and dynamically adjusting transport plans, these teams create a more resilient and efficient supply chain that adapts seamlessly to market shifts and evolving customer expectations.

Digital consignment notes are becoming a game changer in the rail sector. Unlike road transport, where they are primarily used to speed up administrative tasks, in rail freight, they enable automated rebooking, faster customs clearance, and seamless multimodal transitions.

Building materials industry is implementing digital consignment notes to increase visibility, speed up deliveries and allow its logistics teams to spend more time on higher-value tasks. This sector has been at the forefront of rail digitization, largely due to its urgent need to address Scope 3 emissions, having already made significant progress on Scope 1 and 2. The steel industry, still primarily focused on Scope 1 and 2, is beginning to follow suit, adopting similar digital innovations to improve efficiency and reduce paperwork-related delays in rail freight.

Agribusiness is also undergoing a transformation in rail logistics. With a strong focus on sustainability, agribusiness companies are prioritizing digital solutions to enhance efficiency and reduce emissions in their supply chains. Using digital collaborative platform for rail operations, can make whole rail processes more efficient, from order to invoice. Although dealing with different products and constraints, the steel industry could learn interesting lessons from its neighboring industries and their digitalization journeys to accelerate its own.

Steel transport and rail freight: Become the driver for change

Rail freight remains essential for steel transport, and new technologies are unlocking even greater efficiencies. Real-time tracking through IoT sensors eliminates blind spots and provides live updates on the location, condition, and estimated arrival time of wagons.

Automation also plays a critical role. Digitizing all rail transport documents, including consignment notes and wagon damage reports, makes operations smoother, ensures compliance with legal requirements, and improves maintenance tracking. Digital consignment notes replace manual paperwork, speeding up customs processes and minimizing errors. These advancements will enable logistics teams to gain real-time insights, optimize wagon utilization, and improve fleet efficiency, while also reducing Scope 3 emissions.

Regulatory compliance is also a key driver of digitalization in rail logistics. As governments push for greener and more efficient transportation, new regulations make digital tools essential for tracking, reporting, and ensuring profitable operations. Automated documentation not only improves transparency but also ensures that logistics teams meet evolving regulatory requirements while reducing administrative burdens.

The future of steel logistics lies in combining human expertise with digitalization. Teams no longer just manage flows: they anticipate them, optimize routes, and reduce CO_2 emissions.

But digitalization is not just about the tools and the day-to-day work of teams. It is also about building a lasting legacy of knowledge for the industry and within companies. By capturing operational expertise and industry knowledge and integrating it into structured processes and collaborative systems, companies can preserve expertise and make it accessible to future generations of colleagues. This also makes the steel industry more attractive to young talent, who are drawn to workplaces where modern technology drives efficiency and innovation.

Real-time collaboration, automation, and intelligent forecasting are redefining rail transportation, making it more agile, resilient, and sustainable. Those who embrace these advances will shape a future where performance and responsibility go hand in hand, ensuring ever more efficient and environmentally friendly steel transportation.

Source: Green Steel World News Update, 17 April 2025

Industrial Innovations in Steel

Heavy industry is responsible for about 30 percent of global carbon pollution. Over half of that comes just from the cement, steel, and chemicals sectors. This is partly because they rely on emissions-intensive processes, and largely due to the sheer volume of global production of these materials. The mass of all human-made materials, including concrete, metals, and plastics, outweighs the mass of all living things on Earth by 200 billion tons, and demand for these materials is continuously growing. These industries are quite literally the building blocks of our society. Without intervention, heavy industry is expected to become the largest source of global carbon emissions within a decade. High capital requirements, strict codes and standards, and extreme risk aversion contribute to the challenge of commercializing innovations that these sectors need to build our sustainable future.

The Innovation Solutions

Critical technologies needed to transform these sectors can be classified into three general categories:

1. **Make Less:** Innovations to reduce demand for virgin materials through materials substitution, recycling, upcycling, and increasing efficiency in supply chains and material use — in addition to non-technology efforts like reducing overconsumption and overproduction
2. **Make Better:** Reducing emissions in existing processes through direct electrification, materials and feedstock innovations, and process efficiency
3. **Make New:** Disruptive technologies and novel processes to fundamentally change how materials are produced, with low or zero emissions from the start

Innovative solutions by some startups for enabling significant emissions reductions in steelmaking are described below.

