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The Indian Institute of Metals – Delhi Chapter

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2025 Global Crude Steel Production

Total world crude steel production in 2025 was 1,849.4 Mt in 2025. a 3.7% decrease compared to December 2024.

Top 10 steel-producing countries are:

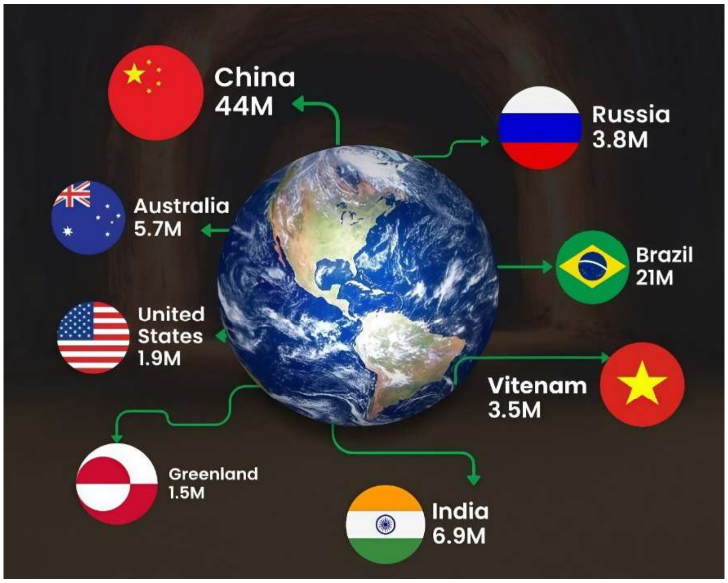
	Jan-Dec 2025 (Mt)	% change Jan-Dec 25/24
China	960.8	-4.4
India	164.9	10.4
United States	82.0	3.1
Japan	80.7	-4.0
Russia (e)	67.8	-4.5
South Korea	61.9	-2.8
Türkiye	38.1	3.3
Germany	34.1	-8.6
Brazil	33.3	-1.6
Iran (e)	31.8	1.4

e – estimated – annual figure estimated using partial data or non-worldsteel resource

Crude steel is steel in its first solid (or usable) form: ingots, semi-finished products (billets, blooms, slabs), and liquid steel for castings.

Global Rare Earth Reserve: Production and Consumption Scenario

In the 19th century, steel became the backbone of global industrial strategy. In the 20th century, it was oil. And, in the 21st century, it is the rare earth elements. 17 metallic elements from the periodic table, chemically similar and physically unremarkable to the eye, have become the scaffolding of electric vehicles, wind turbines, fighter jets, smartphones, navigation systems, medical devices, modern weapons and everything else that powers clean energy, digital connectivity and national defence. They are the ingredients behind the magnets that spin a wind turbine's rotor, the catalysts that refine fuels, the phosphors that light an aircraft cockpit, and the polishing compounds that perfect wafer-thin lenses.



Why are these named 'rare earth'?

The very name "rare earth" is misleading. These metals are not rare in absolute geological terms. Cerium, for instance, is more abundant in the Earth's crust than copper. What makes them "rare" is the economic viability of extraction and processing. They seldom appear in concentrated ore bodies that are easy to dig and refine. They are dispersed, chemically entangled with other minerals, or locked inside sands.

To complicate matters further, monazite and other common rare-earth minerals carry thorium or uranium, and the environmental equation becomes even more fraught. Strict radiation-handling regimes slow projects; lax regimes leave behind tailings ponds and anxious communities.

Yet despite such challenges, the world is chasing them harder than ever, jointly pulling rare earths from geology's basement into prime-time geopolitics.

The rare earth resource map

Global rare-earth reserves, based on the most recent United States Geological Survey estimates, sit around 110 million tonnes of rare-earth oxide equivalent. What matters, however, is not the volume but its distribution.

China holds roughly 44 million tonnes, nearly two-fifths of all the known reserves on the planet. Brazil follows with about 21 million tonnes, an under-discussed mineral advantage that is drawing attention from global investors.

India, with 6.9 million tonnes, is among the few Asian economies other than China with meaningful geological leverage. Australia holds 5.7 million tonnes, Russia and Vietnam 3.8 million tonnes and 3.5 million tonnes respectively, while the United States, despite its technological and defence-industrial strength, sits at 1.9 million tonnes. US's neighbour Canada also holds 830 thousand tonnes of reserve, whereas Greenland, with around 1.5 million tonnes, represents the northern fringe of this concentrated resource map.

Mining prowess is not the same as industrial power

As is evident in the meantime, country-wise reserve volume has never been the problem. But far fewer nations can point to industrial systems that actually turn rare earth-bearing rocks into refined oxides, speciality metals, alloys and high-performance magnets. And that is where China's true advantage lies. It not only leads in reserves but has spent decades building, subsidising and refining the midstream and downstream architecture.

In 2024, China produced an estimated 270 thousand tonnes of rare earths, accounting for over 70 per cent of global production. In terms of separation and processing, it leads the world with over 90 per cent market share. The country exported 17,700 tonnes valued at over USD 170 million, with the top destinations being Japan, Vietnam, and the United States.

The US, which mined about 45 thousand tonnes last year, tells a tale of imbalance. Much of what it dug up has been shipped abroad for refining, and even magnets manufactured within the US frequently rely on Chinese-origin oxides or metals.

Brazil, India and Vietnam face an even wider gap, with considerable ore potential but underdeveloped beneficiation, refining, separation and metallurgical ecosystems. Without those, reserves remain rocks in the ground rather than strategic leverage.

Why rare earths are costly, messy and slow to scale

To extract rare earths at an industrial scale, miners must move large amounts of ore with only a few thousand parts per million of useful content. They must then separate a suite of elements that behave almost identically in chemical solutions.

This typically demands extensive solvent-extraction trains, long chains of mixers, settlers, precipitators and roasters, whose operational footprint is expensive and often environmentally controversial.

These realities are what made China the global workshop. Through the 1990s and 2000s, low labour costs, lenient environmental enforcement and heavy state support allowed the country to shoulder the dirty stages of extraction and solvent separation while other nations stepped back.

On the other hand, the US's rare earth extraction industry has seen a decline from its peak in the 1960s, primarily due to the closure of its main mine, Mountain Pass, in 1998 after environmental issues arose. However, a revival is underway, led by the reopening of Mountain Pass by MP Materials in 2018, with ongoing projects aiming to create a complete domestic supply chain from mining to manufacturing, including new projects for extracting rare earths from alternative sources like coal mine waste and kaolin tailings.

The demand engine: magnets, catalysts and the age of electrification

Once refined, rare earths are funnelled into a few dominant sectors. Nearly half of global consumption today goes into permanent magnets — the compact, ultra-strong magnetic cores that are indispensable to electric motors. They are what make an EV accelerate without a combustion engine, and what lets a wind turbine harvest energy without bulky gearboxes. Global rare earth consumption for EV motors in 2024 was 37 thousand tonnes, a 32 per cent increase from 2023. This demand is projected to continue growing, with forecasts suggesting it will reach 43 thousand tonnes in 2025.

While a specific 2024 global rare earth consumption figure for wind turbines isn't available, the demand is estimated to be around 19 kilotons (kt) for the "cleantech" sector, which includes wind, and growing. This growth is driven by the increasing use of permanent magnet generators, especially in offshore wind, and the higher efficiency they offer. Neodymium is a key rare-earth element used for these magnets.

Another large wedge of demand comes from automotive and petroleum catalysts. Cerium-based polishing powders claim their chunk in the smartphone and optics industries. The remainder threads through aerospace alloys, phosphors, lasers, ceramics, advanced glass and speciality electronics.

The price roller-coaster

The numbers tell the volatility story best. For example, Neodymium oxide, the bellwether rare-earth used in magnets, has swung from around USD 40 per kilogram to nearly USD 200 in the last few years. During the 2011 crisis, it shot beyond USD 300 before collapsing as supply pressure eased. In 2025, prices jumped more than 50 per cent within months on the back of export-control rumours and strong EV and wind-turbine demand.

