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	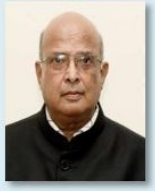		
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Editor-in-Chief
S C Suri

Chairman's Message

Dear Esteemed Member,

It is my proud privilege to be the Chairman of The Indian Institute of Metals, Delhi Chapter and I feel honoured to serve this Chapter, having illustrious members from Industries, R&D Institutions, Academia and Government. I would like to sincerely thank the members for reposing their trust in me and look forward to our collective leadership in organizing various technical activities.

I would also like to thank all the past Chairmen and Executive Committee Members for their outstanding contribution in making this Chapter quite active and vibrant.

As the members are aware, metal sector is witnessing a steady growth in our country. The contemporary issues in the current scenario of ferrous and non-ferrous sectors are decarbonisation, circular economy and resource efficiency and digitalization. We shall focus on organizing technical activities related to current and futuristic industry oriented issues.

I look forward to receive suggestions and ideas from fellow members to increase the activities of Delhi Chapter. I have no doubt that with your support and active participation, our Chapter will continue to climb ladders of excellence and make the Chapter more industry oriented.

With Best Regards,

R K Vijayavergia
Chairman

Annual General Meeting of IIM Delhi Chapter

The 71st Annual General Meeting (AGM) of our Chapter was held on 8th July 2023. The following items were taken up in the AGM:

- Confirmation of minutes of the 70th AGM of the Chapter held on 2.7.2022
- Presentation of Annual Report of the Chapter for 2022-23
- Adoption of audited accounts of our Chapter for the financial year 2022-23
- Election of the Executive Committee for 2023-24
- Approval of Auditor for 2023-24

Some of the visuals of the AGM are as under:


71st Annual General Meeting
8th July 2023
DR. RAMEN DATTA
DR. MUKESH KUMAR
R. K. NARANG
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Metallurgy
Materials Engineering
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1st Quarter Performance of Indian Steel Industry

Tata Steel, SAIL, JSW Steel and JSPL have reported robust production volumes in the first quarter (Q1) of FY24, indicating strong growth in output compared to the previous year. SAIL witnessed an 7.7% year on-year (Y-o-Y) growth in crude steel production, highlighting positive prospects for the steel industry in terms of increased production and potential financial performance reported.

Provisional Data

Producers	JUNE			JUNE Vis - A - Vis MAY			APRIL - JUNE		
	2023 - 24 (Prov.)	2022 - 23 (Final)	% Variation	JUNE (Prov.)	MAY (Prov.)	% Variation	2023 - 24 (Prov.)	2022 - 23 (Final)	% Variation
A SAIL	1566	1395	12.3	1566	1564	0.2	4667	4332	7.7
B TSL GROUP	1688	1662	1.5	1688	1687	0.0	4976	5057	-1.6
C RINL (VSP)	361	360	0.1	361	236	53.0	995	1008	-1.3
D AM / NS (ESSAR) + JSWL Group+ JSPL	3106	2833	9.6	3106	3116	-0.3	9319	9178	1.5
E OTHERS	4559	3671	24.2	4559	4564	-0.1	13676	11459	19.4
PRODUCTION	11280	9922	13.7	11280	11167	1.0	33633	31034	8.4
Total PSU Production	1927	1755	9.8	1927	1800	7.1	5662	5340	6.0
% Share of PSU	17.1	17.7		17.1	16.1		16.8	17.2	

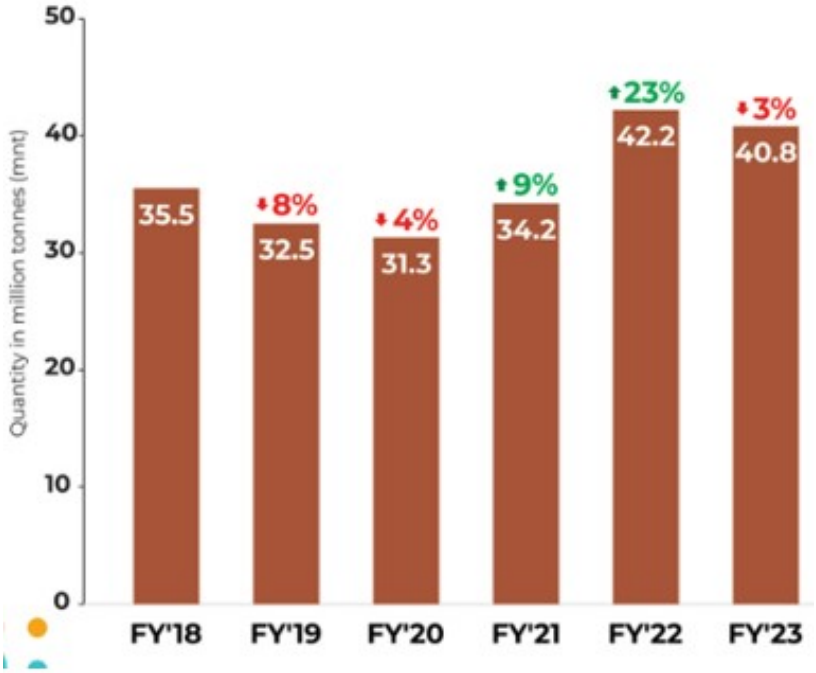
Performance: Apr-Jun'23

Crude Steel	:	33.6 (+8.4%)
Import (finished steel)	:	1.4 (+20%)
Export	:	2.05 (-6.4%)
Demand	:	30.3 (+10.2%)

