



IIM

Metallurgy
Materials Engineering
The Indian Institute of Metals-Delhi Chapter

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Chairman's Message

I am grateful to the members of Delhi Chapter of The Indian Institute of Metals for reposing faith once again and giving me the responsibility of the Chairmanship of Delhi Chapter. I convey my sincere thanks to all the esteemed members of the Delhi Chapter for reposing trust in me to discharge the responsibilities for one more year.

The Chapter has been very active in the past few years in organizing technical events. The Chapter organized, in February 2026, the second edition of International Minerals and Metals Summit 2026 (IMMS 2026) with well-known Conference Organizing Firm – DIIA Event Solutions. The third edition is planned to be held sometimes in February 2027.

Delhi Chapter is privileged to have excellent infrastructural facilities. We have an excellent Lecture Hall and Board Room. These facilities must be made use of by our members for organising technical programmes. Besides this, we have a good library. These facilities have to be extensively used.

It is my earnest belief that Delhi Chapter has still not reached its full potential of technical excellence. I would request each member of the Executive Committee to initiate at least one technical activity in 2026-27 so that this Chapter is able to further enhance its professional and technical potential.

I look forward to support and contribution of members of the Chapter to undertake the professional activities further. I have no doubt that with the cooperation of all of us, the Chapter will attain new heights.

Manoranjan Ram
Chairman
IIM Delhi Chapter

AGM of IIM Delhi Chapter

74th Annual General Meeting of the IIM Delhi Chapter was held on 30th May 2026 at Maple Room of Indian Habitat Centre.

Shri KR Krishnakumar Hon. Secretary, presented the Annual Report of the Chapter for the year 2025-26. Subsequently, audited accounts of the Chapter for the year 2025-26 were presented by Shri R K Narang, Hon Treasurer, which were unanimously approved. Executive Committee for 2026-27 was finalized and approved in the meeting.



Rare Earth Elements

Rare earths underpin a wide range of technologies, from electric vehicles and AI data centres to robotics, aerospace and defence systems. Demand for rare earths has grown sharply in recent years, mostly due to the growing deployment across sectors of high-performance permanent magnets.

Yet the production of rare earths is hugely concentrated geographically – including for neodymium, praseodymium, dysprosium and terbium, which are used in these magnets. Today, China accounts for around 60% of global mined production of these elements – and its share of refining for them is above 90%. The country also accounts for almost 95% of permanent magnet production.

Rare earth elements have rapidly moved to the forefront of the policy agenda in recent years. Their critical role in strategic applications, ranging from energy technologies and advanced electronics to aerospace and defence systems, combined with highly concentrated supply chains, has elevated their importance in both energy and broader economic security discussions.

What makes rare earth elements critical? Rare earth elements are a set of 17 elements, comprising 15 metallic elements from the lanthanide series and scandium and yttrium. Many of these elements are often found together in known deposits. Though relatively plentiful in the Earth's crust, they have garnered the label "rare" because economically viable concentrations are uncommon and they are seldom found in pure form. Their chemical similarities make them hard to separate during the extraction process, but their different physical and magnetic properties give individual rare earth elements distinct value for various technological applications in their isolated forms. Based on their atomic weight, rare earth elements are usually classified into:

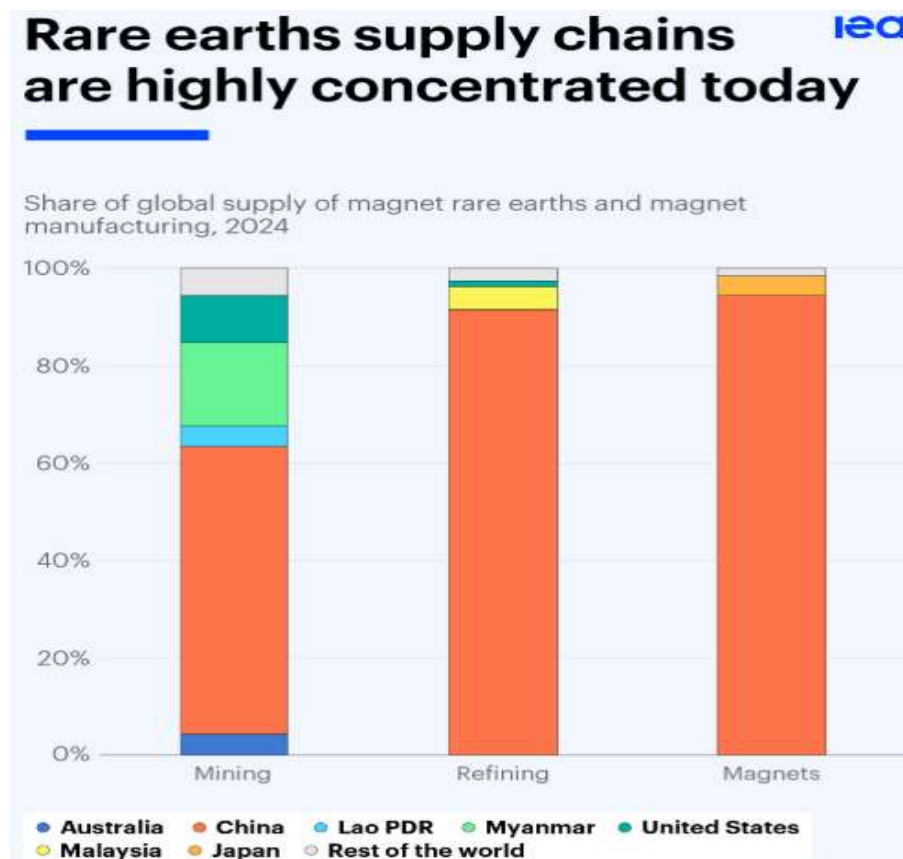
- Light rare earths (LREEs) such as lanthanum, cerium, praseodymium, neodymium, samarium and europium; and
- Heavy rare earths (HREEs) such as gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, lutetium, scandium and yttrium.

Since their discovery, these elements have found applications across the breadth of modern economies – from glass and fibre optics to permanent magnets, ceramics, phosphors, pigments, catalysts, lasers, medical and dental equipment (magnetic resonance imaging [MRI], computed tomography scan [CT], X-ray, pacemakers), to sensors and defence and aerospace equipment.

A single application that is reshaping the industry is their use in permanent magnets. Magnets containing four rare earths, neodymium, praseodymium,

dysprosium and terbium, known as high-performance neodymium-iron-boron (NdFeB magnets), are among the strongest permanent magnets in the industry, able to withstand temperatures as high as 230 °C. A permanent magnet is a material that produces its own magnetic field indefinitely without the need for an external electric current to maintain its poles. Neodymium and dysprosium can handle a greater saturation magnetisation than more common magnetic elements such as iron, which allows for fabrication of stronger and smaller magnets. Rare earth-based permanent magnets play a very important role in the energy sector, owing to their use in automotive traction motors for conventional cars and electric vehicles (EVs) as well as in wind turbine motors. Their importance, however, extends well beyond the energy sector. They are also essential across the broader economy, with applications in industrial motors, household appliances, artificial intelligence and data centres, aerospace, and defence systems. Electric motors and generators based on rare earth permanent magnets represent the most energy-efficient devices developed so far, leading to energy savings of about 20-40% compared with ordinary motors.

In the case of EVs, the addition of small quantities of magnet rare earth elements in a motor can boost efficiency, thereby dramatically reducing the requirements for other critical minerals needed in the battery to power the EV. In the example of wind turbines, the use of permanent magnets makes it possible to eliminate gearboxes, which are among the most frequent sources of mechanical failure.



Rare earth elements play a crucial role in a wide range of strategic applications, from energy, transport and artificial intelligence (AI) technologies to aerospace, medical and defence systems. The wide range of applications, combined with highly concentrated supply chains, has elevated their importance in both energy and broader economic security discussions. Though relatively plentiful in the Earth's crust, this set of 17 elements have garnered the label "rare" because economically viable concentrations are uncommon and they are seldom found in pure form. Their chemical similarities make them hard to separate during the extraction process, but their different physical and magnetic properties give individual rare earth elements distinct value for various technological applications.

Permanent magnets represent the fastest-growing and most strategically important applications, accounting for around 95% of total rare earth consumption by value. High-performance neodymium-iron-boron (NdFeB magnets) – primarily composed of neodymium and praseodymium, often with dysprosium and terbium as performance-enhancing additives – are among the strongest permanent magnets in the industry. These magnets underpin a wide range of critical technologies, including electric vehicles (EVs), wind turbines, industrial motors and AI data centres, as well as medical, aerospace and defence applications.

Demand for magnet rare earth elements (neodymium, praseodymium, dysprosium and terbium) has doubled since 2015 and is set to expand further by a third by 2030 under today's policy settings, thanks to growing electrification and the rapid deployment of new energy technologies such as EVs and wind turbines. Growth in automation, robotics and digital technologies plays an increasing role in driving demand beyond 2030, as permanent magnets enable precision motion control, miniaturisation and energy efficiency improvement for these applications.

The supply of magnet rare earths remains among the most geographically concentrated of all critical minerals. The rare earth value chain spans a series of technically demanding stages, each adding distinct value as materials move from geological deposits to refined products and permanent magnets. These stages include extraction, beneficiation, chemical upgrading, separation into oxides, metal refining, alloying and magnet manufacturing. After extraction, ores are crushed and milled to liberate minerals, which are then concentrated. Separation – the technical core of processing – converts mixed rare earth feeds into individual oxides. Refined oxides are then transformed into metals, and then into alloy powders, the primary inputs for magnet production.

Among the strategic minerals analysed by the International Energy Agency (IEA), rare earths exhibit one of the highest levels of geographical concentrations across the

value chain. In 2024, the People's Republic of China (hereafter, "China") accounted for 60% of global mined production of magnet rare earths. For refining, the level of concentration is more pronounced, as the country represented 91% of global refined output. Its share is even higher for permanent magnet production. In 2005, China accounted for around 50% of the production of sintered permanent magnets, but its share expanded significantly to reach 94% in 2024. China's extensive magnet production activity generates substantial economies of scale and provides a strong and stable demand base for upstream raw materials.

Source: International Energy Agency (IEA) Report on "Rare Earth Elements: Pathways to secure and diversified supply chains"

***worldsteel* Short Range Outlook for 2026 and 2027**

The World Steel Association (*worldsteel*) released its Short Range Outlook (SRO) steel demand forecast for 2026 and 2027. *worldsteel* forecasts that global demand will grow by 0.3% in 2026 to reach 1,724 Mt, followed by an accelerated growth of 2.2% in 2027 to reach 1,762 Mt.

The outlook for 2027 is more robust, with growth forecast to rebound to 5.1%. This resurgence will be fuelled by sustained momentum in developing Asia and Africa, complemented by an anticipated recovery in the Middle East.

India maintains its position as the world's fastest-growing major steel market, with demand projected to expand by 7.4% in 2026 and accelerate to 9.2% in 2027.