Binding Solutions (Middlesbrough, United Kingdom)

Iron ore is agglomerated at 1000°C or more to create pellets or sinter. Binding Solutions produces cold agglomerated pellets without high temperatures, reducing energy use by up to 80 percent and carbon emissions by up to 70 percent — while matching or exceeding the performance of conventional pellets.

DexMat (Houston, TX | United States)

Together, steel, aluminum, and copper production consume about 12 percent of global energy and contribute about 8 percent of global emissions. DexMat produces Galvorn, a high-performance carbon nanomaterial that is stronger than steel, lighter than aluminum, electrically and thermally conductive, flexible, corrosion-resistant, non-toxic, and recyclable. Galvorn has a variety of possible use cases to displace steel, aluminum, copper — and potentially most impactful — steel cabling.

Greenore (Salt Lake City, UT | United States)

Steelmaking produces over 500 million tons of solid waste per year. Greenore converts iron and steel slag and waste carbon dioxide into valuable products — including carbon-negative precipitated calcium carbonate, a filler material to reduce the carbon intensity of paper, plastics, and rubber, and carbon-negative SCMs to reduce cement content and carbon intensity of concrete.

Helios (Tzur-Yigal, Israel)

Cleaner alternatives to the combustion of coal in blast furnaces are often limited by iron ore quality, high temperature requirements, and clean hydrogen supply. Helios can leverage all grades and types of ore in their low-temperature sodium-based iron reduction process, yielding significant cost and energy savings and producing zero direct carbon emissions. Their low-temperature process avoids emissions from direct combustion and is not reliant on large volumes of hydrogen, which is currently a commercial bottleneck.

Hertha Metals (Conroe, TX | United States)

Conventional direct reduced iron-based clean steel production has often been limited by iron ore quality. Hertha's novel platform technology for oxide smelting reduction, which can combine electricity with either green hydrogen or abundant natural gas, is uniquely able to utilize low-grade ores in a variety of formats (lumps, fines, etc.), not just high-grade pellets. This innovation enables a pathway to cheaper and greener steel compared to incumbents.

SUN METALON (Chicago, IL | United States)

Traditional recycling methods degrade the quality and utility of metals, resulting in significant value loss. SUN METALON's microwave-based metal recycling process uses special electromagnetic energy and booster materials to enable fast and efficient metal heating to reduce energy consumption and enable the recycling of contaminated or non-ideal scrap with near-zero emissions.

Source: RMI, Climate Tech & Innovation Newsletter, April 2025

India's Metal Recycling Sector

India is poised to strengthen its position in the global metal recycling and steel manufacturing landscape. India's metal recycling sector is expanding amid increased global demand for green steel. Ministry of Steel National Steel Policy (NSP) 2017 estimates that 70-80 million metric tons of ferrous scrap will be required by 2030 to meet India's growing steel production, more than doubling the 30 million metric tons presently needed.

In the domestic market, challenges like poor material quality, weak collection networks and limited and outdated processing infrastructure hinder India's circular economy goals. As global sustainability targets tighten, India need to overcome these barriers. As Europe moves toward carbon neutrality with rules like its Carbon Border Adjustment Mechanism, India needs to reduce carbon emissions associated with steelmaking. Failure to lower emissions could lead to steelmakers paying a potential surcharge of $80 per metric ton by 2030. This is significant because Europe is a key market for Indian steel.

Steelmakers are shifting to low-carbon technologies to avoid that potential surcharge. JSW Steel is piloting hydrogen-based direct reduced iron (H2-DRI) processes, which could reduce emissions by up to 97 percent compared with traditional blast furnaces. Meanwhile, Tata Steel Ltd. has begun constructing a 750,000-metric-ton electric arc furnace (EAF) mill in Ludhiana. Once the EAF is operational, the company could add similar plants, taking its total domestic capacity to 36-40 million metric tons from its current 21.6 million metric tons.