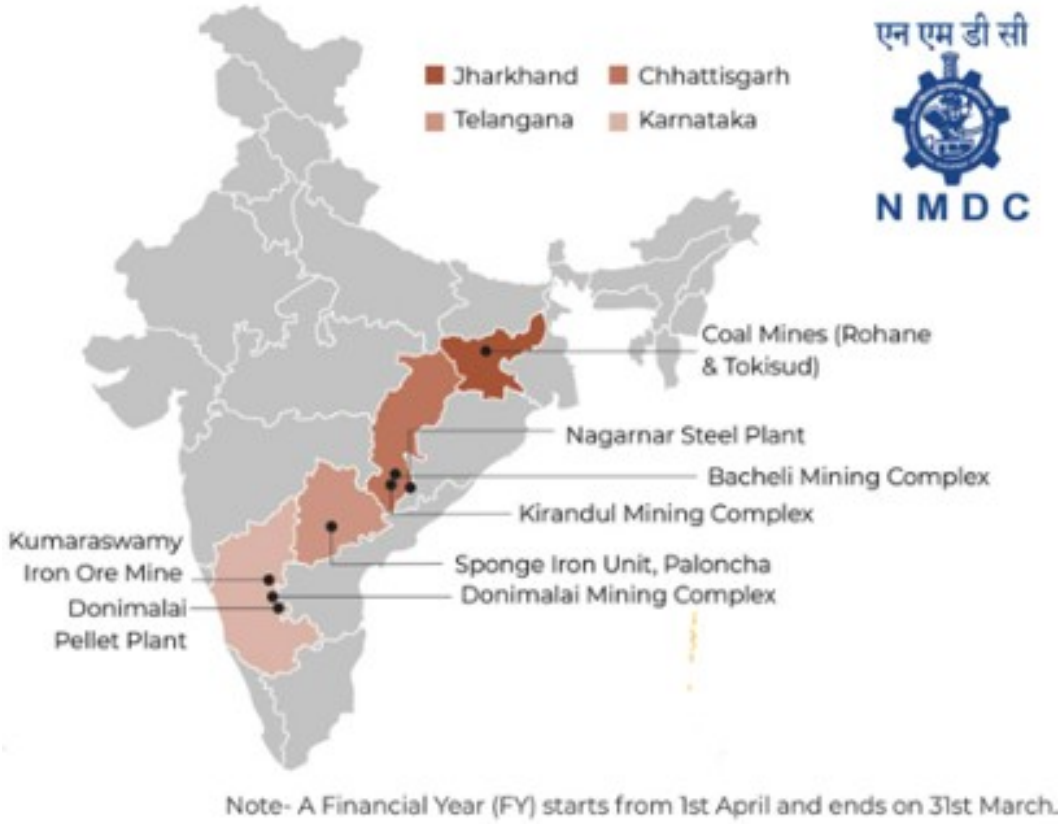
Source: JPC Data

NMDC Aims for 46-50 mt of Iron Ore Output in FY'24

NMDC Limited, India's largest iron ore producer, announced its financial year (April 2022-March, 2023) results. The company reported its second-best iron ore production volumes. Expected production in FY24 will be around 46-50 million tonnes.



NMDC Limited Iron Ore Production: FY18-FY23



Note- A Financial Year (FY) starts from 1st April and ends on 31st March.

Delivering a Net-Zero Future for Aluminium

Decarbonizing the aluminium industry, responsible for approximately 2 percent of global greenhouse gas (GHG) emissions, is critical for a safer climate future. With demand projected to increase 80 percent by 2050, aluminium companies are facing mounting pressure from corporations and governments to reduce their carbon footprints. Investing in and deploying more sustainable production practices is essential to averting an equivalent climate pollution increase.

Energy-intensive processes used in aluminium production currently rely heavily on fossil-fuel generated electricity. Current carbon accounting systems are inadequate in providing an accurate and comprehensive view of emissions associated with their processes and products, making it difficult to drive real decarbonization actions. But access to renewable power, emissions reduction technologies, scrap availability and emissions data transparency is currently increasing to meet the demand for low-carbon aluminium.

Uniting Industry Stakeholders to Drive Progress in Emissions Transparency

Importance of adopting consistent GHG accounting methodologies was discussed by aluminium industry stakeholders at the World Aluminium Conference to make industry emissions more transparent and actionable to accelerate the industry's decarbonization strategies. Lack of supply chain emissions data transparency and disparate definitions for low carbon aluminium were identified as two of the major challenges to address in creating greater product demand. The need was felt for comparable and reliable primary data at the product level to enable informed decision making by both aluminium producers and buyers.

Draft Aluminium Emissions Reporting Guidance was released for public consultation. This decarbonization-focused and impact-driven GHG guidance helps producers disclose the emissions of their aluminium products and increase the transparency, comparability and quality of emissions data.

Unveiling Decarbonization Strategies in Supply and Demand Through Emissions Data

In an era of increasing carbon constraints, corporate buyers are seeking to fulfil their purchasing commitments and drive supply chain decarbonization. Understanding the impact of corporate decisions on low-emissions supply is crucial in this context. Aluminium Emissions Reporting Guidance provides valuable support to buyers, enabling them to make informed choices that promote essential decarbonization technologies. By leveraging this guidance, buyers can effectively direct their procurement spending towards suppliers that lead in climate action, while mitigating the risks associated with potential greenwashing practices.