This is what happens when thin markets collide with concentrated supply, long project timelines and industries growing faster than chemistry can keep up. These are not metals that respond smoothly to supply-demand signals; they behave like strategic choke points with price tags.

Source: AL Circle, 01 December 2025

Aluminium and Magnesium: Shaping Lightweight Manufacturing

Two sister metals that are everywhere in our lives: Aluminium and magnesium

Magnesium is the third most common metal, as a structural metal, after steel and aluminium. It is also one of the metallic materials with the lowest density used in industry.

Magnesium and its alloys are characterised by advantages such as lightweight, high specific strength, good damping and machinability, which make them promising structural materials. It is traditionally used in transportation, aluminium alloying, steel desulphurisation and magnesium alloys diecasting.

Magnesium and aluminium are two lightweight structural metals and each has its own advantages in industrial applications. Aluminium gives natural resistance against corrosion through its oxide layer, while magnesium has electromagnetic shielding capabilities and vibration dampening. Also, magnesium is the lightest structural metal, 33% lighter than aluminium.

Table 1: Aluminium and Magnesium – A Comparison

	Magnesium	**Aluminium**
Melting point (◦C)	650	660
Boiling point (◦C)	1091	2470
Vapour pressure (Pa) at melting temperature	408	2.42×10^{-6}
Density of liquid phase (g/cm^3)	1.584	2.375

Magnesium

Magnesium was discovered about the same time as aluminium. Sir Humphrey Davy, the British chemist, first extracted aluminium in 1807 and identified magnesium in 1808. Faraday produced magnesium metal by electrolysis of fused anhydrous magnesium chloride in 1833. Commercial production of magnesium by electrolysis is credited to Robert Bunsen, the German scientist, who made a small laboratory cell for the electrolysis of fused magnesium chloride in 1852.

Commercial electrolytic magnesium began in Germany in 1886, using a modification of Bunsen's cell. *The Aluminium und Magnesium Frabik, Hemelingen (Germany)* designed and built a plant for the dehydration and electrolysis of molten carnallite.

The history of magnesium, from a curiosity metal to an industrial material, was greatly affected by wars. While the Germans were developing magnesium production and uses in the early 1900s, they were also spurred along by the need for magnesium in the military.

In the mid-1990s in China, a variation of the silicothermic process developed by Dr Lloyd M. Pidgeon in 1940-41 began to be used to meet almost 90% of the country's magnesium production and remains the most common production process.

Magnesium production in China was approximately 810 thousand tonnes in 2023 and China's production of primary magnesium accounted for approximately 85% of the global magnesium supply.

Magnesium production paths

- ***Hydrometallurgical processes***: Hydrochloric acid leaching to produce magnesium chloride solution, followed by thermal hydrolysis or electrolysis to produce magnesium. The electrolytic process, or hydrometallurgical process, is mainly used to produce magnesium from carnallite, salt brines and seawater. In this process, magnesium chloride ($MgCl_2$) is extracted, dried, melted and reduced in a direct current electrolytic cell to produce magnesium.

- ***Thermal reduction processes***: Mainly dolomite calcination, thermal reduction and recovery of condensed magnesium vapour. The thermal reduction method utilises a reductant such as silicon or aluminium at an elevated temperature and low pressure to extract magnesium from calcined dolomite. Currently, the majority of magnesium is produced using the Pidgeon Process, which is one of the thermal reduction methods (silicothermic reduction). Reduced carbon emissions of thermal reduction can be realised through the use of renewable energy, as well as utilising aluminothermic processes, where the ferrosilicon reductant is replaced with aluminium.

Aluminium-Magnesium Alloys

Magnesium is an essential element in aluminium alloys due to its ability to increase strength, enhance corrosion resistance and improve workability. In the context of concerns about the sustainable future, the demand for aluminium-magnesium alloys will continue to increase, especially in transportation sectors where lightweight is required.

From aerospace to electric bicycles and beyond, aluminium-magnesium alloys represent the future of sustainable and high-performance manufacturing.

The relationship between magnesium content and alloy properties can be complex. The simple explanation is that in aluminium-magnesium alloys, magnesium atoms replace some of the aluminium atoms in the crystal lattice. This substitution helps in the formation of a solid solution, which strengthens the alloy through solid-solution strengthening.

However, the presence of magnesium also affects ductility, which is the ability of the material to deform without fracturing. Typically, increasing magnesium content can lead to higher strength but lower ductility. Balancing these two properties depends on the precise control of magnesium levels during the casting and rolling of aluminium ingots.

It's used generally in two major series:

- 5xxx series: These alloys exhibit a high strength-to-weight ratio with excellent corrosion resistance and a wide range of applications
- 6xxx series: Combines magnesium and silicon for heat treatment.

Moreover, magnesium improves the corrosion resistance of aluminium, particularly in saltwater environments, making these alloys essential for marine applications.

Conclusion

There are two aspects of sustainability in metallurgy and material science:

- Sustainability of metallurgical processes and downstream processes

- Sustainability enabled through new materials/alloys for dematerialisation

From a metallurgical perspective, newly developed primary magnesium production methods can significantly increase both process and energy efficiency and, consequently, decrease carbon emissions. Aluminothermic vertical retort technology, developed as an alternative to Pidgeon technology, which relies on silicothermic reduction with a horizontal retort and which is also based on metallothermic reduction, can be exemplified as new metallurgical applications that directly address sustainability concerns.

Over the past decade, magnesium and its alloys have begun to be used in a variety of new applications, including biomedical devices, energy storage/battery products, computers, consumer electronics and communications, while also becoming increasingly common in areas requiring lightweight materials. The challenges in downstream applications that limited the use of magnesium and its alloys are gradually being overcome.

Therefore, technological advancements in the design of both new magnesium alloys and new aluminium-magnesium alloys (high-magnesium alloys), along with their subsequent application areas and the resulting increase in the variety of end products, offer a bright future for magnesium.

Source: AL Circle Blog, 23 December 2025

Essentiality of Aluminium and Other Critical Minerals in the Metals Age

The U.S. Geological Survey (USGS) has updated the critical minerals list, which now contains 60 distinct materials, representing 80 per cent of the mined items on the periodic table. Some of these include nickel, copper and zinc. Exotic metals like gadolinium, praseodymium, and ytterbium have been added under the rare earth elements. Recognised as "vital for a modern American economy," the spectrum of metals bears the potential to revolutionise their use.

The USGS comments that from aluminium to zirconium, these metals are found "essential for national security, economic stability and supply chain resilience." This reflects a subtle shift from the dogmatic tradition to a refined laboratory approach.

Aluminium as a critical mineral

Recognised as a critical mineral by the US in 2022, the EU in 2023 and the UK in 2025, aluminium has proved to be indispensable, being implemented in areas of defence, electric vehicles, frames of solar photovoltaic (PV) panels, and green energy technologies. Despite its abundance, it has drawn strategic focus on its supply chain and recycling.

In the defence sector, aluminium is used in the construction of missiles, airframes, ship hulls, UAVs, and radar systems. Its strength-to-weight ratio and corrosion resistance are massive advantages in the area. NATO lists it as an essential metal for defence supply chains.

Regarding Electric Vehicles, aluminium enables lightweight frames, battery enclosures, cooling systems, and motor housings. These enhance EV range and efficiency. Aluminium content is found more in EVs than in traditional cars by 25-27 per cent for these applications.

In solar PV Frames, aluminium comprises over 85 per cent of the mineral materials. Owing to their weather resistance, lightweight support, and recyclability, aluminium frames dominate this market. They have a long-term durability of 15-25 years, allowing for efficient rooftop installations.

In the green energy transition, aluminium powers wind electrolysers, turbines, hydroelectric plants, as well as transmission lines. The low-carbon "green" aluminium reduces emissions considerably, promoting these sustainable applications.

The newly added metals have been categorised as per their roles and functions into three different groups.