Table 1. Steel Demand Forecasts
SRO April 2026, finished steel products

Regions	million tonnes			y-o-y growth rates, %		
	2025	2026 (f)	2027 (f)	2025	2026 (f)	2027 (f)
European Union (27) & United Kingdom	144.9	146.7	151.2	3.8	1.3	3.0
Other Europe	46.8	48.8	49.1	3.3	4.4	0.5
Russia & other CIS + Ukraine	53.6	53.5	54.5	-9.5	-0.1	1.7
USMCA	128.4	131.1	134.1	-1.0	2.1	2.2
Central and South America	50.5	49.8	50.8	7.8	-1.3	2.0
Africa	45.0	46.7	48.8	10.4	3.8	4.6
Middle East	61.8	57.3	62.2	3.8	-7.4	8.6
Asia and Oceania	1 187.2	1 190.1	1 211.4	-3.5	0.2	1.8
World	1 718.2	1 724.1	1 762.0	-1.9	0.3	2.2
World excl. China	922.2	940.1	977.9	3.1	1.9	4.0
Developed Economies	348.8	352.5	360.5	0.2	1.0	2.3
China	796.0	784.1	784.1	-7.1	-1.5	0.0
India	159.8	171.6	187.4	8.0	7.4	9.2
Em. and Dev. Economies excl. China & India	413.6	415.9	430.0	3.8	0.6	3.4
ASEAN (5)	86.5	87.7	89.8	10.2	1.3	2.4
MENA	80.2	76.6	82.4	5.2	-4.5	7.7

f - forecast

ASEAN (5): Indonesia, Malaysia, Philippines, Thailand, Viet Nam

This robust outlook is underpinned by broad-based strength across all key steel-consuming sectors. Growth is primarily driven by sustained, infrastructure-led construction and a thriving automotive sector fueled by increasing freight demand.

Furthermore, a resilient capital expenditure cycle continues to bolster demand for capital goods, while nationwide rail network expansion and an affordability-driven surge in consumer durables provide additional structural tailwinds.

Table 2. Top 10 Steel Using Countries 2025

SRO April 2026, finished steel products

Countries	million tonnes			y-o-y growth rates, %		
	2025	2026 (f)	2027 (f)	2025	2026 (f)	2027 (f)
China	796.0	784.1	784.1	-7.1	-1.5	0.0
India	159.8	171.6	187.4	8.0	7.4	9.2
United States	90.9	92.4	94.3	2.0	1.7	2.0
Japan	48.0	47.9	48.7	-3.4	-0.1	1.7
South Korea	43.6	43.7	44.2	-8.8	0.3	1.1
Türkiye	39.3	41.2	41.2	2.6	5.0	0.0
Russia	37.6	37.2	37.6	-14.0	-1.0	1.0
Germany	29.2	30.7	32.5	10.3	5.1	6.0
Viet Nam	28.8	29.4	29.9	12.0	2.0	2.0
Brazil	26.8	27.0	27.7	2.6	1.0	2.5

f - forecast

Source: World Steel Association (*worldsteel*), 14 April 2026

worldsteel 2026 Steel Sustainability Champions

The World Steel Association (*worldsteel*) has recognised 14 companies as Steel Sustainability Champions for their work in 2025.

Now in its ninth year, the Steel Sustainability Champions Programme commends those *worldsteel* members that are most clearly demonstrating their commitment and action to sustainable development through their involvement in *worldsteel* sustainability activities.

The 2026 Steel Sustainability Champions are:

- ArcelorMittal
- China Steel Corporation (CSC)
- EMSTEEL
- Gerdau S.A.
- HBIS Group Co., Ltd.
- HYUNDAI Steel Company
- InfraBuild
- JFE Steel Corporation
- Jingye Group

- JSW Steel Limited
- POSCO Holdings
- Tata Steel
- Tenaris
- Ternium

Recognised for the ninth consecutive year this year, Tata Steel and Tenaris have been Champions every year since the programme launch in 2018. In the programme's first year, *worldsteel* recognised only six members. There is a steady increase in the number of members qualifying for most demanding sustainability recognition.

All members must do the following to be recognised as Sustainability Champions:

- Be recognised as members of the *worldsteel* Sustainability Charter. Provide evidence of meeting the 20 criteria covering the fields of environment, social, governance and economics (ESGE).
- Provide Life Cycle Inventory (LCI) data to *worldsteel's* Data Collection Programme. The data for LCI should cover more than 60% of the company's crude steel production and should be less than 5 years old.
- Be shortlisted in one of the 6 categories of the *worldsteel* Steelie Awards or be recognised in the *worldsteel* Safety and Health Recognition Programme.

Source: World Steel Association (worldsteel) 14 April 2026

Understanding Aluminium Alloys

Aluminium alloys are named and grouped so you can tell what they're made of and how they behave. Each alloy gets a number that shows its basic composition and purpose. This helps engineers, fabricators and buyers understand what the metal does and how it compares to others.

The number system covers a range of materials, from highly pure aluminium (99%+) in the 1xxx series to high-strength alloys used in aerospace, such as those in the 7xxx series. Knowing this system makes it easier to talk about alloys and choose the right one for particular application.

What are Aluminium Alloys?

Aluminium is a versatile, lightweight metal commonly used across many industries. Pure aluminium, however, isn't always strong enough for demanding applications. This is where aluminium alloys come in. By adding other elements like copper, magnesium and silicon, manufacturers can improve the metal's properties to suit specific needs.

Aluminium alloys are classified into series based on their primary alloying elements, which are selected to enhance specific properties like strength, corrosion resistance, or formability. Each series offers a unique combination of properties, making it easier to choose the right material for specific applications.

Properties and Applications of 1xxx to 8xxx Series Aluminium Alloys

1xxx Series: Pure Aluminium

The 1xxx series alloys are made from at least 99% pure aluminium. These are known for their excellent conductivity and resistance to corrosion, making them ideal for applications where these properties are essential.

Properties: High thermal and electrical conductivity, excellent corrosion resistance, good workability and low strength.

Popular Alloys:

- 1050: Used primarily for electrical conductors like wires and cables.
- 1100: Common in chemical equipment, food processing and decorative applications.

Applications:

- Electrical conductors (wires, cables)
- Food and chemical containers
- Architectural materials (roofing, cladding)

2xxx Series: Aluminium-Copper Alloys

The 2xxx series alloys are alloyed with copper, offering high strength for aerospace and military applications. However, they are more susceptible to corrosion and often require protective coatings or anodising.

Properties: High strength, good machinability, lower corrosion resistance than other series and heat treatable.

Popular Alloys:

- 2024: Known for its high strength-to-weight ratio, commonly used in aircraft structures.
- 2011: Popular for precision machining applications.

Applications:

- Aircraft components (wing structures, fuselage)
- Military parts (missile casings)
- Automotive parts requiring high strength

3xxx Series: Aluminium-Manganese Alloys

The 3xxx series alloys are known for their good corrosion resistance, particularly in general atmospheric and mild marine environments. However, they are not as resistant as the 5xxx series in saltwater but offer good formability and weldability.

Properties: Excellent corrosion resistance, especially in marine environments, good formability, moderate strength.

Popular Alloys:

- 3003: Used in roofing, siding and cooking utensils.
- 3105: Commonly found in residential siding and mobile homes.

Applications:

- Roofing and siding
- Cookware
- Heat exchangers

4xxx Series: Aluminium-Silicon Alloys

The 4xxx series alloys are chosen for their low melting points and good wear resistance. Due to their silicon content, this alloy is ideal for casting applications where fluidity and easy shaping are of utmost importance.

Properties: Low melting point, good wear resistance, excellent casting ability and easy machinability.

Popular Alloys:

- 4045: Frequently used in automotive heat exchangers.
- 4032: Commonly used for engine components like pistons and cylinder heads.

Applications:

- Engine components (pistons, engine blocks)
- Welding wire
- Heat exchangers in automotive and industrial applications

5xxx Series: Aluminium-Magnesium Alloys

The 5xxx series alloys are highly resistant to corrosion, especially in saltwater environments. This makes them popular for marine and automotive applications.

Properties: Exceptional corrosion resistance, good strength, good weldability.

Popular Alloys:

- 5052: Known for excellent corrosion resistance, used in marine environments.
- 5083: Often used in shipbuilding and pressure vessels due to its superior strength.

Applications:

- Marine equipment (boats, ships)
- Automotive components (fuel tanks, bumpers)
- Pressure vessels

6xxx Series: Aluminium-Magnesium-Silicon Alloys

The 6xxx series alloys are the most versatile, combining good strength, formability and excellent corrosion resistance. These alloys are widely used in structural applications.

Properties: Excellent balance of strength, formability and corrosion resistance.

Popular Alloys:

- 6061: Commonly used in structural and industrial applications.
- 6063: Primarily used in architectural applications like window frames.

Applications:

- Structural applications (bridges, buildings)
- Automotive (frames, parts)
- Aerospace (aircraft fuselage)

7xxx Series: Aluminium-Zinc Alloys

The 7xxx series alloys provide the highest strength of all aluminium alloys, making them ideal for aerospace and military uses. These alloys can be heat-treated to improve strength.

Properties: Very high strength, lower corrosion resistance, heat treatable.

Popular Alloys:

- 7075: Known for its high strength, widely used in aerospace and military applications.
- 7050: A choice for aerospace parts requiring strength and good corrosion resistance.

Applications:

- Aerospace parts (aircraft wings, fuselage)
- Military equipment (missile bodies, rocket casings)
- Sporting goods (bicycles, skis)

8xxx Series: Miscellaneous Alloys

The 8xxx series includes various alloys designed for specific applications, often with a combination of elements not found in other series.

Properties: Designed for niche applications with unique combinations of elements.

Popular Alloys:

- 8006: Used primarily in food packaging, particularly aluminium foil.
- 8090: A high-strength, lightweight alloy used in aerospace.

Applications:

- Packaging (aluminium foil)
- Electrical cables

- Aerospace (lightweight structural components)

Unwrought Aluminium Alloys Naming System

The four-digit aluminium alloy number system provides detailed information about the alloy's composition, its primary or dominant alloying elements and its sequence of modifications within the series.

The First Number: This indicates the primary alloying element group the alloy belongs to. Each number corresponds to a particular element:

- 1 = Pure aluminium
- 2 = Aluminium-copper alloys
- 3 = Aluminium-manganese alloys
- 4 = Aluminium-silicon alloys
- 5 = Aluminium-magnesium alloys
- 6 = Aluminium-magnesium-silicon alloys
- 7 = Aluminium-zinc alloys
- 8 = Miscellaneous alloys (with various elements)

For example, in 5183, the "5" tells you that magnesium is the primary alloying element.

The Second Number: This represents the modification number of the alloy within that specific alloy group. It shows how many times the base alloy has been modified or improved.

In 5183, the "1" indicates that it is the first modification of the base alloy, which was originally 5083.

The Last Two Digits: These indicate the sequence in which the alloy was created within its series. The last two digits are typically used to show the order of development for alloys within that series.

In 5183, the "83" refers to the 83rd modification or version of the original alloy.

So, 5183 means:

- It's part of the 5xxx series (magnesium alloys),
- The "1" shows it's the first modification of 5083 and
- The "83" signifies the sequence in which it was developed within the 5xxx series.

Note: Unlike other series, the 1xxx series alloys (pure aluminium) have a unique numbering system where the last two digits indicate the minimum aluminium content percentage, rather than the modification number.

For example, 1350 means 99.50% minimum aluminium, while 1100 typically contains 99% aluminium.

Wrought vs Cast Aluminium Alloys: What's the Difference?

Aluminium alloys are broadly grouped as wrought or cast based on how they are processed.

- Wrought alloys are mechanically worked (rolled, extruded, forged, drawn, etc.). They are usually designated with four-digit numbers (like 6061 or 7075) and are selected where strength, formability and durability are needed.
- Cast alloys are produced by pouring molten metal into moulds. They use a three-digit-plus-decimal designation system (e.g., 356.0). Cast alloys are chosen for parts with complex shapes, such as automotive housings, cylinder heads, pump bodies and structural castings.