The guidance enhances emissions transparency for both primary production and recycling by highlighting the progress of individual suppliers in aligning with sectoral decarbonization pathways identified by the International Aluminium Institute (IAI). These pathways encompass decarbonizing electricity, adopting zero-emissions technology to minimize direct emissions and maximizing scrap utilization. By acknowledging the efforts of first-moving aluminium producers, governments and businesses can help incentivize further investment in decarbonizing the sector — including nascent, low emissions technologies — to meet global climate goals.

What the Industry is saying

Alcoa has committed to reducing their GHG emission intensity 30 percent by 2025 and 50 percent by 2030. Alcoa highlighted that "calculating and communicating mine-to-smelter carbon footprint emissions of aluminium products in a harmonized manner is essential to raise awareness for both users and buyers of aluminium made with lower carbon emissions" and that "a clear carbon footprint calculation approach is also crucial to assess the potential impact of various decarbonization technologies and, eventually, track improvements."

Ball Corporation has set a course to achieve net-zero carbon emissions prior to 2050 and highlighted in their Business & Sustainability Update that "this will require working with initiatives such as the First Movers Coalition (FMC), RMI Horizon Zero, the Mission Possible Partnership and the Aluminium Stewardship Initiative (ASI)."

Tesla has also recognized the need for emissions transparency and supported the efforts of RMI "to create a better framework for calculating emissions from the aluminium industry and moving it toward a low-carbon future."

Aluminium Emissions Reporting Guidance is a great step towards creating a unified reporting framework that is used by all aluminium suppliers. High quality environmental impact data of manufactured products is critical to drive decarbonization of the building construction industry.

Source : Spark Newsletter June 29, 2023

H_2 Green Steel and *thyssenkrupp nucera* to Build One of the 'World's Largest' Electrolysis Plant

H_2 Green Steel and water electrolysis specialist *thyssenkrupp nucera* have signed an agreement for the construction and supply of one of the world's largest electrolysis plants to date.

The partnership will cover alkaline water electrolysis technology (AWE) and large-scale electrolysis plant engineering, with *thyssenkrupp nucera* being chosen due to its proven track record with more than 600 installed projects and over 10 GW capacity in the chlor-alkali technology.

Through this collaboration, *thyssenkrupp nucera* will deliver capacity of more than 700 MW to the electrolysis plant, which is based on a concept where H_2 Green Steel will use several complementing technologies for green hydrogen production, enabling balancing of the system for cost- optimization and operational flow as each technology's core benefits can be harvested.

The electrolysis plant in Boden will be many times bigger than most electrolyzer installations that exist today.

Source: Steel Times International, Weekly News, May 24, 2023

World's First Commercial-scale Green Steel Plant

Swedish start-up H_2 Green Steel plans to make its flagship green steel facility. The plant in Boden, northeast Sweden, is set to be the world's first commercial-scale green steel factory in operation when it comes on line in 2025 — and it

will also make H_2 Green Steel one of the largest green hydrogen producers in Europe.

While traditional steelmaking requires coking coal to extract iron from iron-oxide ore — to both melt it and remove oxygen at the same time — H_2 Green Steel will use green hydrogen instead, and then use renewables-powered electric arc furnaces to turn iron into steel in an almost entirely carbon-free process. The start-up aims to produce two-and-a-half million tonnes of steel a year in Boden by the end of 2025, ramping up to five million tonnes by 2030. The 700 MW of electrolysers would form one of the largest green hydrogen projects in Europe when it comes on line.

The electrolysis plant in Boden will be many times bigger than most existing electrolyser plants today claims H_2 Green Steel.

Source : Accelerate Hydrogen Newsletter, 25 May 2023

Green Hydrogen and Water

As green hydrogen projects move from the drawing board to final investment decision, water stress and other water management issues are attracting interest.

Green Hydrogen is produced through the electrolysis of water with 100% or near 100% renewable energy. Around 9 litres of water are needed to produce 1 kg of green hydrogen, with 8 kg of oxygen as a by-product. On this basis, the IEA recently calculated that if all current hydrogen production (circa 90 million tonnes per annum) were produced through electrolysis (using water and renewable electricity), the water requirements would be 790 million cubic meters. While that's a lot of fresh water, it's only a tiny proportion of global water use (less than 0.01%). However, this also significantly underestimates the challenge.

Worldwide, we use more than 4 trillion cubic meters of freshwater each year. Agriculture accounts for 70%, industry 19% and households 10%. 2 billion people lack access to safe drinking water and 40 per cent of the world's population are affected by water scarcity. In addition, humanity's demand for water keeps growing, with pressure on freshwater projected to increase by more than 40 per cent by 2050. The UN's 2023 Water Conference in New York

recently noted that climate change will “hit hardest through water”, impacting forced migration, conflict, poverty and food security.

While it is not the total amount of water used which will be a challenge, some of the best opportunities for producing renewable energy (in particular solar energy) are in water-stressed environments. Desalination is often considered a solution. However, this increases the energy use, and raises additional challenges regarding saline wastewater disposal. Compared to alternative ways of producing energy, it may not be a huge challenge, but it nevertheless needs to be taken seriously.

Water demand can be much higher than the 9 litres per kilo cited above. Commonly overlooked water supply and disposal factors are:

- Raw water feed requiring treatment to meet high purity electrolyser requirements – with around 20-40% of the water sent to waste during the treatment process, depending on the quality of the imported raw water;
- Cooling load for electrolysers – which can require an additional 30 to 40 kg of water per kg of hydrogen in evaporative cooled systems;
- Other cooling loads– such as the multi-stage compressors with intercooling to compress the produced hydrogen to a suitable pressure for storage or use.