Phoenix metals

Copper and tin, two of the oldest and traditional metals, have once more proved essential to modern technology. After being replaced by plastic fibre optics and eventual decline, both have found new roles. Presently, over half of tin is used in solder for circuit boards. Copper remains the most cost-effective electrical conductor for wiring electric vehicles, charging infrastructure and power systems.

Power metals

These have proved imperative in the phasing out process of fossil fuels and checking carbon emissions. Cobalt, lithium, manganese and nickel are key elements in this procedure. Like the use in EV by Tesla, lithium and other metallic cathode components reside at the heart of batteries in EV technology, largely contributing to the global green goals.

Spice metals

Applied in tiny quantities but with seminal transformative impact, these are grouped as "spice metals." Minerals like silicon, germanium, iridium, palladium, titanium, etc. have exponential input spanning from the fields of technology to packaging. The U.S. military developed the Defence Advanced Research Projects Agency with the help of the spice metals. Super-powerful gallium nitride chips enhance radar capability and boost drone-jamming capacity.

Metals age

Metals, known and unknown, are embedded in modern technology, contributing to its smooth functioning. A US study depicts that almost 78 per cent of American weapons systems rely mainly on five critical minerals, viz., antimony, gallium, germanium, tungsten or tellurium, most of which are predominantly produced by China.

Source: AL Circle 30 December 2025

Expansion of ISP

Steel Authority of India Limited (SAIL) has awarded Danieli the contracts to supply key technologies for the IISCO Steel Plant expansion in Burnpur, West Bengal.

The project, one of the most important in the Indian steel market, will include a new blast furnace with a volume of 5,557 m^3, three slab continuous casting machines, and a state-of-the-art hot-strip mill designed primarily for coil production serving the automotive and durable goods sectors. The slab casters will produce high-quality slabs up to 250 mm thick and 2,100 mm wide, feeding the new hot-strip mill—among the three largest in India—which will deliver premium coils ranging from 1.2 to 25.4 mm in thickness.

This investment will add 4 million tons per year of steelmaking capacity, transforming the IISCO integrated steel complex into one of India's most advanced and sustainable steelworks. The expanded product portfolio will be supported by cutting-edge technologies that ensure market competitiveness and the highest safety standards.

The initiative underscores SAIL's commitment to reduce carbon footprint and technological excellence, aligning with India's growing steel demand and national sustainability goals.

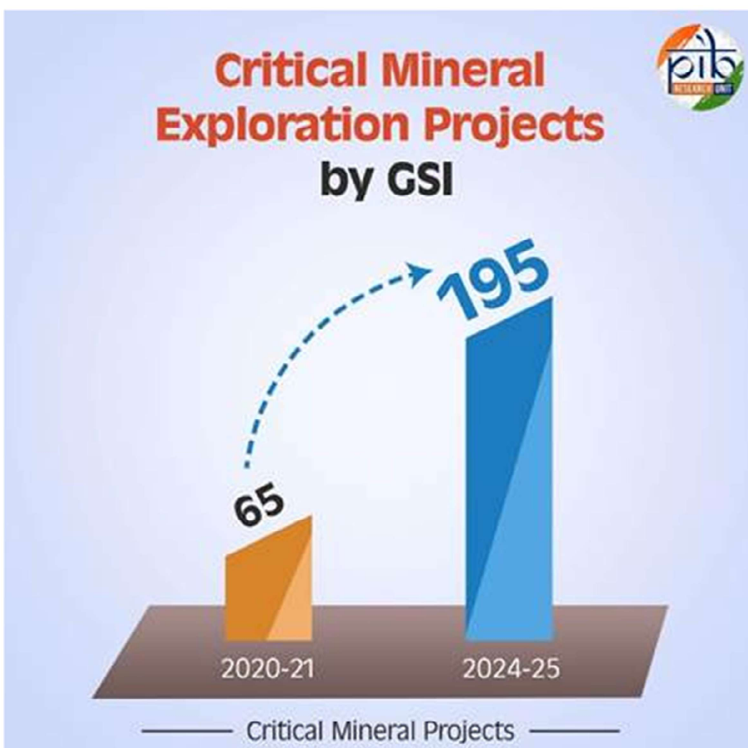
India's Critical Minerals Drive: Domestic Extraction and Aluminium's Emerging Role

As the global clean energy transition, electric vehicle boom, and digital economy accelerate, India's deep reliance on imported critical minerals is unsustainable. In an attempt to increase the domestic production of critical minerals.

Demand meets domestic potential

Government data suggests there were 3,007 mining leases in India as of March 31, 2003, excluding coal, lignite, petroleum, gas, atomic, and minor minerals. These leases spread across 23 states and Union Territories, covering 2.82 lakh hectares, which have the licence to mine 34 minerals.

Allowing all these mining blocs to extract minerals beyond what their original licence permits will enable India to generate a substantial volume of critical minerals against the background of growing demand of rare.



Why critical minerals matter?

According to the World Bank estimates, about 3 billion tonnes of critical minerals will be needed to decarbonise the global energy system by 2050. The production of minerals such as graphite, lithium and cobalt is needed to increase worldwide by nearly 500 per cent by 2050 to meet the need for clean energy. India's needs for critical minerals also include clean energy sector, particularly for solar panels, wind turbines, electric vehicles, and energy storage. Other sectors in India that demand critical minerals are electronics (semiconductors and telecommunications), defence, and food production.

- ***Clean energy transition*** - Critical minerals like silicon, tellurium, indium, and gallium are essential for the production of photovoltaic (PV) cells used in solar panels. Rare earth elements are required for permanent magnets in wind turbines. Lithium, nickel, and cobalt are vital for lithium-ion batteries used in advanced energy storage systems.

- ***National food security*** - Minerals like potash are vital for food production

- ***Defence*** - Rare Earth Elements (REEs), Gallium, and Germanium are essential for creating strong magnets used in guidance systems, advanced sensors, and semiconductors for navigation and communication.

India's imports of permanent magnets, containing rare earth elements (REEs), nearly doubled to 53,700 tonnes in 2024-25 (FY25) from around 28,700 tonnes the year earlier, with about 93 per cent of the imports coming from China. Consumption of permanent magnets has grown significantly in India over the last five financial years from just 12,400 tonnes in FY21 to 28,700 tonnes in FY24, before imports surged 88 per cent to 53,700 tonnes in FY25.

India's self-reliance efforts for rare earth minerals

India has 6 per cent of global reserves for rare earth elements to build its critical minerals foundation on. India Rare Earths Limited (IREL) has been active since 1950 and recently partnered with BARC to establish a rare earth permanent magnet facility in Visakhapatnam. IREL also commissioned its flagship mining and mineral extraction plant in Odisha in 1986 and also set up a rare earths extraction plant there, with a capacity of around 11,000 tonnes.

Alongside, private sector participation is also growing. Global commodities firm Trafalgar Group plans to set up a plant in Gujarat by 2027, eyeing to meet 20 per cent of India's demand for neodymium iron boron (NdFeB) magnets, widely used in EVs.

Untapped role of aluminium value chain

A lesser discussed but a critical angle is the role of aluminium value chain in critical mineral recovery. Interestingly, some of the critical minerals are possible to be sourced from alumina refineries. Such as Gallium, which forms a critical semiconductor with Arsenic like Gallium-Arsenide, is found in bauxite, though in ppm (parts per million). Alkali Digestion renders this mineral in soluble form in refinery and it is possible with alteration of process and process equipment to recover this critical mineral.

Red Mud, an infamously famous residue generated from alumina refineries during the processing of bauxite ore, is another important source of critical minerals such as rare earth elements (REEs), titanium, and scandium. Its composition varies depending on the bauxite ore used, but it generally contains significant amounts of iron and aluminum oxides along with valuable trace elements.

There has been no primary source of scandium deposits with concentrations over 100 ppm. Hence, secondary resources such as red mud with scandium content between 50 to 80 ppm can be considered important ore.