Cast Aluminium Alloy Series & Principal Alloying Element

<i>Alloy Series</i>	<i>Alloying Element</i>
1xx.x	99.000% minimum Aluminum
2xx.x	Copper
3xx.x	Silicon Plus Copper and/or Magnesium
4xx.x	Silicon
5xx.x	Magnesium
6xx.x	Unused Series
7xx.x	Zinc
8xx.x	Tin
9xx.x	Other Elements

Cast Aluminium Alloys Naming System

For cast alloys, the alloy numbering system follows a three-digit-plus-decimal format (e.g., 356.0). Here's what it means:

First digit: Indicates the primary alloying element added to the aluminium (e.g., silicon, copper, magnesium).

Second and third digits: These are arbitrary numbers used to identify a specific alloy within that series.

Decimal point: The number after the decimal tells you if it's a casting or ingot:

- .0: Indicates a final shape casting.
- .1 or .2: Indicates an ingot.

Capital letter prefix: Shows a modification of a specific alloy in the series.

For example, A356.0:

- A: Indicates a specific process or treatment applied to the base alloy 356.0
- 3: Silicon plus copper and/or magnesium alloy series

- 56: Identifies the alloy within the 3xx.x series
- .0: Indicates it's a casting, not an ingot

This system helps classify cast alloys more specifically, identifying not only the alloy but also its modification and the form it takes.

Why Understanding These Alloys Matters

Choosing the right aluminium alloy can make a huge difference in your project's success. Whether you're building aircraft wings or designing kitchen appliances, understanding the characteristics of each alloy is essential. Each series offers different strengths, corrosion resistance and workability, making it easier to pick the perfect material.

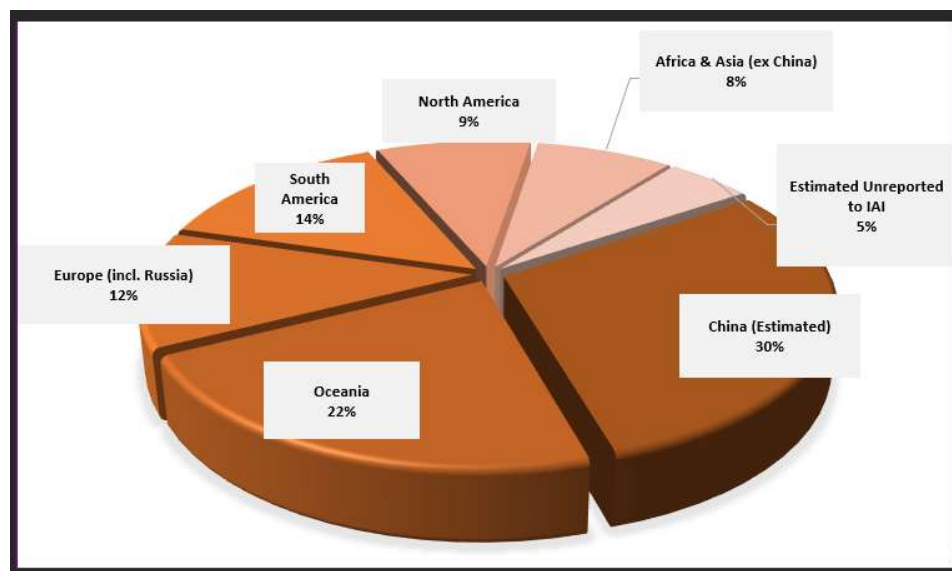
Conclusions

Aluminium alloys are classified into series based on the metals added to aluminium. Whether you're looking for lightweight, corrosion-resistant materials or high-strength alloys, the 1xxx to 8xxx series offers a wide range of options. Knowing which alloy to choose can help ensure your project is both efficient and durable.

Source: AL CIRCLE. 27 March 2026

Red Mud: Environmental Liability or Strategic Resource

As global alumina refining accelerates, from expansion and new addition projects in India, China, Indonesia, the Middle East and a few other regions, a parallel curve is quietly steepening: the rise of red mud.



Red mud generation by region (1974-2023)

Also known as bauxite residue, red mud is the unavoidable by-product of the Bayer process used to refine bauxite into alumina. Red mud generation is estimated as 1.25 tonne generated for 1 tonne of alumina produced.

The challenge is no longer local. It is structural.

The scale of the problem

Red mud contains iron oxides (giving it its red colour), along with alumina, silica, titania, and residual caustic soda. Its high pH and fine particle size make storage complex and environmentally sensitive. Historically, residue has been stored in large impoundments or dry stacks, solutions that manage risk but do not eliminate it.

As refining capacity expands to meet growing aluminium demand from energy transition sectors, EVs, renewables, and infrastructure, the red mud question becomes strategic. The industry is at a tipping point: continue to store, or start to valorise.

Forward-looking economies are choosing the latter.

From waste to resource: A shift in mindset

Red mud is not just waste. It is a secondary resource waiting for a viable business model.

Globally, three utilisation pathways are gaining traction:

- ***Cement and construction materials***

Red mud's iron and alumina content make it a candidate for clinker production and supplementary cementitious materials. Pilot projects in China and India have demonstrated partial substitution in cement and bricks. Scale, however, will depend on logistics integration. Refineries must co-locate or partner with cement plants to reduce transport cost, a key barrier to commercial viability.

- ***Metal recovery (Iron, Rare Earths, Scandium)***

With iron content ranging between 30-60%, red mud can serve as a low-grade iron ore substitute. More strategically, it contains trace rare earth elements and scandium, critical for aerospace alloys and clean energy technologies.

Countries like Australia are investing in extraction technologies to unlock scandium from residue streams. If commercially scaled, red mud could become part of the critical minerals value chain.

Economics can improve when recovery is integrated at the refinery stage rather than treated as a downstream waste-mining activity.

- *Carbon capture and environmental applications*

Emerging research shows red mud can absorb CO₂ through mineral carbonation, reducing alkalinity while sequestering carbon. It can also be processed into materials for wastewater treatment and soil remediation.

Linking residue utilisation with decarbonisation credits could unlock new financing models under ESG frameworks.

What must change?

To move from pilots to mainstream, three intelligent interventions are required:

- *Policy signal*

Mandate minimum utilisation targets for bauxite residue, similar to recycled content mandates in metals. Policy certainty drives investment.

- *Innovation clusters*

Create industrial ecosystems where refineries, cement producers, steel plants, and research institutions collaborate. Red mud valorisation is a systems challenge, not a single-company solution.

- *Economic reframing*

Shift accounting treatment, from “waste management cost ” to “strategic secondary resource inventory.” This mindset changes capital allocation decisions.

The future: Liability or leverage?

The aluminium industry positions itself as a cornerstone of the energy transition. Yet its upstream footprint must align with that narrative.

Red mud is the industry’s credibility test.

If treated passively, it will remain a growing environmental burden. If treated strategically, it can become a source of critical minerals, construction inputs, and carbon solutions.

The world is watching. The question is not whether red mud will grow, it will. The real question is whether the industry grows its imagination alongside it.

Source: AL CIRCLE BLOG, February 24, 2026

Indian Steelmakers Must Match Ambition with Action on Decarbonisation

There’s a widening gap between the headline climate commitments made by India’s major steel companies and their actual progress in building the operational,

technological, and financial infrastructure required to meet their decarbonisation ambitions.

While global peers have achieved reductions, emissions intensity for most Indian steel companies has worsened over the last three years despite ambitious targets, exposing a credibility gap between stated commitments and actual performance.

Progress is slowest in financial alignment. From a sample of seven Indian steel producers and three global peers, no company scored above 43%, indicating that capital allocation and alignment decisions across the sector have not kept up with stated climate strategies.

Indian companies are showing meaningful proactiveness despite the absence of effective carbon pricing or large-scale public financial support. Nonetheless, international experience confirms that the economics of green steel will not work without coordinated government intervention, making the Green Steel Mission and targeted fiscal instruments essential to converting corporate intent into execution.

With a looming spike in blast furnace capacity due for relining before 2030, and over two-thirds of planned additions employing conventional, emissions-intensive technology, every year of deferred action deepens carbon lock-in and narrows the window for cost-effective technology substitution.

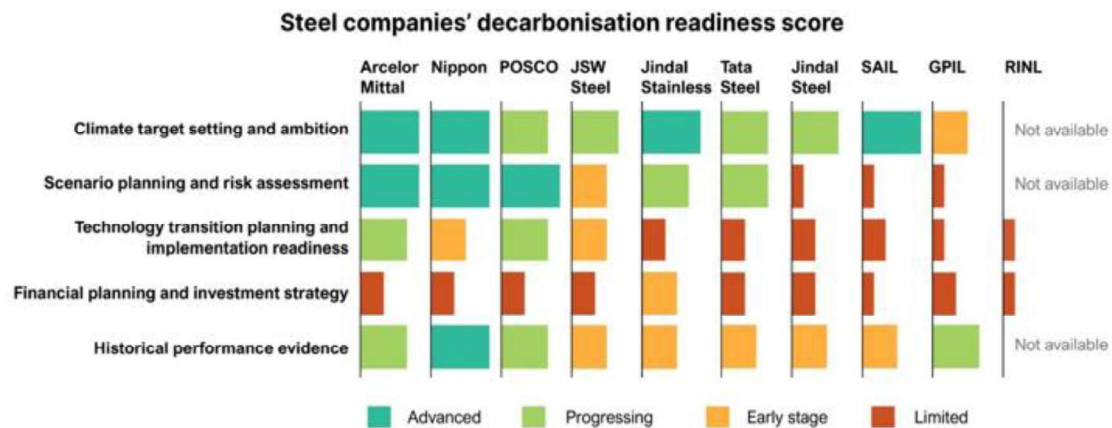
A widening gap between Indian steel companies' stated decarbonisation targets and their concrete actions to achieve them risks locking in emissions-intensive technologies for decades, slowing their progress to net zero, and undermining the sector's long-term competitiveness.

Indian steel sector has embraced climate targets that align with the Paris Agreement. However, this ambition is not matched by corresponding progress in building the operational, technological, and financial infrastructure required. Moreover, the sector faces a critical timeframe over the next decade, in which decisions by companies, investors and government will determine the prospects for steel decarbonisation in India.

India is the world's second-largest steel producer, but while demand has plateaued or is declining among other major steel-producing regions, in India the sector is on a steep growth curve. Therefore, the choices Indian companies make in the next few years will have profound implications for global steel sector emissions trajectories through mid-century.

Decarbonisation readiness of a sample of ten steel producers has been evaluated — seven Indian and three global peers — assessing the connection between their stated emission reduction targets and their actions in terms of strategic planning,

operational capabilities, and financial alignment. The Indian companies assessed include JSW Steel, Tata Steel, Steel Authority of India Limited (SAIL), Jindal Steel, Rashtriya Ispat Nigam Limited (RINL), Jindal Stainless Limited, and Godawari Power and Ispat Limited (GPIL), while the global companies are ArcelorMittal, POSCO, and Nippon Steel.



The findings indicate that climate ambition has outpaced implementation. Five of the seven Indian companies have adopted Paris-aligned net-zero targets for 2050, but they scored comparatively poorly across the five key parameters assessed. In addition, emissions intensity for most Indian steel companies has worsened over the last three years, at a time when global peers have achieved reductions.

Companies have set targets, and technology planning is advancing among the leaders, but capital allocation has not moved. Meanwhile, emissions are heading in the wrong direction, and that problem is set to worsen as the sector grows unless technology substitution accelerates.