These additional loads can require as much as 60 to 95 kg of water per kg of green hydrogen. Even at this level, total water consumption will still be relatively small compared to total consumption (still less than 0.01% of global freshwater use). But it will be a significant constraint in some cases.

The future of the green hydrogen industry depends on developing a sustainable approach to sourcing and disposing of water, reducing water demand, and avoiding negative impacts on water-stressed ecosystems and communities.

More work is needed to address the most challenging aspects of water management:

- More clearly defining water scarcity and water stress;

- Wastewater management from desalination facilities;
- Wastewater management from production facilities;
- Groundwater extraction; and
- Oversizing water treatment facilities to support community development.

Water is at the core of sustainable development. The green hydrogen industry needs to tackle these issues as a high priority. The challenges are not insurmountable. But they require a collaborative approach that leverages support from government, industry and civil society.

Source: GH2 Weekly Wrap: Green hydrogen and Water, 03 June 2023

Hydrogen Leaks May Contribute to Atmospheric Green House Gas Level

Hydrogen as an energy source has been embraced by several global steelmakers as a greenhouse gas (GHG) emissions reduction tactic. However, the Norway-based Centre for International Climate Research (Cicero) says some of that good could be negated if too much hydrogen leaks into the atmosphere during its production, use and transportation.

The global warming effect of leaked hydrogen is almost 12 times stronger than that of carbon dioxide, Cicero concludes in a report published by the journal *Nature Communications Earth & Environment*. The report was prepared to help "fill a gap in knowledge about the climate effects of hydrogen, a central technology in the energy transition".

Unlike exhaust from burning coal and gas that contains CO_2, burning hydrogen emits only water vapor and oxygen, but the leaking of hydrogen from production, transportation and usage can add to global warming. Hydrogen is not a greenhouse gas, but its chemical reactions in the atmosphere affect GHGs like methane, ozone and stratospheric water vapor. In this way, emissions of hydrogen can cause global warming, despite its lack of direct radiative properties.

Steel producers that recently announced projects with hydrogen fuel as an energy source include H_2GreenSteel in Sweden, Liberty Steel in Australia, Voestalpine AG in Austria, Ternium S.A. in Mexico, Blastr Green

Steel in Finland and ArcelorMittal in France. Proponents of increased scrap recycling use in steel produced via the electric arc furnace (EAF) method have not opposed the use of hydrogen but have lobbied for wider acknowledgement that recycling has proven itself as a GHG emissions reduction method. But it is indicated that in metals production applications, substituting hydrogen for coal as a fuel still offers net reductions in carbon emissions. It is important to note that though hydrogen leaks have a climate impact, using hydrogen to phase out very CO_2- intensive applications is still likely to be a very effective climate mitigation measure. What the study points out is that attention should be paid to potential leakages to ensure the best climate outcome.

The climate effects of hydrogen have been an under-researched topic. This study used five different atmospheric chemistry models and investigated changes in atmospheric methane, ozone and stratospheric water vapor. Uncertainties were assessed. A global warming potential (GWP100) of 11.6 is significant, and the study clearly shows the importance of reducing hydrogen leaks. GWP is an index designed to measure how much infrared thermal radiation a GHG added to the atmosphere would absorb over a given time frame.

There is no technology to monitor and detect hydrogen leaks at the scale needed, but it is being developed now as the industry adapts hydrogen. Potential benefit of switching to a hydrogen economy will depend on the magnitude of hydrogen leakages and to what extent hydrogen replaces fossil fuels.

Source: Accelerate Hydrogen; *7 June 2023*

Pipelines for Safe Transportation and Storage of Hydrogen

UK-based LIBERTY Pipes Hartlepool has successfully passed trials to become the first UK producer of pipelines for safe transportation and storage of hydrogen.

Physical testing specialist *Element Materials Technology* has confirmed that LIBERTY's 42-inch submerged arc welded (SAW) line pipe meets international requirements for hydrogen piping and pipelines set by the American Society of Mechanical Engineers in the standard ASME B31.12 (2019).

The demanding fracture mechanics testing loaded the weld, heat affected zone and pipe material to twice the required stress intensity and exposed them to a 100 barg hydrogen atmosphere for 1000 hours with no crack growth recorded.

Demand for SAW line pipes is rising rapidly as part of the expected need for significant quantities of new pipelines required to meet the demands of the transition to Net Zero.

LIBERTY Steel in Australia announced last month that it has engaged global equipment suppliers for the installation of a direct reduction plant (DRP) at its Whyalla steelmaking operations to produce low carbon iron. The unit will initially use a mix of natural gas and green hydrogen as the reducing agent, before fully transitioning to green hydrogen as it becomes available at scale.

The successful SAW tests are an important step in LIBERTY Pipes Hartlepool's development of a suite of hydrogen service fracture mechanics tests, including future quasi-static testing. The company will continue to work with Element Materials Technology to further extend its availability of pipes suitable for hydrogen.

LIBERTY Pipes Hartlepool has also developed line pipe steel capable of supporting the emerging market in CO_2 gas gathering, transmission and sequestration.

Source: Weekly News from Steel Times International, 17th May, 2023

India to Issue Tenders for Green Hydrogen Production and Electrolyser Manufacturing

India is set to issue its first tenders under its National Green Hydrogen Mission programme. In January, the Indian cabinet approved an "initial outlay" of 187.44 bn rupees ($2.4 bn) for its National Green Hydrogen Mission, which aims to make India a global hub for the production, utilisation and export of renewable H_2 and its derivatives. At the time, it was announced that the vast majority of the funding - 174.9 bn rupees ($2.11 bn) - would be spent on two distinct financial incentives: one for the production of green hydrogen and the other for the domestic manufacturing of electrolysers.