However, the recovery of minerals from red mud is typically challenging in terms of processing and cost. This requires scientific and engineering man powers deployment and suitable capital expenses. It is a challenge yet an imperative that such secondary sources are considered as a road map for a holistic utilisation of the bauxite residue.

Source: AL Circle Blog, 22 September 2025

Advancing India's Net-zero Plans: India-Sweden Projects Pioneer a Greener future for Steel and Cement in India

Indian companies with ambitions to build low-carbon pathways for industry are partnering with Swedish technology innovators on seven projects that will kick-start decarbonization in India's steel and cement sectors.

The projects include utilising hydrogen for rotary kilns in steel making, the recycling of steel slag for green cement, and the use of AI to support cement decarbonization.

Today, heavy industry accounts for around one-quarter of global greenhouse gas emissions and consumes approximately one-third of the world's energy. In India, the iron and steel sector is the largest industrial source of carbon emissions, contributing 10–12 per cent of the national total, while cement production adds almost 6 per cent.

As India advances towards its net-zero target by 2070, reducing emissions from these hard-to-abate sectors is essential to supporting the country's infrastructure development, industrial growth, and long-term climate ambitions.

Seven innovative projects have been selected to conduct pre-pilot feasibility studies in India under the *LeadIT industry transition partnership*, with funding from the *Indian Department of Science and Technology* and the *Swedish Energy Agency*.

The seven projects

- Tata Steel, Cemvision, IIT-ISM Dhanbad, JK Cement

Steel Slag Reborn: Dual value generation through high metallic recovery and sustainable supplementary cementitious material (SCM) production. Will create industrial symbiosis, where steel industry by-products become a resource for cement production.

- Tata Steel, IIT Hyderabad, GREEN14

Microwave plasma-assisted CO_2-conversion of blast furnace off-gas. Explores microwave plasma-assisted conversion of steel blast furnace off-gas CO_2 into carbon monoxide (CO), which can be reinjected as a reducing agent.

- IIT Bombay, Ambuja Cements Ltd, EcoTech Solutions

Feasibility study for establishing an integrated carbon capture and utilization unit at a cement industry facility.

- Ecometrix AM, Prism Johnson, Datta Meghe College of Engineering

Feasibility study for AI-based platform ACORN to optimize concrete mix designs in the RMC industry for reduced climate impact. Explores the potential of using AI for concrete recipe optimization.

- Kanthal, Swerim from Sweden, Jindal Steel and Power

Electric heating methods for future CO_2-neutral steel production. Assess concepts for electric gas heating, focusing on hydrogen and other process gases in ironmaking process, with the specific aim to reduce or eliminate CO_2 emissions.

- Metsol AB, Höganäs AB, Hoganas India Ltd. and IIT Bhubaneswar

Electrified green ironmaking pilot using rotary kiln technology. Aims to conduct a feasibility study for a pilot plant based on a novel fossil-free ironmaking process using hydrogen and an electrically heated rotary kiln.

- Captimise AB (Andritz Group), My Home Industries Pvt. Ltd. (Maha Cement)

Decarbonisation of cement production with carbon capture. Screen three carbon capture technologies – amine absorption, hot potassium carbonate, and membranes.

Leadership Group for Industry Transition (LeadIT)

LeadIT was established by the Governments of India and Sweden in 2019 to mobilize public and private sector action to drive the global industrial transition. The initiative brings together 18 countries and 28 companies committed to accelerating pathways towards an inclusive, just and equitable transition to net zero emissions from heavy industry. Stockholm Environment Institute (SEI) hosts its secretariat.

India–Sweden Industry Transition Partnership (ITP)

The Sweden–India Industry Transition Partnership (ITP) is a bilateral initiative launched in 2023 by the Governments of India and Sweden as part of the Leadership Group for Industry Transition. It aims to accelerate the decarbonization of heavy industry, particularly steel and cement, in India.

Indian and Swedish funding for projects

The Swedish Energy Agency and the Indian Department of Science and Technology (DST) launched parallel calls for proposals during the summer of 2025, to identify joint Indo-Swedish industrial transition projects for steel and cement. The calls invited companies, research institutions, and technology providers to propose collaborative solutions that could be advanced through early-stage demonstration. This announcement is a result of these coordinated calls.

Source: MRAI News Updates: 08th December, 2025

JSW Steel Starts World's First RH Ladle Rocker with Fast Vessel Exchange

JSW Vijayanagar Metallics (JVML) has commissioned a new 350-ton Ruhrstahl Heraeus (RH) unit from SMS Group.

The installation at Vijayanagar Works Steel Plant 4 in India marks the world's first operational combination of a RH Ladle Rocker with Fast Vessel Exchange (FvE).

The new 350-ton RH unit with Fast Vessel Exchange represents a step change in the production capability and grade flexibility. It integrates seamlessly into JVML Steel Plant 4 and maximises our operational efficiency, while improving safety and maintainability.

The facility enables JVML to produce various grades of high-quality steel for industries such as construction and manufacturing. The total production capacity is 3m tons per year.

RH vacuum treatment yields cleaner steel with superior mechanical properties. This technology offers clear, quantifiable benefits in terms of plant effectiveness, lifecycle costs and safety.

Source: Weekly news from Steel Times International, 18 December 2025

WSA Sustainability Indicators

Recognising the interconnected nature of sustainability challenges, the steel industry has expanded its monitoring framework from 8 to 19 indicators, providing a more comprehensive perspective on environmental, social, and governance performance. This evolution reinforces the collective drive to understand the impact more fully and to translate that understanding into measurable, lasting progress

CO_2 and GHG emissions intensity

worldsteel's CO_2 emissions reporting has now expanded scope, now greenhouse gas emissions (GHG) reporting is also included.CO_2 intensity indicators go beyond carbon dioxide (CO_2) to also cover methane (CH_4) and nitrous oxide (N_2O), as well as emissions from upstream mining activities.

These changes are implemented to better align the reporting with the GHG Protocol, ISO standards, worldsteel's own life cycle assessment (LCA) framework, and the expectations set out in SBTi guidance. They represent an important step forward in transparency and credibility.


19 worldsteel Sustainability Indicators
Economic value distributed (EVD)
Investment in new processes and products
GHG emissions intensity
Renewable energy consumption
Energy intensity
Material efficiency
Environmental management systems (EMS)
NOx emissions intensity
Dust emissions intensity
SOx emissions intensity
Fresh water withdrawal
Fresh water consumption
Lost time injury frequency rate (LTIFR)
Employee training
Women in workforce
Women on the board
Community investment
Supply chain assessment
Employee education on business ethics
Innovation & prosperity
Climate action
The circular economy
Environmental care
Safety and health
Our people
Local communities
Responsible value chains
Ethical & transparent operations
ECONOMIC
ENVIRONMENTAL
SOCIAL
GOVERNANCE
9 worldsteel sustainability topics

	Indicator	Unit	2022	2023	2024
ENVIRONMENTAL PERFORMANCE					
1a	**GHG emissions intensity**	**tonnes of CO_2e per tonne of crude steel**			**2.18**
1b	CO_2 emissions intensity	tonnes CO_2 per tonne of crude steel	1.92	1.92	1.92
2	Energy intensity	GJ per tonne of crude steel	21.01	21.30	20.95
3	Material efficiency	% of solid materials converted to products and co-products	97.60	93.14	92.79
4	Environmental management systems (EMS)	% of employees and contractors working in EMS-registered production facilities	97.19	90.82	96.08
5	**Renewable energy consumption**	**% of total energy consumption**			**1.94**
6	**SOx emissions intensity**	**kg SOx per tonne of crude steel**			**0.64**
7	**NOx emissions intensity**	**kg NOx per tonne of crude steel**			**0.66**
8	**Dust emissions intensity**	**kg PM per tonne of crude steel**			**0.32**
9	**Fresh water withdrawal**	**m^3 per tonne of crude steel**			**8.50**
10	**Fresh water consumption**	**m^3 per tonne of crude steel**			**2.30**
SOCIAL PERFORMANCE					
11	Lost time injury frequency rate (LTIFR)	injuries per million hours worked	0.85	0.76	0.72
12	Employee training	training days per employee	8.22	8.98	6.77
13	**Women in workforce**	**% of total employees**			**11.44**
14	**Women on the board**	**% of total board members**			**14.06**
15	**Community investment**	**% of revenue**			**0.08**
ECONOMIC PERFORMANCE					
16	Investment in new processes and products	% of revenue	6.37	7.27	8.31
17	Economic value distributed (EVD)	% of revenue	96.57	98.83	100.68
GOVERNANCE PERFORMANCE					
18	**Supply chain assessment**	**% of total active input-material suppliers**			**79.72**
19	**Employee education on business ethics**	**% of total employees**			**88.07**

The Indicators highlighted in bold are new in 2024.