Steel companies' decarbonisation readiness score

A blast furnace (BF) typically operates for 20–25 years, with each relining extending its lifespan by another 15–20 years. In India, around 43 million tonnes per annum (MTPA) of existing BF capacity is due for relining before 2030, which would allow these furnaces to continue operating for an additional 15–20 years. Extending and expanding these technologies will lock in emissions for decades, undermining decarbonisation targets. This in turn will expose Indian companies to tightening international controls such as carbon border adjustments, green procurement mandates, and investor pressure for credible transition plans.

Overcoming these issues will require coordinated government action. The roughly USD24 billion (INR2.25 lakh crore) investments globally in steel decarbonisation to date have been overwhelmingly enabled by public capital, underscoring a basic reality: The economics of green steel do not yet work without substantial public

support. For India, targeted public capital deployment through instruments such as credit guarantee facilities, competitive contracts for difference, and green public procurement mandates will be needed to shift the risk-reward calculus for producers and unlock private investment at scale.

The steel sector's transition will ultimately be determined not by the targets companies announce, but by the investments they make and the assets they build. On that measure, the sector in India has considerable ground to cover.

Source: IEEFA Friday Week in Review, 28 April 2026

Decarbonisation Pathway of the Aluminium Industry

The importance of aluminium for the global energy transition is undeniable, yet the fact remains that its production is one of the most carbon-intensive processes in the industrial sector. According to the International Aluminium Institute (2023), the aluminium value chain accounts for roughly *3 per cent of global direct industrial carbon emissions*. Primary aluminium production, which involves three key stages, is the main contributor to this footprint. On average, each tonne of primary aluminium emits about 14.8 tonnes of carbon dioxide equivalent (CO₂e). When the emissions profile is broken down across the production chain, bauxite mining contributes around 0.1 tonnes of CO₂e per tonne of aluminium, alumina refining adds approximately 2.6 tonnes, and the primary smelting process accounts for *14-15 tonnes of CO₂e*. This stark carbon intensity presents a structural challenge for an industry that is simultaneously positioned as a cornerstone of a low-carbon economy.

As a result, the sector is increasingly focused on deep decarbonisation pathways, with industry-wide targets aiming to reduce emissions intensity to around *11.5 tonnes of CO₂e per tonne of aluminium by 2030* and ultimately to as low as 0.5 tonnes by 2050. The key question is how these ambitious reduction targets can realistically be achieved while meeting the rapidly rising global demand for aluminium.

Advanced technologies: Inert anode and carbon capture & storage

While the world is wondering how to achieve decarbonisation in the aluminium industry, technologies like Inert Anode and Carbon Capture & Storage are quietly playing their key roles. Inert anode technology is a breakthrough process that replaces traditional consumable carbon anodes with non-consumable, inert materials. It releases oxygen as a byproduct instead of CO₂, eliminating direct greenhouse gas emissions from the smelting process.

RUSAL, recently, has commissioned the first industrial electrolyser using inert anodes. The company that has been decarbonising its aluminium production by integrating renewable energy and recycled metal has made another step of progress by embracing inert anode technology. The new unit is designed to replace the most widely used smelting technology in Russia, demonstrating a practical pathway to decarbonise existing production infrastructure. With this launch, RUSAL becomes the first company globally to move inert anode technology from industrial trials into commercial implementation.

For every tonne of aluminium produced using this technology, approximately 900 kilogrammes of oxygen are released into the atmosphere, eliminating direct greenhouse gas emissions from the smelting process itself.

For RUSAL, the technology has already moved beyond pilot stage. Since 2017, RUSAL has systematically advanced inert anode electrolysis, producing approximately 6,000 tonnes of commercial-grade aluminium (A7, or P1020) and demonstrating consistent process stability and product quality. RUSAL's low-carbon brand ALLOW INERTA - aluminium produced with inert anode technology - has already been supplied to customers across multiple industries.

With global policies in place aimed at tightening requirements on embedded carbon emissions, access to such materials becomes critical. Aluminium made with inert anode technology enables RUSAL to help customers meet the most stringent regulatory standards and position their own products as leaders in the low-carbon transition.

Like RUSAL, Alcoa and Rio Tinto through their joint venture have also brought forth their widely cited inert anode initiative, which is already in operation since late 2025. In November, Alcoa and Rio Tinto together launched the 450 kA commercial-size inert anode cell at Rio Tinto smelter in Alma (Québec). However, the exact volume of the metal being produced and shipped from this new cell has not been disclosed.

Iceland-based Arctus Aluminium in collaboration with local industrial partners like Nordural is also actively developing its own inert anode smelting approach focused on *Vertical Electrode Cell (VEC)* technology with vertical inert anodes and low-temperature electrolyte operation. Germany's TRIMET Aluminium is also one of them involved in inert anode development in collaboration with Icelandic partners, aiming to commercialise in Europe by around 2030

Among the advanced technologies, carbon capture has become another crucial system in the decarbonisation of aluminium production. RUSAL has brought Russia's first *industrial carbon capture, utilisation, and storage (CCUS) project*, which

captures CO₂ using a closed-loop water circulation system to prevent its release into the atmosphere. Over the next decade, this initiative is expected to eliminate 1.8 million tonnes of CO₂ equivalent emissions. This achievement is a key element of RUSAL's broader strategy to reduce its carbon footprint and implement climate-resilient technologies.

Other technologies available in the market are HalZero, a proprietary technology from Hydro that uses a closed loop recycling system for carbon and chlorine to eliminate CO₂ emissions from smelting. Then there's Mechanical Vapour Recompression, which employs electricity to boost the pressure and temperature of waste steam, offering a highly efficient alternative to fossil fuel boilers in refining.

Not to forget, there are advanced recycling technologies and innovation in sorting and removing impurities for higher volume of recycled aluminium.

Recycling and the role of recycled aluminium

Recycling and incorporating recycled aluminium is a proven solution to significantly reduce carbon emissions, as it consumes 3 to 5 per cent of the energy needed for primary metal production. Furthermore, about 80 to 95 per cent of greenhouse gas emissions can be reduced at aluminium recycling compared to primary metal production. This means, instead of 15 tonnes of CO₂e generated from one million tonne of primary aluminium, *only 0.52 tonnes of CO₂e are emitted per tonne of recycled aluminium*. Some of the notable recycled aluminium brands are owned by Hydro, Novelis, EGA, Alcoa, and Capral Aluminium.

Owing to the 75 per cent post-consumer scrap content, Hydro's recycled aluminium boasts a carbon footprint as low as *1.9 kg CO₂e per kg of aluminium*. Also, with some variants containing up to 100 per cent recycled aluminium, have a carbon footprint below 0.5 kg CO₂e per kg of aluminium. Alcoa's recycled aluminium contains at least 50 per cent of recycled content, while ALBA's, available in four variants, come with 15 per cent, 20 per cent, 30 per cent, and 50 per cent, recycled aluminium content, respectively. ALBA also offers recycled aluminium that generates net-zero to up to 4 tonnes of CO₂e per tonne of aluminium. Capral's recycled aluminium generates less than 8 kg and 4 kg CO₂e per kg of aluminium, respectively, made from a mix of post-consumer scrap and low-carbon primary aluminium.

These companies' initiatives towards producing recycled aluminium do not end here. Novelis has pledged to incorporate 75 per cent of recycled content in its products by 2030 and has launched the "3x30" vision to advance circular solutions, while Alcoa is developing the ASTRAEA process to purify post-consumer scrap, allowing lower-grade scrap to be used in high-end applications.

While global aluminium majors have advanced their recycled aluminium capabilities, RUSAL has taken a distinct technological lead in this space. The company has developed an electrolysis-based process to produce high-quality aluminium directly from scrap, including off-grade materials with higher impurity levels. This approach enables the conversion of lower-quality scrap into metal of P1020 grade, in addition to achieving low carbon footprint as this technology boasts high energy efficiency with about 9 *MWh of energy* consumed to produce one tonne of aluminium from scrap.

Recycled aluminium mixed with primary aluminium produced from renewable energy is another practice towards decarbonisation, followed by EGA. The company offers aluminium containing both recycled metal as well as primary produced from renewable energy.

Renewable energy in decarbonisation

Talking about the usage of renewable energy in producing aluminium reminds of RUSAL, which carries out 90 to 98 per cent of aluminium production with the use of renewable power. RUSAL's low-carbon aluminium brand ALLOW offers the metal produced using hydropower energy, *with a footprint below 4 tonnes of CO₂e* (Scope 1 and 2).

Primary aluminium industry can reduce carbon footprint by 60 to 75.5 per cent with the usage of renewable energy as a source of power, albeit subject to baseline energy mix and specific production technologies used. Electricity consumption is the single largest contributor to aluminium's carbon footprint, accounting for approximately 70 per cent of total emissions globally. Coal-fired aluminium production typically generates round 12.7 to 20 tonnes of CO₂e per tonne of aluminium. In contrast, with the use of renewable energy, such as hydropower or wind, carbon footprint remains between 4 and 5 tonnes of CO₂e per tonne of aluminium.

Even in the United States and Europe, aluminium is produced predominantly with the use of hydropower, which is why the industry in those countries has carbon footprint of about five tonnes of CO₂ per tonne. Aluminium produced by Century Aluminum uses 100 per cent renewable energy, sources being hydro and geothermal, *generating below 4 tonnes of CO₂ per tonne of aluminium*.

There are companies that are even exploring beyond local green grids by planning to set up production complexes powered by renewable energy. For instance, AM Green in India has entered into an agreement with Mitsui & Co. to explore investment options for constructing a green aluminium complex with capacity 1 million tonnes per year. The complex will have an aluminium smelter and alumina refinery powered by renewable wind and solar backed up by pumped hydro storage. This

could be the first fully-integrated renewable energy aluminium plants globally. Rio Tinto in partnership with AMG Metals and Materials and NALCO are also planning to build integrated aluminium capacity. NALCO is actively installing captive wind and solar capacity to cut emissions at facilities.

Given India's rapidly growing electrical sector, RUSAL has particularly developed innovative, high-performance aluminium-scandium wire rod that offers higher strength and durability than other aluminium alloys, without compromising electrical conductivity. This product brings the discussion full circle that aluminium is central to energy transition while its production demands decarbonisation. This product of RUSAL reflects that dual reality – engineered for electrical infrastructure and produced using more than 99 per cent renewable energy.

The market fundamentals support this direction. In 2024, the global electrical sector drove strong aluminium demand, accounting for *16.3 per cent of total consumption*. This trend is driven by large-scale investments in energy infrastructure and clean energy, with global investments exceeding USD 2 trillion.

Overall, while the aluminium industry faces significant challenges in reducing its carbon footprint, the combination of recycling, renewable energy, and technological advancements such as inert anode and carbon capture presents a promising path toward achieving the sector's decarbonisation goals.

Source: AL CIRCLE, 11 December 2025

Rare Earth Magnet Production in India

India is planning to increase its domestic production of rare earth permanent magnets, like lithium, with a target of reaching 5,000 tonnes by 2030. The idea is to reduce dependence on imports and slowly build a stronger base for critical minerals within the country.

At the moment, demand is around 4,000 tonnes, but that number is expected to rise quite a bit. Some estimates suggest it could go up to nearly 8,000 tonnes by 2030.