The government said in January that the funding "is likely to" enable at least five million tonnes of annual green hydrogen production capacity by 2030 — powered by about 125 GW of new renewable energy projects. And in April, it was reported that green hydrogen producers would receive a subsidy of at least 30 rupees ($0.36) per kilogram, with 50 rupees/kg offered in the first two years, although these figures have not been confirmed by the government.

By comparison, the US is offering production tax credits of up to $3/kg — 88% higher than 30 rupees — while the EU is set to have an auction-based system with a subsidy price cap of €4 ($4.36) per kg.

Source: Accelerate Hydrogen Newsletter, 18 May 2023

World's First Green Hydrogen Price Index Launched

The European Energy Exchange (EEX) launched what it describes as the first "market-based" *green hydrogen price index*, called *Hydrix*, in an effort to improve price transparency - despite the lack of a traded renewable H_2 market.

EEX will base its weekly updates on what price potential buyers and sellers would theoretically be willing to pay or sell at on a week-by-week basis

While EEX says there are "already price indications from bilateral supply contracts", the methodology of the index depends on industry contributors from both the production and consumption side submitting a single buy or sell price (in euros per megawatt-hour) each week, based on what they would theoretically be willing to spend or accept.

The levelized cost for producing green hydrogen in a given region could be estimated based on renewable power-purchase agreement and electrolyser costs, taking into account storage and transportation, but actual agreed offtake prices may be very different, depending on what buyers are willing to lock in for a long-term contract. And the details of those contracts are usually, if not always, confidential. This all raises questions about how useful or accurate such an index would be in the short to medium term, but EEX is adamant that Hydrix will be a significant development in the race to net zero emissions.

Hydrix estimates that the green hydrogen price in Germany — the only currently country listed on its launch — is €228.16 ($245.52) per MWh this week, rising from €222.84/MWh the week before.

The EU plans to hold its first auction at the end of this year for fixed premiums of up to €4 per kilogram of renewable hydrogen — equivalent to around €121/MWh — in order to bring costs down to parity with fossil-fuel equivalents.

A further complication is that the Hydrix methodology merely describes green H_2 as "hydrogen produced by electrolysis powered by renewable energies". But in reality, the price of green hydrogen will be affected by yet-to-be-passed regulations around concepts such as additionality (the requirement to use new renewable-energy projects to power electrolysers) and temporal correlation (rules regarding the potential to use electricity, from the grid at times when the wind isn't blowing and the sun isn't shining, to the grid at a later time or date).

Source: Accelerate Hydrogen Newsletter, 25 May 2023

GIGA Steel

Over the last 60 years, consumers, automakers, and regulatory agencies have been looking for ways to build cars that are safer for their passengers. As standards for fuel efficiency, CO_2 emissions, and auto safety become more strict, auto manufacturers and consumers are looking for lighter, more eco-friendly, and safer cars. The steel industry has responded by offering material solutions that are stronger and able to absorb more powerful impacts.

POSCO GIGA STEEL is one of those solutions, with the strength more than three times than aluminium and with formability properties that allow it to be made into complex auto parts. It is more environmentally friendly as it reduces carbon dioxide emissions from the producing process to assembly by a quarter compared to emissions from the production of aluminium products. Giga steel combines several unique features:

- ***Strength & Safety:*** POSCO GIGA STEEL is more than three times stronger than automotive aluminium. Because of its high strength, POSCO GIGA STEEL also adheres to some of the most stringent international safety standards.

- ***Formability:*** Because the mixing ratio of manganese has been precisely controlled, POSCO GIGA STEEL has highly formable properties that allow it to be made into complex auto parts without any special processing.
- ***Lightweighting:*** Because POSCO GIGA STEEL boasts high strength, it is possible to use less of it. This ultimately makes it lighter than car frames made of general steel or aluminium.
- ***Affordability:*** POSCO GIGA STEEL is a cost-effective solution for automakers, especially when compared to alternative materials, which in turn helps lower prices for consumers.
- ***Sustainability:*** When looking at the entire lifecycle of a vehicle made with steel, POSCO GIGA STEEL emits 10% lower CO_2 emissions compared to aluminium.

Giga steel is a next-generation steel sheet that is extremely strong, withstanding over 100 kg of load per 1 mm^2, and also exhibits excellent tensile strength and formability. Giga steel is especially seen as a crucial material for electric vehicles that require lightweight components for increased energy efficiency. Given that electric vehicles, due to a battery weight of 400-450 kg, are on average 25% heavier than internal combustion engine vehicles, all global electric vehicle companies are focusing on weight-reducing strategies. Giga steel, due to its strength, can reduce the thickness of vehicle components, contributing to a lighter vehicle body.

In order to meet the request for weight reduction of the parts while keeping stable stiffness in case of an accident the automotive industry, especially in regards to E-mobility, has focused on Giga steel (UHSS) as an alternative to currently used materials. Giga steel can be used for bumpers and crash boxes, for conventional automotive and E-mobility and for the main frame of battery cases as protection in case of an accident.

European OEMs and big U.S players have started using Giga steel for EV battery cases and EV body structure parts, however compared to processing regular steel (tensile strength: 400 ~ 800 Mpa), processing Giga steel (tensile strength: 1.8 Gpa) is more challenging.