Impact on reported data

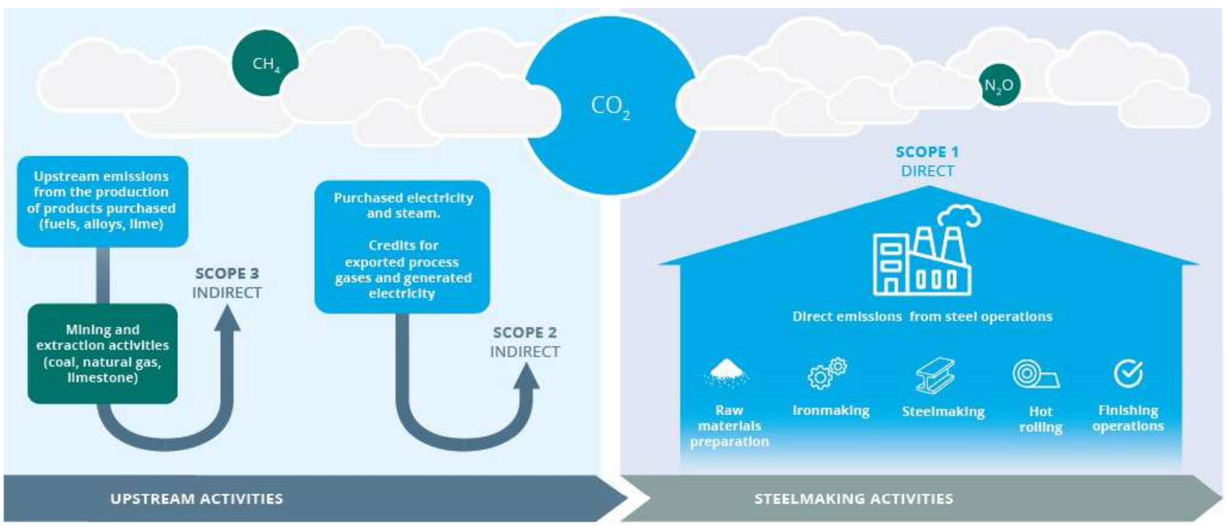
The effect of these improvements is that reported emissions per tonne of steel is higher. This is not an actual increase in emissions, but a reflection of the improved accounting approach and increased coverage. Importantly, applying these revised factors across the entire time series does not alter the industry's long-term trajectory. Historical performance trend remains unchanged.

GHG emission intensity in 2024

	BF-BOF (Scrap use ~ 10%)	Scrap-EAF (Scrap use >70%)	DRI-EAF (Scrap use <30%)	Global
Original indicator	2.34	0.69	1.47	1.92
Direct CH_4 and N_2O (GWP 100)	0.09	<0.01	<0.01	-
Upstream mining CO_2 only	<0.01	<0.01	0.01	-
Upstream mining CH_4 and N_2O (GWP 100)	0.23	0.03	0.18	-
Expanded indicator	2.66	0.71	1.66	2.18

Expanded indicator vs original indicator

Key: Original indicator Expanded indicator



Transportation and downstream activities are not included in our scope 3 calculation.

Source: World Steel Association- Sustainability performance of the steel industry

Aluminium Dross Processing

The global aluminium industry stands at a critical juncture where efficiency, sustainability, and resource recovery are shaping new business priorities. As per recent business market research, the aluminium sector — formed of primary aluminium smelters, secondary aluminium facilities, and downstream processing plants — generated an estimated 4.78 million tonnes of dross in 2024.

The growing concern for sustainability and environment-friendliness has intrigued the aluminium industry to think of dross recovery and reutilisation. A by-product formed during the melting and processing of aluminium is called dross. When the metal is in a molten state and undergoes oxidation, a skin-like layer appears on the surface, known as dross.

Earlier, aluminium dross used to be disposed of in landfills, but the practice proved hazardous to the environment. Furthermore, the industry would also lose valuable aluminium content and other elements in the dross by doing so. All these factors have led to profound research and development for aluminium dross processing and rescuing valuable metal from the by-product.

Till today, about 30-40% of dross generation, especially from the secondary aluminium sector, continues to end up in landfills. But extensive research and technological advancements point to significant improvement in the future. Immense research is also undergoing to reduce the amount of dross generation from both the primary and secondary aluminium sectors.

What is aluminium dross, and why is its processing important for the aluminium industry?

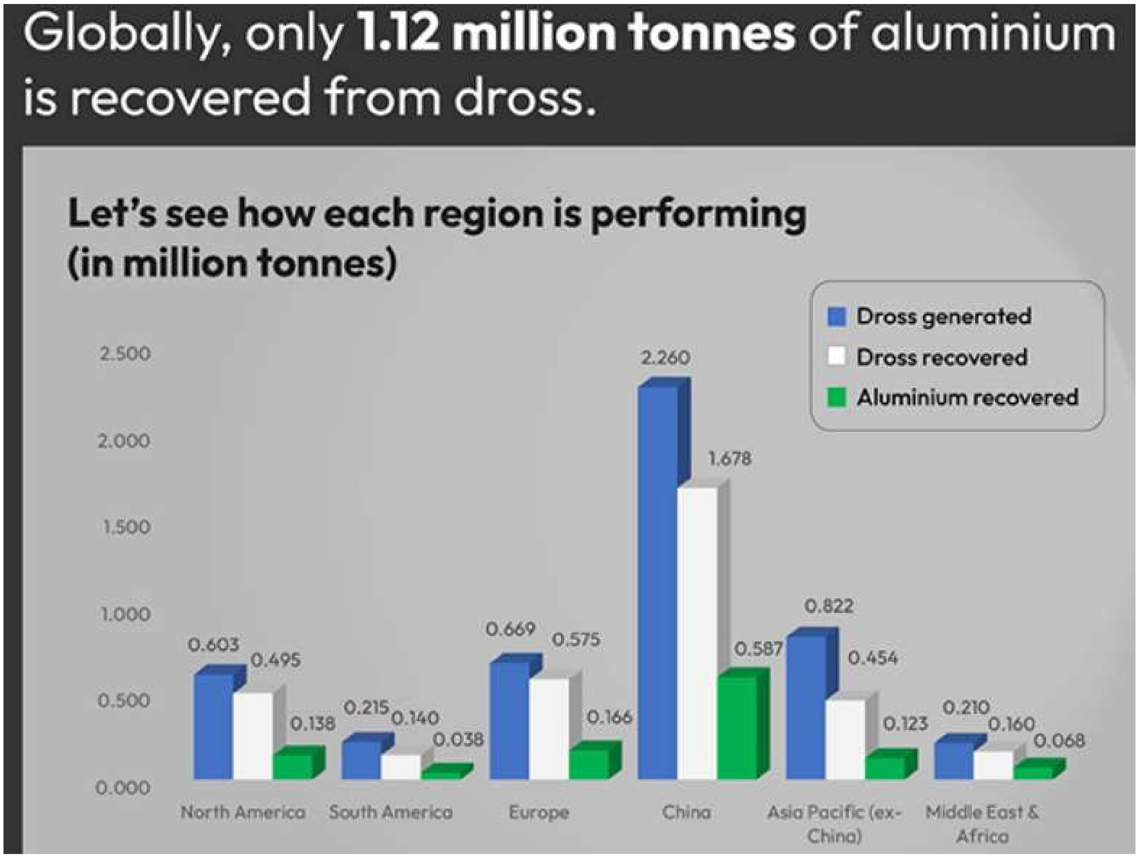
Aluminium dross is a by-product generated during the melting and processing of aluminium metal. It contains valuable aluminium along with oxides and salts. Proper aluminium dross processing is crucial because it enables the recovery of metal that would otherwise be lost to landfills. With modern aluminium dross recycling technologies, over 85-95% of aluminium can now be recovered, making dross processing a key step in achieving zero waste and circular economy goals in the aluminium industry.