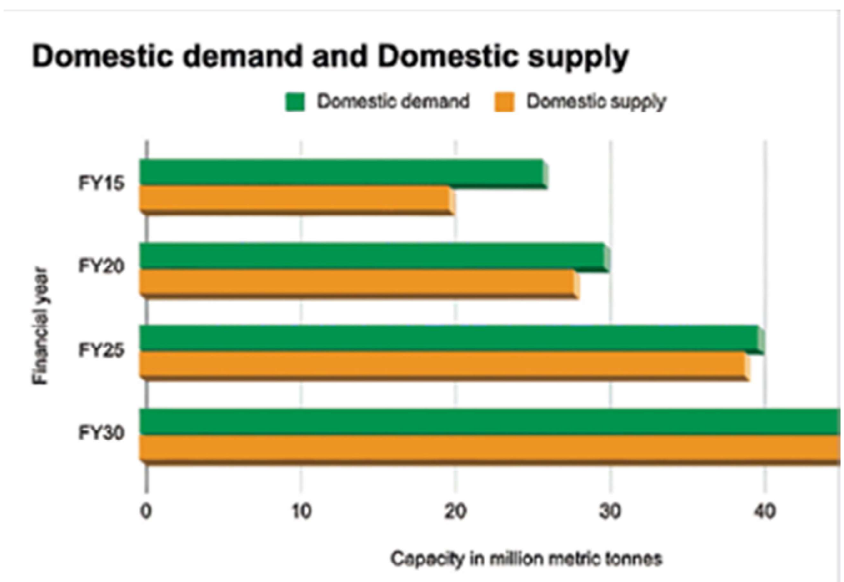
The NSP aims to establish a globally competitive steel industry in the country by expanding production capacity to 300 million metric tons by 2030, with 35-40 percent of that output expected to use the EAF/IF route, yielding roughly 120 million metric tons of green steel annually.

While recycled steel remains the primary raw material for the secondary steel sector, it also constitutes 15 percent of the charge mix in basic oxygen furnaces used by the primary steel sector, enhancing efficiency and reducing production costs. Ensuring the availability of high-quality scrap at competitive prices is crucial for the steel industry's growth and achieving the NSP 2017 targets. Both the EAF/IF and primary steel sectors depend on stable and sufficient scrap supply for sustainable expansion.

Ministry of Steel is promoting the use of recycled materials in steel production. The share of recycled material, currently at 15 percent, is expected to increase to 25 percent by 2030 and to reach 50 percent by 2047, significantly reducing dependency on iron ore. Thus, with insufficient domestic supply, India has to rely on recycled steel imports. The country imported 9.49 million metric tons of recycled steel in 2024, marking a 19 percent decline from 2023's 11.75 million metric tons, according to India Customs data.

Challenges in the way

Despite promising signs of growth, India's metal recycling industry faces a number of persistent challenges. The inconsistent quality of recyclable material, often contaminated with impurities, makes processing difficult and reduces output efficiency. Impurities can contribute significantly to pollution, which prompted China to ban some recyclable metal grades that could contain contaminants. Instead, China relies on other Asian countries to remove impurities before importing cleaner materials.



Source: National Steel Policy (NSP) 2017

India's fragmented supply chains and inadequate collection network further limit scalability as a significant portion of recyclable materials remains uncollected or improperly sorted. A lack of standardized segregation, processing and sorting infrastructure also slows operations, preventing the industry from reaching its potential.

The informal sector's dominance in recycling, weak policy enforcement and changing global metal prices further add to the uncertainty.To meet growing demand, Indian steelmakers have been expanding capacity rapidly, adding 26.3 million metric tons between the 2021 and 2024 fiscal years. An additional 27.5 million metric tons per year of capacity are expected between the 2025 and 2027 fiscal years.

India produced 149.6 million metric tons of steel in last year, marking a 6.3 percent increase from the 140.8 million metric tons the country's steel industry produced in 2023, according to figures gathered by the Brussels-based World Steel Association.