Source: POSCO has completed the construction of a high-strength ..., gmk.center, https://gmk.center › news › posco-has-completed-cons...

India's 30 Critical Minerals

In a significant move to enhance its strategic resource security, India has officially released its first-ever critical minerals list, identifying 30 key critical minerals crucial to the nation's economic growth and technological development.

This pioneering step aims at reducing import dependence, enhancing supply-chain resilience, and supporting the country's net-zero objectives.

The critical minerals list, formulated by the Ministry of Mines, includes a diverse range of minerals considered essential for various industries such as defence, electronics, renewable energy, tele-communications, and transportation, among others.

Critical minerals for which India is 100% import-dependent

Mineral	Major application
Lithium	Rechargeable batteries, ceramics
Cobalt	Rechargeable batteries and superalloy
Nickel	Stainless steel, superalloys, rechargeable batteries
Vanadium	Alloying agent for iron and steel, batteries
Niobium	Steel and superalloys, construction, transportation
Germanium	Fiber optics and night vision applications
Rhenium	Superalloys, aerospace and machinery use
Beryllium	Alloying agent in aerospace and defense industries
Tantalum	Electronic components, mostly capacitors and in superalloys
Stronium	Aluminium pigments and fillers, glass, magnets

Source: A report on *Unlocking Australia–India Critical Minerals Partnership Potential* by Australian Trade and Investment Commission, July 2021/ Critical Minerals of India report

The list comprises 30 minerals, including 17 rare earth elements (REEs) and six platinum-group elements (PGE), each designated as critical based on their economic importance and limited availability in India's geological reserves.

Among the minerals featured on the list are antimony, beryllium, bismuth, cobalt, copper, gallium, germanium, graphite, hafnium, indium, lithium, molybdenum, niobium, nickel, PGE, phosphorous, potash, REE, rhenium, silicon, strontium, tantalum, tellurium, tin, titanium, tungsten, vanadium, zirconium, selenium, and cadmium as critical to Indian economy.

Ten minerals on the list are 100 percent import-dependent. These are lithium cobalt, nickel, vanadium, niobium, germanium, rhenium, beryllium, tantalum, and strontium.

To expedite the development of domestic mineral resources, the government plans to encourage public and private investments in exploration, mining, and processing facilities. It also intends to facilitate the adoption of advanced technologies and international collaborations to enhance efficiency and environmental sustainability in the extraction and processing of critical minerals.

India has already entered into the US-led Mineral Security Partnership to secure a global supply chain for critical minerals. This is India's second such alliance this year.

In April, in a first-of-its-kind partnership, the Indian and Australian governments decided to jointly invest $3 million each for five critical mineral exploration projects in Australia.

In mid-2020, India, through Khanij Bidesh India Limited, a joint venture of three public sector undertakings — National Aluminium Company, Hindustan Copper Limited, and Mineral Exploration Company Limited — signed an agreement with an Argentinian firm to jointly prospect lithium. Besides this, it is also exploring options in Chile and Bolivia.

Critical minerals have complex global supply chains with a high concentration in the extracting and processing countries, resulting in high supply risks.

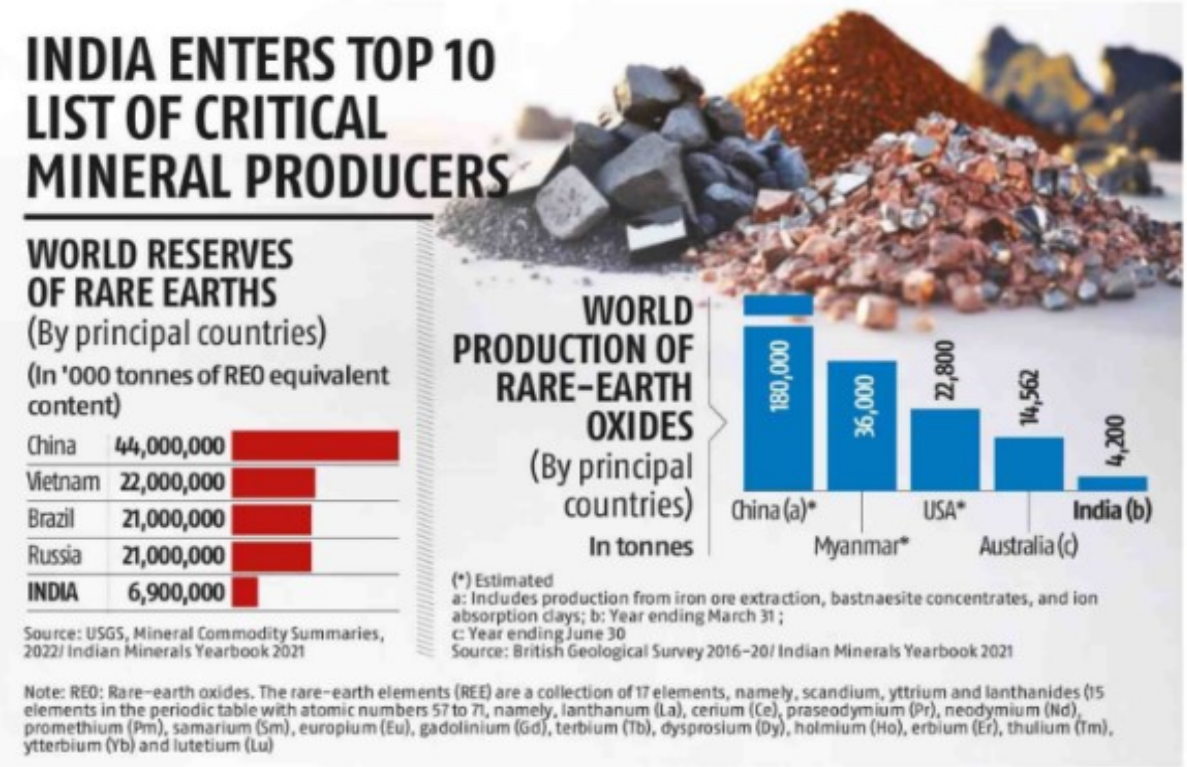
The US has declared 50 minerals critical in light of their role in national security or economic development.