How much aluminium dross is generated globally, and which sectors contribute the most?

In 2024, global aluminium dross generation was estimated to be more than 4 million tonnes, with the secondary aluminium sector contributing the largest share, with more than 50%, followed by downstream and primary sectors. The Asia Pacific region, including China, accounts for over 55% of global dross production, highlighting a major concentration of opportunities for dross recycling and recovery technologies in these regions.

Which regions lead in aluminium dross generation and recovery?

As of 2024, China leads the world in aluminium dross generation, accounting for around 50% of the global total, followed by the rest of Asia Pacific, Europe, and North America. The recycled aluminium sector is the largest contributor, generating nearly 3 million tonnes of dross. While China leads in generation, developed regions like Europe and North America show higher recovery rates, driven by strict environmental regulations and advanced dross recycling infrastructure.



What are the top aluminium dross processing technologies available today?

Key technologies include PyroGenesis' DROSRITE™, a salt-free, on-site processing solution; TAHA's two-stage dross recovery system; ALTEK's tilting rotary furnaces and AluSalt™ salt slag treatment; and Hydrova's DrossZero™ technology for total waste conversion. These systems enable high-efficiency aluminium recovery, reduce hazardous residues, and support zero landfill targets, making them essential for aluminium producers seeking sustainable dross management solutions.

What are the emerging uses of processed aluminium dross in industrial applications?

Processed aluminium dross is increasingly used in construction materials, such as cement additives and concrete fillers, offering improved strength and durability. It also finds application in refractory materials, steelmaking deoxidizers, and advanced ceramics. Notably, ongoing R&D is exploring dross use in energy storage devices like lithium-ion batteries, expanding its role in the green technology sector.

Some of the recent developments in reducing dross generation

- Reducing oxidation in furnace and during transportation and reducing the iron contamination prior to remelting process
- In-Furnace Dross Processing (IFDP) in skimming squeezes dross in the furnace. releasing liquid aluminium remained in the bath, increasing recoveries.
- Drain plates used for a precise positioning of the dross cake and repeated until the furnace is completely de-drossed.

AL Circle 09 December 2025

Endothermic Approach to Dross Valorisation

Green aluminium production based on scrap melting is now essential in the aluminium market. Melting contaminated scrap can present quality, environmental and yield issues. The dross generated in recycling process is contaminated with carbon and tends to burn, even violently. This is a safety, environmental and economic problem. Thermised dross has virtually no value, because the dross combustion ends with the almost complete oxidation of the aluminium contained in it. In conclusion, preventing the ignition of the dross or stopping its thermisation brings multiple benefits.

The oxidation of aluminium is a highly exothermic reaction, meaning it occurs with a significant release of heat; it can be considered a "combustion" in which aluminium acts as a fuel. The idea is to use that heat to boost reactions that, from an energetic perspective, move in the opposite direction; these are "endothermic" reactions, which occur by absorbing energy. In this way, it is possible, within certain limits, to limit the temperature rise of the dross, preventing combustion from self-powering in an uncontrolled way.

This idea has resulted in several chemical formulations based on substances capable of endothermic reactions. Two categories of fluxes based on the this principle have been developed:

- fluxes that limit the ignition of dross inside the furnace; and
- fluxes that stop the underway combustion of dross outside the furnace.

The first category is produced in the form of small tablets; the second category in powder form.

The reasons behind the adoption of two different forms for the two families of fluxes are as follows:

- Small tablets are chemically more stable than granulates and powders, and therefore, the endothermic reaction can take place in the furnace for a longer time.
- The powder shape provides the best covering power. Flux is loaded into the furnace along with the scrap; the This product forms a stable and homogeneous layer that isolates the dross from oxygen and, at the same time, reacts endothermically (and without emitting irritating fumes), leading to rapid quenching and cooling of the dross within a few hours.

In conclusion, this type of fluxes acts as a fire extinguisher, an additional safety for the operators who treat the dross.

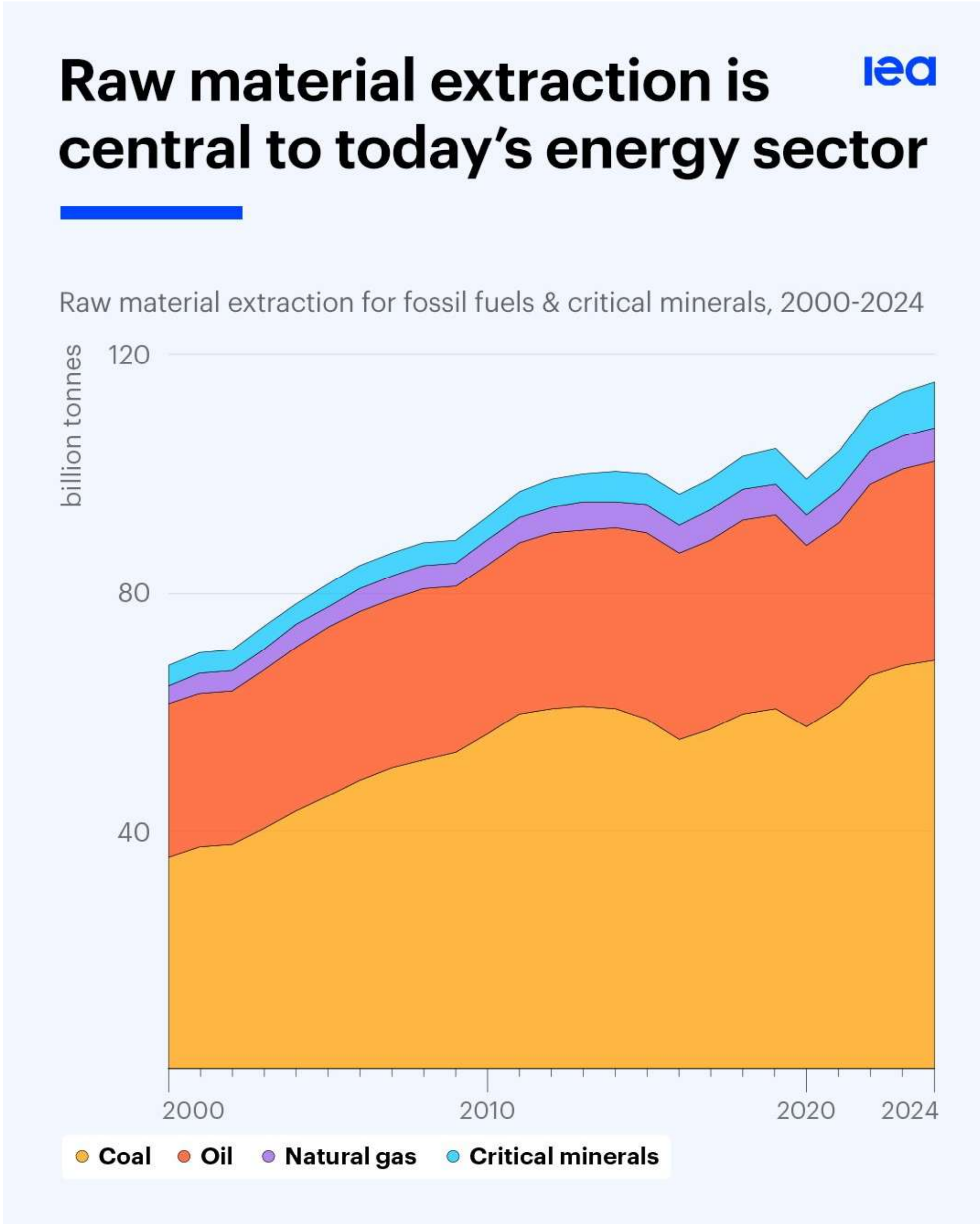
Source: AL Circle 09 December 2025

Over 115 billion tonnes of Raw Materials Related to the Production of Fossil Fuels and Critical Minerals were Extracted from the Earth Last Year

Meeting the world's demand for energy today means extracting vast amounts of material from the ground to produce key fuels and technologies.