To get things moving, a pilot project for *neodymium-iron-boron* magnets has already been started. At the same time, a *samarium-cobalt* magnet plant in Visakhapatnam is now operational, with an initial capacity of 500 tonnes per year. The scale-up is expected to happen in steps. First to around 2,000 tonnes, and then eventually reaching 5,000 tonnes by 2030, according to the Department of Atomic Energy.

On the exploration side, lithium is also getting attention. Work has already begun in Rajasthan's Degana region, and similar efforts are happening in the Reasi district of Jammu & Kashmir.

Materials like lithium and rare earth elements are becoming more important across a range of industries: electric vehicles, renewable energy, electronics, defence, aerospace, even space. As these sectors grow, especially with the shift towards cleaner energy, demand for these materials is only going to increase.

Apart from that, rare earth corridors have been identified in states such as Tamil Nadu, Odisha, Andhra Pradesh and Kerala. The aim here is to strengthen processing and also make sure more value addition happens within the country instead of outside.

Source: AL Circle Monthly Newsletter 04 April 2026

Types of Aluminium Scrap and their Sources

Aluminium is the second most recycled metal in the world. More than one-third of aluminium comes from scrap. It can be recycled and reused 100%. Nearly 75% of the 1.5 billion tonnes of aluminium produced are still in use.

Here is a list of the types and their respective commercially available sources.

Pre-consumer scrap: A direct line from production floors

Pre-consumer scrap, or machining scrap, is generated during manufacturing processes, typically from milling, boring, turning, stamping, or extrusion. It includes clean, high-purity aluminium shavings, chips, and offcuts that never reach the end-user market.

Sources & grades

- Aluminium Borings and Turnings: Generated during CNC machining and metalworking.
- Extrusion Offcuts: From profile cutting, window frame production, or pipe manufacturing.

These scraps often retain their alloy identity and are ideal for closed-loop recycling systems.

Post-consumer scrap: Recovering value from end-of-life products

Post-consumer scrap originates after the product has served its purpose, typically requiring collection, sorting, and decontamination. Despite additional processing, this scrap is a critical feedstock for secondary smelters.

Common forms

- Aluminium Wire and Cables: Found in motors, electronics, and HVAC systems.
- Used Beverage Cans: A high-volume source with consistent alloying.
- Cast and Sheet Scrap: Recovered from automobiles, construction, and demolition waste.



The quality and yield from post-consumer scrap depend heavily on how well it's sorted and cleaned.

Secondary aluminium

Sourcing secondary aluminium through scrap markets reduces production costs, lowers carbon footprint, and ensures supply chain resilience, especially during primary metal price volatility.

Secondary aluminium is also alloy-specific, meaning manufacturers can directly acquire feedstock matching their production requirements (e.g., 6061, 6063, or ADC12), especially from clean pre-consumer streams.

Source: Source: AL Circle Blog 07 October 2024

Green Aluminium

There's no single global definition of green aluminium. The term green aluminium is used to describe aluminium that has a lower carbon footprint than standard smelted metal. But how much lower and measured how, varies widely.

In practice, most people mean one of three things:

- Low-carbon primary aluminium: Made with hydropower or other renewable electricity instead of coal. This significantly reduces emissions at the smelting stage.
- Recycled or secondary aluminium: Made by remelting scrap. It uses around 95% less energy than primary production.
- Certified responsible aluminium: Verified against a third-party standard for environmental and social performance, such as the Aluminium Stewardship Initiative (ASI).

Why the Carbon Footprint Number Matters

Aluminium production is carbon-intensive. Making one tonne of primary aluminium from bauxite generates, on average, around 16 to 17 tonnes of CO₂ equivalent. But that number swings dramatically depending on the electricity source used in smelting.

Energy source used in smelting	Approx. CO ₂ e per tonne of aluminium	Classification
Coal-fired grid (e.g. parts of China, India)	20–22 tCO ₂ e	High carbon
Average global grid mix	~16–17 tCO ₂ e	Standard
Hydro-powered smelter (e.g. Norway, Canada)	4–8 tCO ₂ e	Low carbon
Recycled/secondary aluminium	0.5–1.5 tCO ₂ e	Very low carbon

These figures are lifecycle assessments (LCAs) and will vary by smelter, product form and methodology. But the gap between coal-based and hydro-based primary aluminium is stark.

The Certifications Worth Knowing

Several schemes exist to verify sustainability claims on green aluminium. They're not all equal, and they don't all measure the same things.

Scheme	What it covers	Relevant for buyers?
ASI (Aluminium Stewardship Initiative)	Environmental, social and governance performance across the chain. Two standards: Performance and Chain of Custody.	Yes, widely recognised
ResponsibleSteel	Steel-focused, but growing into base metals. Less applicable to aluminium directly.	Partial

Supplier self-declaration (unverified)	Supplier's own claim with no third-party audit.	Risk, verify separately
ISO 14064	Greenhouse gas quantification and reporting standard. Used to underpin carbon claims.	Yes, supports LCA data
Low Carbon Aluminium labels (smelter-specific)	Product-level claims made by individual smelters (e.g. Hydro REDUXA, Rusal Allow). Methodology varies.	Useful, check methodology

ASI is the most established framework specifically for aluminium.

ASI Chain of Custody certification means the sustainability attributes of the metal can be traced through the supply chain to you. That matters if you're passing the claim downstream to your own customers.

Recycled Content: How It Works and What to Check

Recycled aluminium is, in many ways, the most straightforward green claim. The energy savings are real and well-documented. But there's nuance here too.

Pre-consumer vs post-consumer scrap

Not all recycled content is the same:

- Post-consumer recycled (PCR) — scrap that came from end-of-life products. A drinks can, a car part, a building façade. This is generally considered the more valuable claim because it diverts waste from landfills.
- Pre-consumer recycled — manufacturing scrap that never reached a consumer. Offcuts, trimmings, rejected parts. It's still recycled, but regulators and buyers are increasingly distinguishing between the two.

How recycled content is measured and traded

Because aluminium alloys are often blends, "recycled content" is typically measured at the point of production and reported as a percentage. Two main accounting methods exist:

- Physical allocation: The recycled content in your specific parcel of metal is physically traceable. Harder to achieve at scale.
- Mass balance: Recycled inputs are tracked across a production system, and the sustainable attributes are allocated to buyers proportionally. More common, but requires a robust chain of custody to be credible.

Mass balance is widely accepted in certified systems.

Greenwashing: What It Looks Like in Aluminium

Here are the most common problems:

1. Vague claims with no data: “Our aluminium is sustainably sourced.” What does that mean? Sourced from where? Measured how?
2. Carbon figures without scope clarity: A supplier quotes a PCF (Product Carbon Footprint), but excludes upstream emissions (Scope 3). The number looks good, but doesn’t tell the full story.
3. Certification mismatch: The smelter is ASI-certified, but the supplier isn’t. Or the certification covers operations but not the specific product you’re buying.
4. Renewable energy claims without additionality: A smelter buys renewable energy certificates (RECs) to offset grid electricity. That’s not the same as running on actual renewable power.
5. Recycled label on primary metal: This is rare but does happen.

A Checklist for Green Aluminium

1. What is the *carbon intensity* of this metal, in tCO₂e per tonne of aluminium produced?
2. Which lifecycle stages are included in that figure (cradle to gate? cradle to grave?)?
3. What energy source powers the smelter?
4. Is the smelter or supplier *ASI-Certified* ? If so, which standard (Performance or Chain of Custody)?
5. What percentage of this material is recycled content? Is that pre-consumer, post-consumer, or both?
6. How is recycled content accounted for — physical or mass balance?
7. Is there a third-party verified product carbon footprint (PCF) document we can receive?

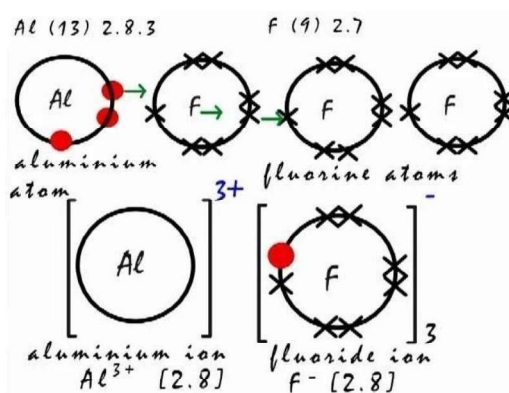
The EU Carbon Border Adjustment Mechanism (CBAM)

CBAM came into its transitional phase in October 2023 and applies to aluminium imports into the EU. From 2026, importers will need to buy certificates covering the embedded carbon in their imports. The carbon intensity of your aluminium will directly affect your costs. This means buyers sourcing high-carbon aluminium from coal-heavy regions will face rising import costs. Low-carbon metal, particularly hydro-powered primary or recycled content, will be comparatively cheaper to import. Sustainability claims that couldn’t be backed up with documentation are always a risk. Risk may be financial as well as reputational.

Source: AL Circle Newsletter Blog, April 21, 2026

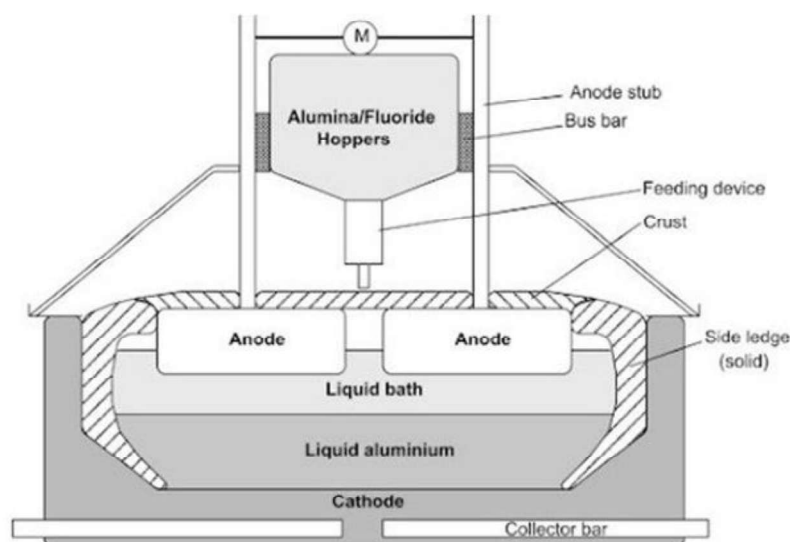
Aluminium Fluoride's Dual Reality - Indispensable to Aluminium, Burdensome to Producers

Aluminium fluoride (AlF_3) has long been a critical ingredient in aluminium production – vital for efficient electrolysis yet scrutinised for its environmental and economic costs. On one hand, it is a necessity, on the other, a dilemma. Functionally, aluminium fluoride is a cornerstone of the Hall–Héroult process as it reduces electrolyte's melting point from $\sim 2000^\circ\text{C}$ to $<1000^\circ\text{C}$, cuts energy consumption, increases the bath's conductivity, and helps dissolve alumina into the electrolyte. In short, this additive allows for efficient electrolysis of alumina (Al_2O_3) into molten aluminum metal.



But its utility comes at a cost, both literally and environmentally. The price of aluminium fluoride, although varies by purity and supplier, typically ranges. for industrial grades (99 per cent purity), around USD 1,200-1,700 per tonne. Like mentioned above, in addition to the high costs it bears, the raw material carries a tag of high GHG emitter. Well, aluminium fluoride itself is not the main emitter of greenhouse gas emissions in smelting, but of course, the process does. When aluminium fluoride is added and alumina levels drop in the electrolyte bath which is called “anode effect”, voltage increases causing carbon from the anode react with the fluorine from the dissociated cryolite bath (which contains AlF_3), leading to potent perfluorocarbon (PFC) gas emissions. The primary PFCs emitted are tetrafluoromethane (CF_4) and hexafluoroethane (C_2F_6), which are two extremely potent greenhouse gases with long-term atmospheric impacts.