Source: Business Standard, 29th June 2023

India's First Critical Minerals List a Step Towards Supply-Chain Security

The release of the first list of critical minerals by India and the country's entry into the US-led Minerals Security Partnership (MSP) have boosted its prospects of securing a global supply chain for the items.

In April, in the first such partnership, the Indian and Australian governments decided to jointly invest $3 million each in five critical mineral-exploration projects in Australia. Though India is ramping up its supply chain, it is still lagging behind China, which is one of the world's largest producers or processors of critical minerals.



China produces 60 percent of the world's rare earth elements (REEs). Not just the minerals it produces, Beijing, by importing and processing, has taken the lead in controlling the critical minerals it does not produce. For example, Australia produces 52 percent of the world's lithium, but China is the major importer and processor of 58 percent of the global supply according to a report of the Centre for Social and Economic Progress.

China's race for renewables and advanced technology started in 2001. In the past two decades, the country has created five of the top 10 battery manufacturers in the world. The country is among the top five producers of semiconductors and has around more than half the electric cars on the road worldwide.

India, on the other hand, despite having the fifth-largest reserves of rare earth minerals in the world, lags behind its peers due to a lack of private participation, stringent laws, and the absence of technology. India imported, every year, titanium dioxide worth $1 billion because of technological inefficiencies and litigation. To unlock the mining sector's potential, opening up

the sector to private players, encouraging domestic exploration, and adopting efficient technologies are essential.

The government's push to build a global supply chain came after the country's manufacturing sector faced a shortage of semiconductors and other essential components required for the electronics and auto industry during Covid-19 and the Russia-Ukraine war.

Though India is the first developing country from the Global South to find a place in the MSP, it has a long way to go before fully securing a global supply chain. Besides the US, the MSP includes Australia, Canada, Finland, France, Germany, Japan the Republic of Korea, Sweden, the UK, the European Commission, Italy, and now India. With an entry into the MSP, India can strengthen its mineral supply chain but it has to develop processing and manufacturing technology.

Critical minerals refer to mineral resources, primary and processed, which are essential inputs in the production process and whose supplies could be disrupted. While some are inputs for traditional industries, many are crucial for the high-tech products required for clean energy, national defence, informational technology, aviation, and space research. Ten minerals are 100 percent import-dependent, and the key issue is to ensure reliability in imports from different sources to meet India's net zero targets.

The US has declared 50 minerals critical in the light of their role in national security or economic development. Demand for critical minerals in India is expected to grow due to the government's increased thrust on "Make in India", "Smart City" programme, Aatmanirbhar Bharat, the 100-GW target for renewable energy, the production-linked incentive schemes for the consumer electronics industry, accelerated growth for electric vehicles, etc.

To do various jobs related to strategic minerals, a joint venture, Khanij Bidesh India Ltd (KABIL), of three public sector undertakings – National Aluminium Company, Hindustan Copper, and Mineral Exploration Company – was announced in 2019, with a stake ratio of 40:30:30. In mid-2020, India, through KABIL, signed an agreement with an Argentine firm to prospect for lithium. Besides this, it is exploring options in Chile and Bolivia.

The country is working on reforming laws to exploit the potential of India's untapped potential in critical mineral mining.

Source: Business Standard, 30th June 2023

Critical Minerals are Critical

The world is witnessing rapid technological advancement, which, while propelling growth and prosperity, is bringing to the forefront the importance of critical minerals, classified into energy minerals and rare earth elements. Nickel, lithium and cobalt have applications across various sectors, such as renewable energy, electric mobility, consumer electronics and high-end industrial applications. Consequently, their demand will rise rapidly, underscoring the need for a reliable and resilient supply chain. Moreover, India aims to be a manufacturing powerhouse and is committed to achieving net zero, implying a shift to clean energy. Thus, to unlock the nation's full potential, it is imperative to formulate a national resourcing strategy for critical minerals. A steady supply of minerals and investments in end-to-end value chains will increase the nation's manufacturing output, thus creating job opportunities and encashing our demographic dividend.

The challenge is that the supply of critical minerals is limited. With demand expected to increase exponentially because of a greater global emphasis on renewable energy, the country needs a concrete strategy. This is more so because the global supply chain of these minerals is concentrated in certain regions and unevenly distributed. Nations blessed with such resources are looking to take control to meet their needs and that of friendly countries.

While several critical minerals are found in India's list of natural resources, there must be a concerted effort on exploration to determine the exact availability of each, besides scouting for other strategic minerals. On the policy front, the government must fund research projects that develop recycling, reusing and repurposing strategies, and breakthroughs in technology for mineral exploration and processing must be pursued as many critical minerals are deep-seated or located offshore and often require complex processing.

Therefore, there is need for a comprehensive national resourcing strategy. The Ficci report on New Age Energy Minerals, released in June, has compiled geographical and geological information, details of the value chain, including end-use sectors and applications, market outlook and long-term demand forecasts for critical minerals. It advocates prioritizing exploration and leveraging India's mining expertise and strategic ties to locate and access critical minerals.