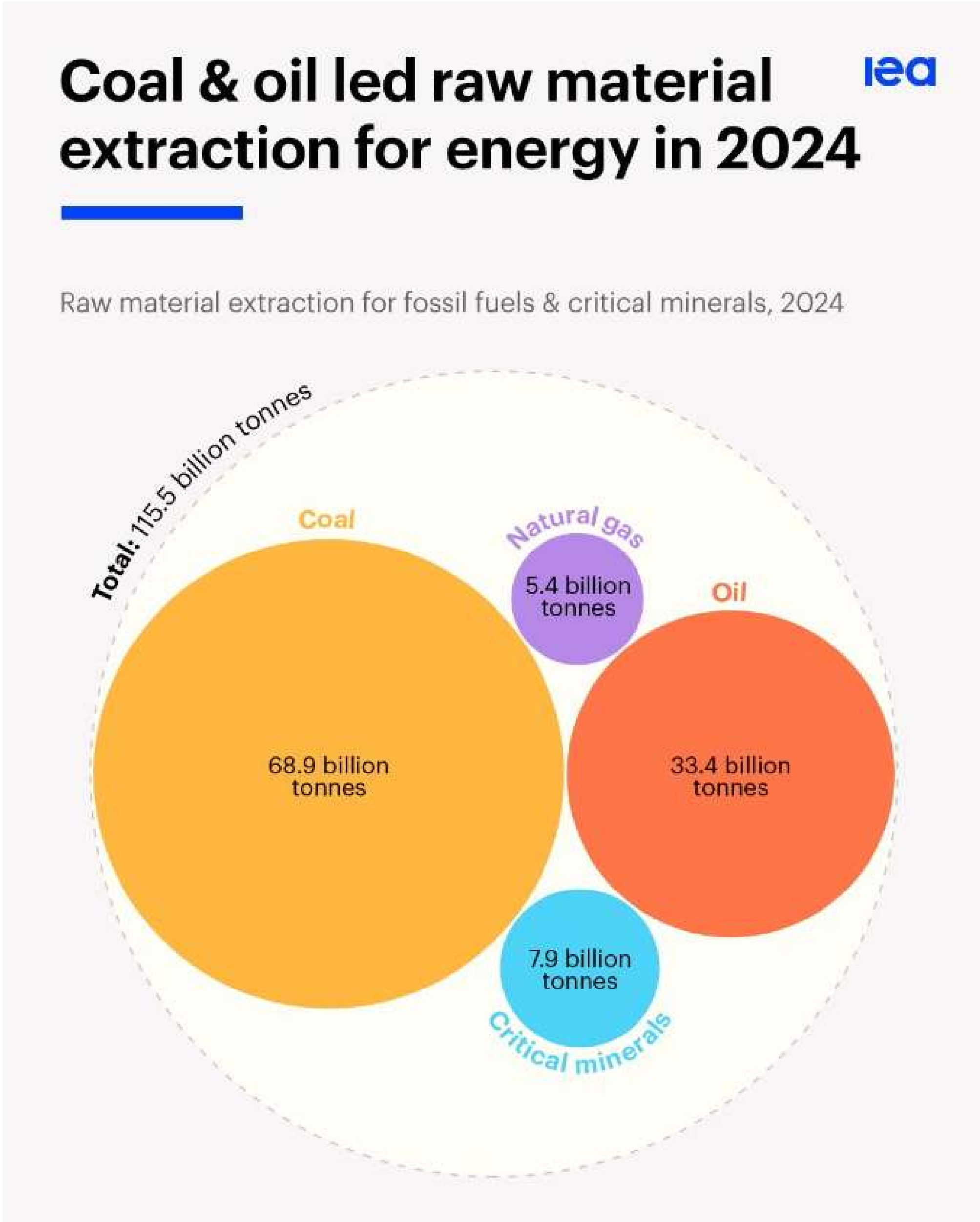
New IEA analysis of the energy system's material footprint states that over 115 billion tonnes of raw materials related to the production of fossil fuels and critical minerals were extracted from the earth last year – with coal production accounting for more than half of the total.

Huge quantities of materials like rock, water and mud are unearthed in the process of obtaining useful energy-related products – such as a barrel of crude oil, or a truckload of lithium to be refined for batteries. In fact, of the more than 115 billion tonnes of raw materials extracted last year, only around 17 billion tonnes ended up as useful energy system products.



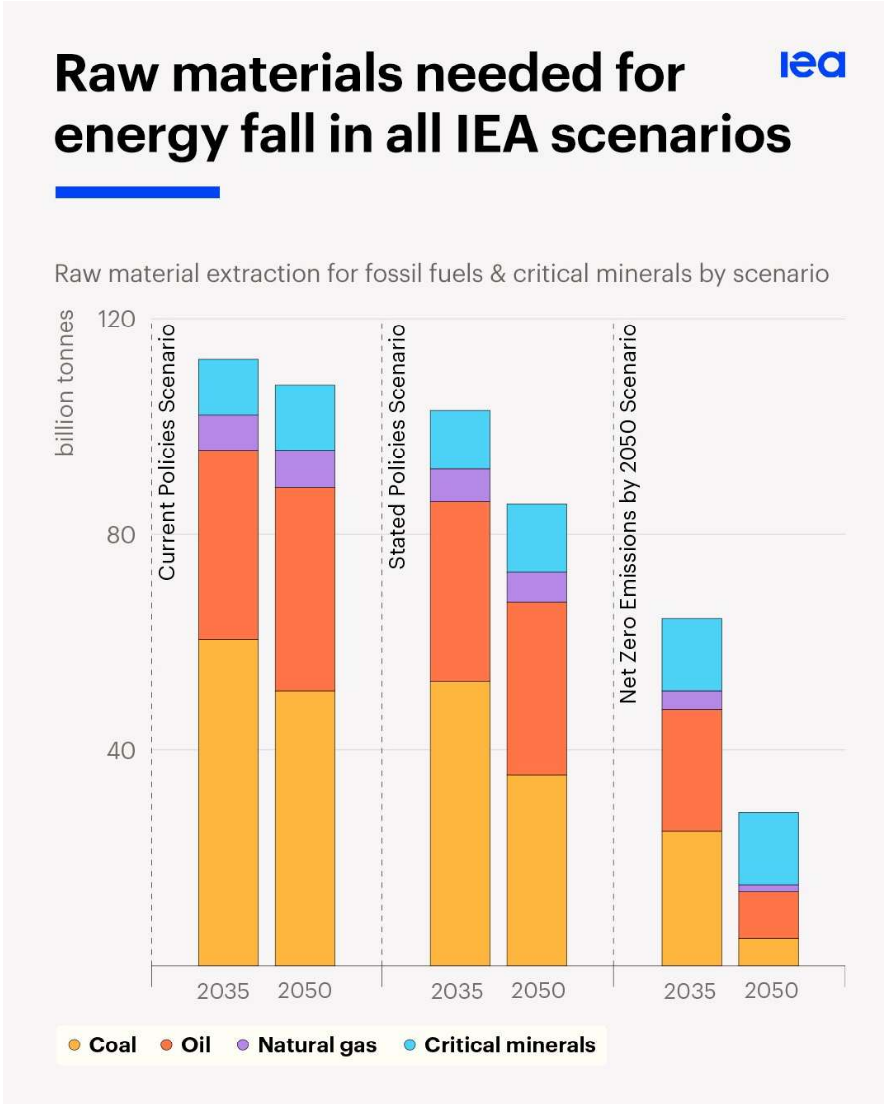
For every tonne of coal produced, around 7 tonnes of material (mostly rock and water) are extracted. A tonne of oil comes with nearly 6 tonnes of water and other byproducts. And for critical minerals – which are key to energy technologies such as electric vehicles, power grids, solar panels and wind turbines – every tonne of usable material means, on average, digging up and sifting out more than 100 tonnes of residue.