Now, in this context, the question arises is whether this additive can be avoided or replaced in the electrolysis process? Likely not because aluminium fluoride fulfils multiple interconnected chemical and operational roles that other additives have yet to replicate at industrial scale. In smelting lines that run continuously and require precise bath chemistry, aluminium fluoride remains irreplaceable.



Role of Aluminium Fluoride in Aluminium Smelting: Step-by-step

Prepares and stabilises the electrolyte bath

The electrolyte in an aluminium smelter is mainly molten cryolite (Na_3AlF_6), which has a very high melting point of 1000 degree Celsius. Here's where the role of aluminium fluoride comes into play to reduce the melting point to around 950 degree Celsius and adjust the bath chemistry. SO, AlF_3 lowers the bath melting point, controls bath fluidity, and helps maintains optimal operating temperature.

Adjusts the bath ratio

Typical, the bath ratio target in Hall-Hérault cells is 2:2-2:8. When this ratio increases, the cell becomes unstable. Adding AlF_3 can reduce the bath ratio and restore ideal electrolyte composition.

Compensates for fluoride losses

Gas emissions and cell reactions continuously deplete fluoride content. Smelters therefore add AlF_3 in small, frequent doses to prevent energy penalties and maintain performance.

Improve alumina dissolution

Aluminium fluoride prevents undissolved alumina dusting because alumina dissolves better in a fluoride-rich bath. AlF_3 also enhances bath acidity, which improves alumina solubility.

Controls bath density and conductivity

Adjusting the bath composition with aluminium fluoride, density can be kept at an optimal level so that alumina suspends properly. It also improves electrical conductivity, reducing energy consumption. As a result, power cost reduces, metal output grows, and cell lining life expands.

However, the excessive usage of aluminium fluoride inflates smelting costs and exacerbates carbon emissions. This adds urgency to the search for more efficient management practices. Adopting some meticulous operational practices can certainly be a way to reduce both consumption and emissions, while practicing recycling and deploying advanced technologies could be other viable solutions.

Operational practices

- Maintain a consistent and optimal concentration of alumina as it helps prevent the “anode effect”, a condition that significantly increases the generation of PFC gases.
- Ensure the electrolysis pots are effectively covered and the hooding system is well-maintained so that they capture the process gases efficiently.
- Optimise parameters like bath chemistry, temperature, and current density in the potline as it can minimise aluminium fluoride losses.
- Minimise water and hydrogen content in AlF_3 to reduce the formation of gaseous hydrogen fluoride.

Advanced technologies and recycling

- Deploy Gas Treatment Centres (GTCs) or Fume Treatment Plants (FTPs) within the smelter that capture over 99 per cent of fluoride emissions by using high-efficiency dry scrubbing systems, often supplemented by wet scrubbing or a combination of methods. Relying on physicochemical processes, these technologies neutralise and remove gaseous and particulate fluorides before the treated air is released.
- Use recycled aluminium fluoride made from aluminium industry waste like spent pot linings, by extracting fluorine using acids (like sulfuric or nitric) or strong alkalis (caustic soda) to form soluble fluoride salts. Then pure AlF_3 or its precursors precipitate out as crystals, often with high purity, while lithium forms a soluble salt.

Groundbreaking innovations

- The implementation of inert anodes made from cermet or metal alloys in the electrolysis process is a promising innovation. Unlike traditional carbon anodes that react to produce CO_2 or other PFC gases, inert anode produces only oxygen as a byproduct while reducing the consumption of aluminium fluoride.
- Shifting energy sources to renewable power like hydroelectric, solar, or wind power can also reduce the emissions from the overall smelting process.

Summing up

Aluminium fluoride sits at the intersection of efficiency and environmental responsibility in primary aluminium production. While it is indispensable to the smelting process, its economic cost and indirect role in high-impact greenhouse gases have intensified pressure on producers to use it more judiciously. Well, some operational discipline, advanced scrubbing systems, recycling streams, and next-generation anode technologies can meaningfully enable the industry to reduce its reliance on AlF_3 and its environmental footprint, but not without compromising production efficiency.

Source: AL Circle, 11 December 2025

India's N-Dream Crosses A Milestone

On April 6, 2026, India's Prototype Fast Breeder Reactor (PFBR) at Kalpakkam attained criticality, the point at which a nuclear reactor sustains a continuous chain reaction on its own, a defining step in the country's civil nuclear journey.

What's "Criticality"?

In everyday speech, "going critical" sounds alarming. In nuclear engineering, it is the goal. Criticality marks the point at which a nuclear reactor achieves a self-sustaining chain reaction, a key milestone before full power generation, confirming that the reactor core is functioning exactly as designed. Think of it as the moment an engine first turns over under its own power after years on the drawing board.

What Makes This Reactor Different?

Most nuclear plants in India – and around the world – run on uranium fuel, consume it, and stop. The PFBR does something far more unusual: it produces more nuclear fuel than it burns. That is precisely what earns it the name "breeder" reactor.

The PFBR has a capacity of 500 megawatts of electricity and uses liquid sodium as a coolant. It runs on a uranium-plutonium mixed oxide fuel loaded into the reactor core, surrounded by a blanket of uranium-238. The fission process reacts with this blanket and converts, or "transmutes", the uranium-238, producing more plutonium than the reactor consumes.

Designed by Indira Gandhi Centre for Atomic Research (IGCAR), built and operated by Bharatiya Nabhikiya Vidyut Nigam Limited (BHAVINI), the PFBR represents a key component of India's long-term nuclear strategy, with major contributions from over 200 Indian industries, including small and medium enterprises.

Why It Was Always About Thorium

India adopted a three-stage nuclear fuel programme and has been pursuing it ever since. In the first stage, Pressurised Heavy Water Reactors fuelled by natural uranium generate electricity and produce plutonium as a by-product.

That Plutonium is then used to make the mixed oxide fuel for a Fast Breeder Reactor in the second stage – the PFBR. This second stage also uses thorium to “breed” a fissile material called Uranium-233, which becomes the fuel for the third and final stage of reactors.

The endgame has always been thorium. India possesses one of the world’s largest thorium reserves, estimated at well over 8,00,000 tonnes, concentrated mostly in the monazite sands of Odisha Tamil Nadu, Andhra Pradesh, and Kerala. Thorium cannot be used directly as nuclear fuel, but the PFBR is the machine that begins converting it into something that can.

India imports much of its uranium: thorium is already sitting under Indian soil in vast quantities. The strategic logic writes itself.

Journey Plagued By Delays

The road to this milestone was long and expensive. Though construction was originally supposed to be completed by 2010, the project was delayed multiple times, and costs ballooned from an initial Rs 3,492 crore to more than double the initial estimate.

Commencement of “core loading” – the process of inserting fuel into the reactor for the first time was done on March 4, 2024. Regulatory clearance came in careful stages. The Atomic Energy Regulatory Board granted permission for the “First Approach to Criticality” only after a thorough multi-tier safety review, regular inspections by a resident site observer team, and extensive evaluation of detailed safety submissions. Criticality was finally achieved on April 6, 2026.

What Comes Next?

Reaching criticality does not mean the lights in Tamil Nadu will brighten tomorrow. Once a sustained nuclear chain reaction is achieved, a series of low-power physics experiments will be conducted to further assess and understand reactor behaviour.

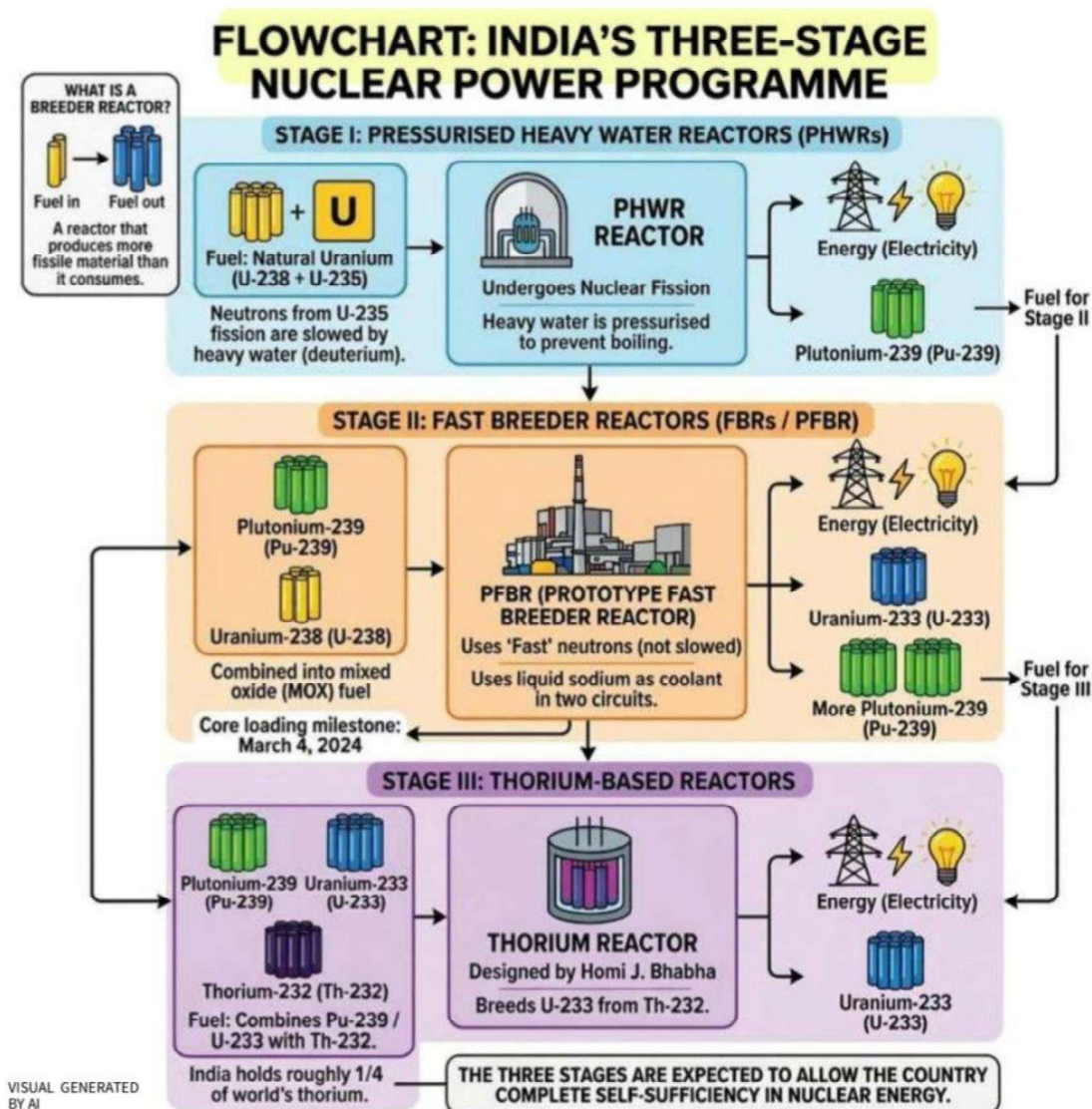
After that, power levels will be raised gradually, with each step requiring regulatory sign-off. The next milestone will be connecting the reactor to the electrical grid to produce power on a commercial basis, pending approval from the AERB.