Source: Scrap Recycling Digital Edition,8.5.2025

EV Push Aids Recycling Sector

The rapid adoption of electric vehicles (EVs) in India also is driving the metal recycling market. EVs rely heavily on metals like steel, aluminum and copper for batteries, motors and structural components. By 2024, India's EV count surpassed 5.6 million, with annual sales exceeding 2 million units for the first time, a 24 percent increase from 1.6 million in 2023.

As EV demand continues to grow, so does the need for these critical metals. Government efforts such as the *Faster Adoption and Manufacturing of Electric Vehicles* scheme are accelerating EV adoption, further increasing demand for recyclable metals.

Meanwhile, the auto industry's sustainability push is upping the use of recycled materials to conserve resources and cut emissions because recycled metals not only save energy but also reduce the environmental impact of mining and processing virgin raw materials.

Recognizing this growing demand for recycled metals, major players are expanding their recycling capabilities.

In November 2024, Nupur Recyclers, based in Dehli, revealed plans to expand its operations by 2027, including its scrap processing and lithium-ion battery recycling capabilities.

Similarly, in June 2024, Japanese trading firm Mitsui & Co Ltd. invested in Mumbai-based MTC Business Private Ltd., which is expanding into end-of-life vehicle recycling and battery processing.

India's metal recycling industry is on a growth path, driven by strong demand, supportive government policies and sustainability efforts. While challenges persist, technology and infrastructure investments will help unlock its full potential.

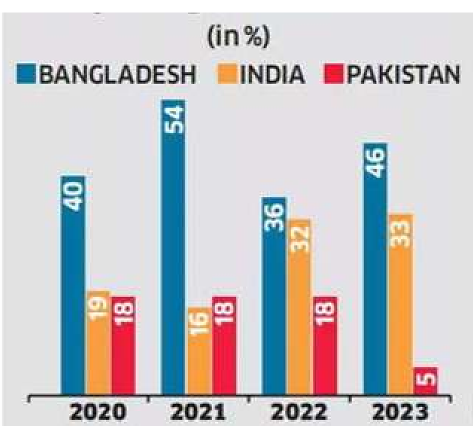
With an ambitious steel production target and a push for higher recycled content, India is poised to strengthen its position in the global metal recycling and steel manufacturing landscape.

Source: Scrap Recycling Digital Edition, 8.5.2025

Iron Ore Production in FY25

The country's iron ore production rose 4.3% year-on-year to 289 million tonnes in 2024-25. The iron ore production was 277 million tonnes in 2023-24.

Global Volume of Ship Recycling in South Asia



Source: Ship Recycling Industries Association, India

Know Your Members

Ms. Chandana Arjun
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Ms. Chandana, a dynamic Structural Engineer with specialization in Computer - Aided Structural Analysis and Design, established her own structural engineering consultancy in Kozhikode (Calicut) In 2017, where she led the design and execution of several significant projects across Kerala. Her portfolio includes the renovation of the Peruvannamuzhi Dam, high-end resorts and villas, auditoriums, hospital facilities, and educational institutions, all designed with an eye for structural integrity and aesthetic value.

She later joined the Kerala Local Self Government Department as an Assistant Engineer, contributing to critical road and bridge infrastructure projects. After a year in public service, she transitioned to Delhi to join Technotherma India Pvt. Ltd., a leading industrial furnace manufacturing company, where she applies her structural expertise to the manufacturing and thermal engineering domain.

Chandana has also contributed to academic research, with published work including:

- *"Smart Base Isolation in Diagrids and Outrigger Structures",* which explores the integration of seismic-resilient techniques in high-rise buildings.

In 2024, she took a bold step toward personal and professional growth by enrolling as Member of The Indian Institute of Management (IIM). Her aim is to combine technical excellence with strategic leadership, and to drive innovation at the intersection of industrial systems, and smart technologies.

Outside her professional endeavours, she remains deeply interested in disaster-resilient design, smart materials, and women's leadership in engineering.

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