Much less material is usually involved in gas extraction. Less than 1 tonne of water and drilling waste is typically extracted for each tonne of natural gas.



In all the scenarios in this year's World Energy Outlook, which explores a range of possible futures for the global energy system, raw material extraction for energy products declines by mid-century. This is largely due to projected declines in coal mining of varying degrees.

Despite increasing use of critical minerals, the reduction in the extraction of raw materials is most pronounced in the scenario that sees the world achieving net zero energy sector emissions by 2050.



Source: IEA ***World Energy Outlook 2025***

Steel Trade and Anti-Dumping Duties

India recently imposed anti-dumping duty on some steel products. Tapan is trying to figure out if the duties serve a purpose and what is the need for continuous intervention by the government, in a conversation with friend Lohith.

Tapan: The tariff spillover continues with India imposing an anti-dumping duty on certain steel products. I guess free trade is losing to protectionism. But as you track steel sector, can you explain why this was required.

Lohith: Let me start with a stark fact. India is the world's second largest steel producer at 150 mtpa. Despite this, India has been a net importer of steel. This is because China manufactures a gigantic 1,000 mtpa of steel a year, six times the second largest.

On top this, China exports 100 mtpa of steel every year and at a steep discount to local products. With such overbearing presence, a normal trade flow will decimate local steel manufacturing in any country, which essentially is the reason for trade barriers.

Tapan: They must really like their steel in China. Are they really good at it?

Lohith: Steel manufacturing is simple. Any region will have to work with iron and coal to produce steel.

This establishes a base line for cost. Yes, scale can lower the cost but only to an extent. Steel production cost is more or less comparable across regions.

But you are making a critical assumption that China profits from steel trade. Forget making a profit, experts believe China barely recovers the variable cost from the prices at which it is selling the steel.

Against the selling price of $500 per tonne, the coal cost of $250-280 per tonne, iron ore cost of $100-110 per tonne alongside power, logistics, processing, labour, interest and other costs, it is difficult to imagine a profit.

China's central planning is willing to take a hit in one sector-steel, to support several other sectors.

Infrastructure, automobiles and energy transition benefit from the cheap steel and sectors associated with steel: transportation, mining, power generation. The employment and economic multiplier benefit makes it loss win deal.

Tapan: Sounds sneaky, loss in steel to support other industries. But, why shouldn't other countries do the same at China's expense. Benefit the same industries domestically, but at the cost of losses in China's steel industry.

Lohith: The straight answer: steel industry is central to any economy and must be protected. To safeguard domestic steel capacity US, Europe, Japan and every other consumer including India do resort to such barriers, and at the moment, these are at the highest.

But, if you read between the lines, countries do analyse the cost benefit and react. In India, for instance, you can pick steel industry comments requesting for duties in

2010s or in 2020s or more recently. The safeguard duties and anti-dumping duties are imposed by the government not immediately but only after careful consideration. Meanwhile, the same set of domestic companies, construction, infra and autos, continue to benefit.

Tapan: Who says you can't have your cake and eat it too? Like, stepping in only before the (steel) mould breaks to balance the domestic industry.

Lohith: Yes, but there is only so much manoeuvring that is possible. Trade barriers cannot be isolated decisions. Imagine the US putting up a trade barrier to Chinese steel. This will divert all the excess to Europe, India or Japan. These countries will then be forced to put up a trade barrier or face a deluge of cheap imports.

Tapan: The only way out seems to be a cut in Chinese steel capacity.

Lohith: That is hope against hope. But for Indian steel manufacturers, this signals an arrest of steel price decline, a support level at which the government is willing to intervene and a confidence to continue with the current expansion programmes. Overall, Indian steel industry will welcome this move even if they are expecting more of such actions.

Source: The Hindu Businessline, 27th December 2025

Technical Talk on "Aluminium Recycling"

A technical talk on **"Aluminium Recycling"** was delivered at IIM Delhi Chapter's premises on 3.1.2026 by Shri R K Vijayavergia, Past Chairman IIM Delhi Chapter and Former Executive Director (Operations), SAIL.

Aluminium Recycling is the process of recovering scrap Aluminium and converting it into reusable metal. Aluminium is 100% recyclable. Various types of aluminium scraps and difficulties in sourcing of domestic scrap and also the challenges in importing aluminium scrap were discussed.

Shri Vijayavergia stated that India is the world's second largest producer of Aluminium. About 6% of the global output of prime Aluminium comes from India. Production capacity of Aluminium in India has more than tripled during the last two decades.

India’s Aluminium consumption is mainly by Power, Transport, Building and Construction sectors. India’s per capita consumption of Aluminium is about 3.9 kg, compared to global average of 11 kg.

Generation and industrial utilization of Aluminium Dross, a byproduct of Aluminium melting process, and various processing technologies for Aluminium dross were touched upon.

Process flow of a small-scale Aluminium Recycling Unit was deliberated in details, including inspection and quality control of Aluminium products.

Rapid population and economic growth over the coming decades will push global aluminium demand to double by 2050, with 50-60 per cent of that demand expected to be met by recycled metal.

The Aluminium Recycling industry is making impressive growth in India. Innovation and responsible practices in Aluminium Recycling can create a more circular and environmentally friendly economy for reducing carbon emissions.

There was a lively discussion during and also at the end of the Talk. Particularly the members who were from Aluminium industry and also those associated with Aluminium Recycling industry actively participated in the discussions.

A memento was presented to Shri R K Vijayavergia as a token of appreciation.

Know Your Members

Dr Suresh Neelakantan

Academic Background

- B.E. (Metallurgical Engineering)
  Govt. College of Engineering, Salem, University of Madras
- M.Sc. (Engg.–Metallurgy), *Indian Institute of Science, Bangalore*
- Ph.D. (Materials Science and Engineering)
  Delft University of Technology (TU Delft), Delft, The Netherlands

Experience and Expertise

Dr. Suresh Neelakantan is currently working as an Associate Professor at the Department of Materials Science and Engineering, IIT Delhi. Prior to joining IIT Delhi in 2016, he worked as a post-doctoral research associate at Department of Engineering, University of Cambridge, UK.

With 20 plus years of research experience, Dr. Suresh Neelakantan's research expertise/interest is broadly on "Mechanical behaviour of advanced metallic materials in bulk and porous forms". Within that, his current research is focused on i) *in situ* phase transformation effect on deformation behaviour in β Titanium alloys and shape memory alloys for various structural applications; and ii) structure-property correlations in high entropy alloys and smart metallic materials such as Ti-, Ni- and Fe- based shape memory alloys, stochastic fibre networks, auxetic (i.e. negative Poisson's ratio) materials for structural and biological applications, including medical implants. Till date, he had successfully graduated 7 Ph. D., 1 MSR and 11 M. Tech. students. He has published about 65 research publications in peer-reviewed international journals and proceedings. He holds about 2 patents, including one on Dental Splints jointly with AIIMS, New Delhi. He has successfully completed eight sponsored and 20 industrial/consultancy projects. He is currently handling 6 sponsored projects (funded mainly by SERB, DRDO, DST and MoTA) in the role of both Principal Investigator and Co-Principal Investigator.

Dr. Suresh Neelakantan's primary teaching interest is in the core topics of metallurgical/ materials engineering. He has received 'Teaching Excellence Award' at IIT Delhi in recognition of his contribution to teaching.

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