Two more fast breeder reactors are planned at Kalpakkam in the next phase, contingent on the Department of Atomic Energy’s satisfaction with the PFBR’s 12

India's Place in History

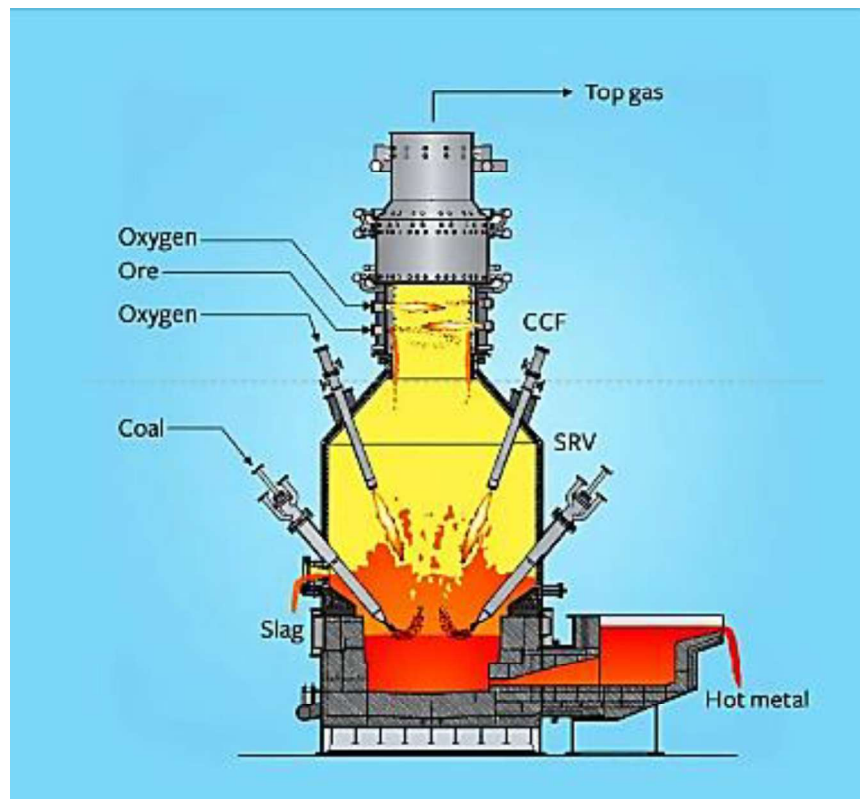
Once successfully commercialised, India could become one of the few countries in the world to operate fast breeder reactors at a commercial scale, joining Russia as a leader in this niche but strategically important technology. Commercialising this technology at scale, reprocessing thorium-based spent fuel, and building out many more such reactors are all tasks that still lie ahead – likely spanning decades.

But the machine is alive the chain reaction is running and a vision conceived in the early years of Indian independence has taken its most consequential step forward.



Source: Times of India, 06 May, 2026

Hisarna Process



Hisarna process, being developed by Tata Steel, eliminates two unavoidable steps in traditional steel-making processes — coke-making and the agglomeration of iron ore (into sinter or pellets). Second, Hisarna doesn't care about ore quality — low-grade iron ore, abundantly available in eastern India, works just as well. Third, carbon dioxide emissions are estimated to be about 20 per cent lower than in a conventional plant of comparable size. Moreover, the carbon dioxide stream is relatively pure, making carbon capture easier and cheaper, without any need for separation from other flue gases.

Hisarna furnace has two chambers, one above the other. Powdered iron ore is injected into the top chamber, where it spirals downward. The spiralling keeps it longer in the chamber, which is essential. The powder injection is also the technology's biggest challenge: The iron ore particles must neither fly out nor fall straight through.

Non-coking coal is injected into the lower, smelting vessel. Oxygen is introduced at multiple points. The coal reacts with oxygen to produce carbon monoxide (CO), which rises to the top chamber. There it meets oxygen again, burns into carbon

dioxide, and releases intense heat. This heat melts the ore, which then drips into the lower chamber.

Iron ore (ferric oxide or Fe_2O_3) must be reduced — its oxygen removed — to yield iron. In HIsarna, this happens in two stages. In the upper chamber, ferric oxide is partly reduced to ferrous oxide (FeO) as it encounters the rising CO and injected oxygen; the heat generated also melts the ore. The molten ferrous oxide then falls into the lower chamber, where it reacts with the carbon in coal. The oxygen bonds with carbon, leaving behind molten iron. The outputs are liquid iron and a relatively pure stream of carbon dioxide.

The process can use low-grade ore, which would otherwise be discarded. The plant footprint is about half that of a comparable blast furnace setup. The slag can go straight into a cement kiln, unlike the steel-making slag. Taken together, these factors could lower operating costs by around 10 per cent. The HIsarna plant in Jamshedpur is expected to go on stream by 2030.

The idea of a new steel-making route was first pursued in Europe under the Ultra-Low CO_2 Steelmaking (ULCOS) initiative, a consortium of 48 companies. One of them was Koninklijke Hoogovens, which later merged with British Steel to form Corus Group and was acquired by Tata Steel in 2007.

The construction of a pilot plant in the Netherlands began in 2010, followed by years of trials. Rio Tinto, the British-Australian mining major, joined in 2011, bringing its HIs melt technology (the bottom chamber). Tata Steel acquired the technology from Rio Tinto in 2017.

Initially, there were many setbacks — refractories failed, operations proved unstable — and most partners lost interest. In 2021, Tata Steel, along with US company Nucor, revived the effort with new operating protocols. The results improved. Higher operating capacity could be achieved than originally planned: 14 tonnes of ore per hour against 12 tonnes.

Source: The Hindu Businessline, 20 April, 2026

Using Rice Husks to Cut Coal in Steelmaking

An Australia-India partnership took a step closer to green steel through a "world-first" use of agricultural waste in steelmaking during a successful commercial-scale trial in India. Researchers from Australia's national science agency, CSIRO, and the Indian Institute of Science (IISc) demonstrated a viable approach to cut emissions by partially replacing coal with locally sourced rice husk pellets. The breakthrough offers a scalable pathway to decarbonise one of the world's fastest-growing

industrial economies in a sector currently responsible for approximately one-tenth of global carbon emissions.

Successful Biomass Trial

Using locally sourced rice husk pellets, the CSIRO team validated sustained production of biomass-derived syngas (synthesis gas) for iron ore reduction at a large-scale commercial steelworks in India, in partnership with commercial steel innovator RESCONS Solutions Pvt. Ltd., a commercial steel entity incubated at the Foundation for Science, Innovation and Development (FSID), IISc.

RESCONS Solutions in environmentally sustainable solutions that benefit present and future generations. Collaborating with CSIRO and IISc, has helped pioneer the use of biomass in steelmaking.

Trial at Jindal Steel

The trial involved blending 5 per cent and 10 per cent rice husk pellets into commercial gasifiers at Jindal Steel in Odisha, achieving production with no loss of performance. CSIRO-led team, with funding from the Australian Government's India-Australia Green Steel Research Partnership, conducted a full-scale trial at Jindal Steel in Odisha. The team successfully blended 5 per cent and 10 per cent rice husk pellets into Jindal Steel gasifiers, achieving sustained syngas production with no loss of performance.

Decarbonisation Challenge and Potential

CSIRO highlighted that India's steel sector currently emits an average of 2.55 tonnes of CO₂ per tonne of steel, significantly higher than the global average of 1.8 tonnes. The industry is projected to enhance its capacity to 300 million tonnes by 2030, posing a challenge for global emissions targets.

According to the research team, if this biomass process is adopted across India, the process could reduce steel sector emissions by up to 50 per cent totalling approximately 357 million tonnes of CO₂ per year.

This trial is a world-first demonstration of how agricultural waste can be harnessed to decarbonise steelmaking at scale. By blending rice husk pellets into commercial gasifiers, it has been shown that biomass can replace coal without compromising performance.

Supporting India's Net Zero Goal

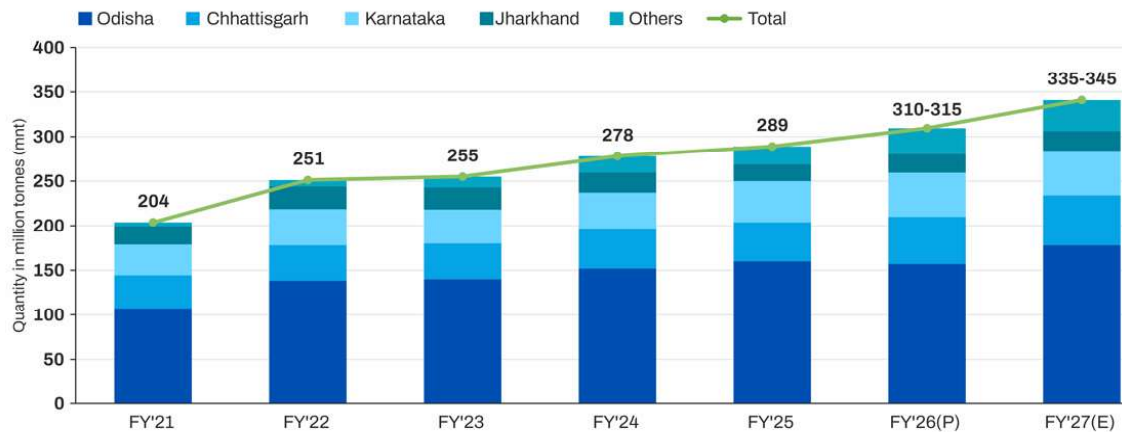
The initiative supports the Indian Ministry of Steel's roadmap to achieve net zero emissions by 2070. Surplus crop residue biomass in India currently totals 228.52 million tonnes.

India's steel sector is a significant source of emissions. CISRO partnership with the Indian Institute of Science and Jindal Steel has demonstrated that biomass can be a viable alternative to coal, especially in regional areas where surplus agri-waste and coal DRI facilities co-exist. The next phase will focus on increasing biomass replacement rates and assessing impacts on the direct reduction process.

Source: Story by Asianet News Central, 21 April 2026

India's Iron Ore Production 2020-21 to 2026-27

India's iron ore production is projected to rise to 340-345 million tonnes (mnt) in FY'27 from around 316 mnt in FY'26, indicating growth of 8% y-o-y. Incremental production shall remain concentrated in Odisha.



f: Forecast | All above figures are rounded off | Note- A Financial Year (FY) starts from 1st April and ends on 31st March.
Quantity in million tonnes (mnt) | % change in year-on-year (y-o-y) | Source: BigMint

Source: BigMint forecast

India's DRI Production in FY25-26

Producers	April 2025 - March 2026 (Prov.)	April 2024 - March 2025 (Final)	% Variation
Tata Steel	2.25	2.13	5.7
AM/NS India	5.22	4.91	6.4
Jindal Steel	2.74	2.54	7.9
JSW Steel	5.04	5.17	-2.4
Others	45.03	41	9.8
TOTAL PRODUCTION	60.3	55.76	8.1

In million tons

In FY25-26 India's total DRI production was recorded at 60.3 MT with an increase of 8.1% on y-o-y. Out of which, 85% was coal-based production, amounting to 51.3 MT with 9.6% surge on y-o-y, while the remaining 15% was gas-based production, which stood at 8.9 MT, up by 0.4% compared from the previous year.

India Steel Exports

India's steel industry continues to strengthen its position in global trade, supported by scale, capability, and a responsive market approach.

During FY21–FY25, India's steel exports have ranged between ~4–8 million tonnes, translating to an export value of ~\$3–7 billion. These figures reflect a sector that is closely aligned with global demand cycles and pricing dynamics.

Strategic Market Presence

India's export footprint spans key regions:

- Europe: value-driven demand with high quality and compliance standards
- Middle East: infrastructure-led demand supporting volume growth
- Asia: competitive markets driven by manufacturing consumption

This diversified reach enables India to effectively balance value realization, volume movement, and price competitiveness.

Product Strength

Exports are largely anchored by flat steel products (HRC, CRC, coated steel), which offer versatility and strong global acceptance across industries.

Competitive Positioning

India's export strength is underpinned by:

- ✓ Cost-efficient manufacturing
- ✓ Flexible production capabilities
- ✓ Strong domestic market support
- ✓ Strategic geographic advantage

At the same time, global factors such as pricing trends, trade policies, and supply cycles continue to shape export outcomes.

India's steel export story reflects a balanced combination of scale, resilience, and adaptability.

As global markets evolve, this ability to align with changing conditions will remain central to sustaining and expanding India's international presence.



Source: Dhrubojoyoti Saha, Likkedin Post, 01 may 2026

India's Macro Economic Indicators: 2025-26

	2025									2026		
Key Parameters	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Crude steel production (in million tonnes)	12.9	13.54	13.55	14	14.09	13.56	13.56	13.71	14.79	15.15	14.07	15.32
Pig iron production (in million tonnes)	0.74	0.73	0.74	0.68	0.72	0.68	0.65	0.67	0.71	0.71	0.65	0.68
Steel Exports (in million tonnes)	0.50	0.58	0.61	0.56	0.67	0.72	0.72	0.88	0.61	0.81	0.80	0.85
Steel Imports (in million tonnes)	0.47	0.7	0.61	0.85	0.70	0.79	0.69	0.6	0.64	0.52	0.59	0.55
Iron ore Imports (in million tonnes)	0.48	0.43	1.45	1.82	1.12	1.00	1.09	0.97	1.49	0.63	0.89	1.11
Coal Production (in million tonnes)	82	86	79	65	70	68	77	93	101	108	101	114
Coal Imports (in million tonnes)	24.7	27.2	24.2	21.3	20.0	20.6	16.9	18.9	16.9	17.9	18.9	22.6
Automobile Production (in million units)	2.43	2.58	2.4	2.69	2.69	3.27	3.2	3.04	3.03	3.21	3.14	2.97
Automobile Sales (in million units)	1.93	2.13	2	2.05	2.31	2.69	2.85	2.52	2.09	2.54	2.47	2.6
Daily Average Power Consumption (*000 MUs)	4.90	4.80	5.00	4.96	4.85	4.86	4.26	4.12	4.47	4.60	4.75	4.82
Merchandise exports (in Billion USD (\$))	38.5	38.7	35.1	37.2	35.1	36.4	34.4	38.1	38.5	36.6	36.6	38.9
EV Registrations (Lakh Units)	1.69	1.81	1.82	1.9	1.89	1.84	2.37	2.19	2.03	2.19	1.98	2.8
GST Collections (in Trillion INR (₹))	2.37	2.01	1.85	1.96	1.86	1.89	1.96	1.75	1.75	1.93	1.83	2.00
Manufacturing PMI Index	58.2	57.6	58.4	59.1	59.3	57.7	59.2	57.4	55.0	55.4	57.5	53.9

Steel imports have declined sharply in early 2026, falling to between 0.52-0.59 mnt per month, compared with higher levels through 2025. At the same time, exports have shown modest recovery.

Automobile production and sales remain elevated, while EV registrations show sustained growth.

Coal production has risen sharply in early 2026, reaching above 110 mnt, alongside a rebound in coal imports. The simultaneous increase in both domestic production and imports indicates rising energy demand from industry, including steel.

India's steel sector is likely to maintain elevated production levels in the near term, supported by ongoing capacity ramp-ups and stable domestic demand.

Source: BigMint Bureau, 30 Apr 2026

India's First Plant for Extraction of Platinum

Amid growing global attention over critical minerals and intensifying competition to secure strategic resources, Odisha Mining Corporation (OMC) has set up the country's first pilot plant for extracting platinum group metals (PGMs) from mineral ore.

Set up at the Institute of Minerals and Materials Technology (IMMT), Bhubaneswar, in collaboration with South Africa's mineral-technology institution Mintek, the Rs 10 crore pilot project is aimed at building India's first integrated ecosystem for beneficiation (the treatment of raw materials), smelting, and refining of PGMs.

The project assumes national significance because PGMs — platinum, palladium, rhodium, iridium, osmium, and ruthenium — are indispensable for a range of

sunrise and strategic sectors, including clean-energy technologies, hydrogen fuel cells, electronics, catalytic converters, defence systems, medical equipment, petrochemical processing, and advanced manufacturing, besides jewellery. OMC officials said, as part of the pilot project, PGMs would be extracted from ore sourced from Bangur chromite mines, Keonjhar.

The one-tonne-per-hour pilot plant will be used to validate the consistency, recovery rates, and scalability of PGM concentrate under real-time operating conditions before moving to commercial-scale development. With global supply heavily concentrated in a few countries, India has so far relied on imports for these metals. Globally PGM reserves are estimated at around 71,000 tonnes, of which South Africa alone accounts for nearly 89 per cent, followed by Russia with 8 per cent, Zimbabwe 2 per cent, and the US 1 per cent.

If commercialized, Odisha could become the nucleus of India's first PGMs and a key contributor to the country's critical mineral security, official added.

Source: Business Standard, 21st April 2026

Technology for the Deep Purification of CO₂ from CO

The Netherlands Organisation for Applied Scientific Research (TNO) developed a method to purify carbon dioxide (CO₂) for underground storage or industrial use. The method removes carbon monoxide (CO) from CO₂ using a process called chemical cycling.

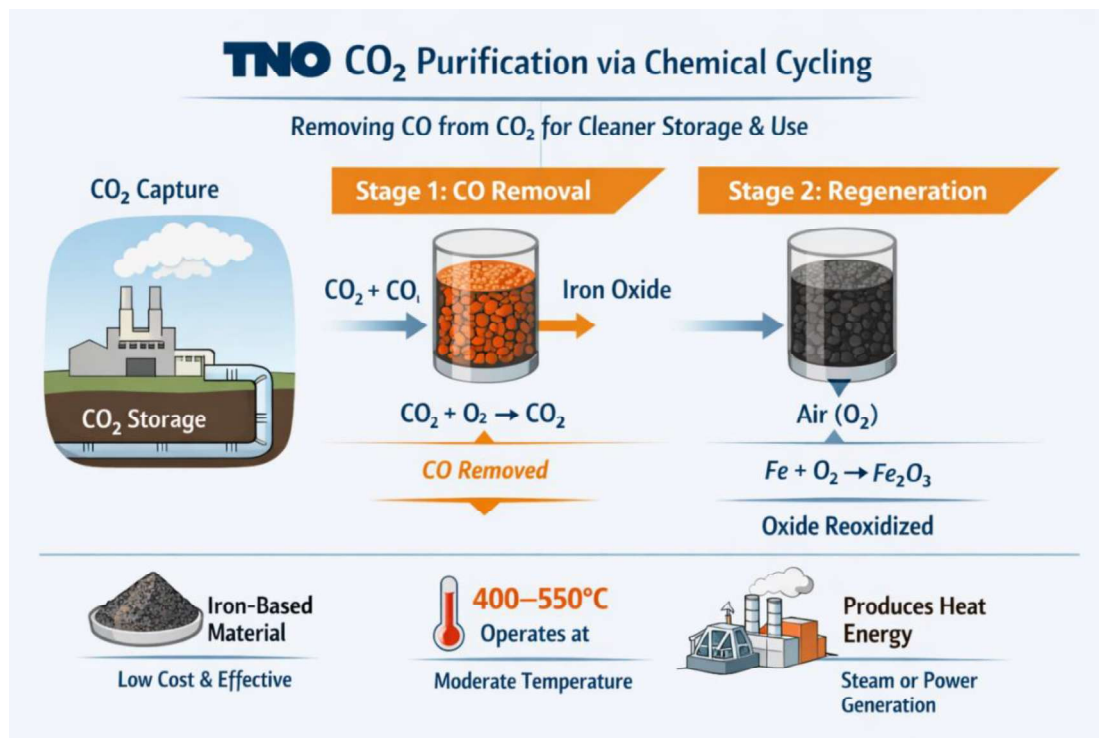
In carbon capture and storage, captured CO₂ often contains impurities. These impurities can damage pipelines, storage sites, or catalysts used in later processes. Carbon monoxide is particularly restricted, and its concentration must generally remain below 100 to 300 ppm. Existing purification methods often require high energy, complex equipment, or may introduce additional contaminants.

The proposed method uses metal oxide particles as oxygen carriers in a two-stage process. In the first stage, a gas mixture of CO₂ and CO passes through the metal oxide. The oxide releases oxygen, which reacts with CO and converts it into CO₂. During this reaction, the metal oxide will be reduced partially.

In the second stage, the reduced oxide reacts with air and becomes oxidised again, restoring it for reuse in another cycle. This process removes CO without adding other substances to the gas stream.

The researchers used thermodynamic analysis to select suitable materials. They evaluated oxides of nickel, copper, manganese, and iron under temperatures below 700°C and low CO concentrations. Copper and iron oxides excelled, while nickel and

manganese were less stable. Both reaction stages released heat, indicating that the process could also produce usable energy for steam or electricity generation.



Iron-based materials were studied in more detail because it is widely available, non-toxic, and cost-effective. Several iron oxide materials supported by aluminium oxide were tested. The most effective sample, produced by an infusion method, operated for about 200 cycles at 400 to 550°C while converting CO to CO₂. The system also functioned effectively at CO concentrations of 2,000 to 4,000 ppm, which are typical of industrial gas streams.

Experiments showed that raising the temperature to around 450°C increased the time required for complete CO conversion, and further increases provided only limited improvement. As a result, the optimal operating temperature depends on the process design and how the released heat is used.

Although iron-based materials performed well, other materials may offer faster reactions or greater durability. Future work will test additional materials and evaluate the technical and economic feasibility of the process compared with methods such as cryogenic separation (energy-intensive) or catalytic oxidation (chemical process using a catalyst for oxidation).

Source: AL CIRCLE 10 March 2026

Obituary



Shri AK Rana

The Indian Institute of Metals - Delhi Chapter is sad to inform about the passing away of Shri A K Rana, Life Member, on 2nd June 2026.

A towering personality, and always a cheerful person, Shri Ashok Rana worked with MECON Ltd. at Ranchi for a long time. After leaving MECON Ltd., he worked with M/s Rollcon Engg. Co. Pvt. Ltd. for some time and then started his own venture - M/s. Yogiji Equipment Pvt. Ltd. Subsequently, his Company was merged with M/s. Yogiji Digi Ltd. He was a Director in M/s. Yogiji Digi, and contributed immensely to its growth.

Shri Rana was actively involved with the IIM Delhi Chapter activities. Our Members fondly recall the visit to Yogiji Digi Works, at Dudhola, Haryana, about 8 years back, when Shri Rana took the members around and explained the capabilities and impressive facilities of the Plant in detail.

IIM Delhi Chapter conveys its sincere condolences to the bereaved family and prays to God that his noble soul rests in peace. The Chapter also prays to Almighty to give enough strength to the bereaved family to bear this irreparable loss