India, Australia and Japan entered the Resilient Supply Chain Initiative (RSCI) in 2020 to attain sustainable, balanced and inclusive growth in the Indo-Pacific

region. This trio and the US, forming the Quad, recently set up a working group for critical materials and technologies. This year, India and Australia committed to working together towards investment in critical minerals, especially lithium and cobalt, and developing supply chains between the two countries. This move came after a year of signing the India-Australia Critical Minerals Investment Partnership.

India is well-positioned to participate in diverse global value chains and contribute to mining, processing and manufacturing. However, we must enhance our domestic research and development and emerge as a market leader in mineral-related technology. Fostering the development of mineral ecosystem is necessary to achieve the nation's economic and environmental objectives. Given this backdrop, a national resource strategy focusing on critical minerals is the need of the hour. India must actively participate in global value chains to create and safeguard its supply chains. Acting quickly and decisively will boost the nation's growth trajectory and lead to Aatmanirbhar Bharat.

Source: The Economic Times, 14th June, 2023

POSCO's High-strength Steel Processing Plant in China

South Korean steel company POSCO Group has announced that it has completed construction of a new integrated plant for the processing of high-strength steel (Giga Steel) used in the automotive industry in China's Jiangsu Province. The new enterprise is located in POSCO-CSPC (China Suzhou Processing Centre).

The company plans to increase the sales of Giga Steel from the current 6% of the total processing centre's sales to 12% in 2027. The company has invested in a special Giga Steel splitting machine with a capacity of 135,000 tons per year and a press machine with a load capacity of 1,600 tons. This will allow changing the shape of steel sheets by stamping for the production of semi-finished products for electric cars.

By installing new equipment for Giga Steel in the Chinese processing centre, POSCO will be able to increase sales of high-strength steel products. With the next-generation steel product, the company aims to continue its expansion in the electric car market. The new facility has been established in response to the surging demand for electric vehicles.

POSCO operates foreign processing centres in 26 locations globally to support its aim of broadening its global sales. CSPC, founded in 2003, is POSCO's largest automotive steel sheet processing centre with an accumulated sales volume of 8.97 million tons. It's strategically situated in the Huadong region of China, a hub for global electric vehicle companies.

Previously, CSPC faced challenges in maintaining quality stability and meeting increased demand when processing giga steel using standard slitters and blanking equipment. However, the introduction of the new specialized equipment enables CSPC to broaden sales of giga steel, a high-value-added product.

The new giga steel processing complex at CSPC will first cut the raw material and then produce semi-finished car parts via press processing. This process not only allows auto parts companies to reduce their costs on press equipment investment but also enables CSPC to eliminate intermediate transportation costs and enhance added value.

POSCO's strategy aligns with the reopening of the world's largest car production market, China, and the global automotive industry's shift towards electric vehicles. The company intends to expand processing centres capable of complex high-strength materials processing, thus ensuring a proactive position in the burgeoning eco-friendly electric vehicle market.

Giga steel is an ultra-high-strength-steel that can withstand a load of over 100 kg per square meter. By utilizing giga steel, vehicle components can be made thinner without compromising strength, resulting in lighter weight.

Advanced high-strength steels (AHSS), like POSCO GIGA STEEL, offer the automakers a unique solution that combines light weighting properties, strength, and affordability.

Trends that Will Forever Change the Automotive Industry

The last 15 years have seen cars that are connected, autonomous, shared, and electric. These recent trends represent a turning point for an industry that is being forced to recognize the quickly changing habits of its consumers as well as the increasingly strict safety and fuel efficiency regulations. In order to adapt, the automotive industry is learning to make

cars differently. Underpinning all of these advancements is a need for stronger, lighter, and more durable materials like POSCO GIGA STEEL.

Automakers Look to Steel for Lower CO_2 Emissions

Several factors are contributing to the growing interest in electric vehicles. Stricter CO_2 emission standards are changing the way cars are being made, and consumers are becoming more environmentally conscious at the same time. To produce more fuel efficient vehicles, car makers are looking to advanced materials in lightweighting that can help make vehicles more eco-friendly while being safe and affordable.

GIGA STEEL Offers Solutions for the Evolving Auto Industry

Last year, POSCO sold approximately 9 million tons of automotive steel sheets, accounting for 10% of the global automotive steel sheet market. POSCO plans to expand their partnerships with automakers by providing customers with the most advanced, high-quality automotive steel. POSCO GIGA STEEL represents the beginning of a new era for automakers. It is lightweight, strong, high formable, and affordable.

GIGA STEEL Opens Door to the Future of the Auto Industry

Mileage, design, and emissions are considered the most when purchasing a car. But more than ever, the industry is requiring that a vehicle goes longer distances with less fuel, which means the car must be lighter while consumers want a car that represents their personality, demanding vehicles with more sophisticated and elegant designs.

Source: POSCO Steel website

POSCO's Hydrogen-based Steel Plant

South Korean steelmaker POSCO is preparing to break ground this month on a pilot facility for hydrogen-based steelmaking, with a capacity of 300kt/yr at its Pohang steel complex in North Gyeongsang Province. Scheduled for completion in 2026, the facility will begin testing the production of low-carbon steel, which the company hopes will ultimately reduce its carbon emissions by up to 90%.

POSCO said the pilot plant will be the world's first of its kind to use fluidized bed reduction reactors (HyREX) and widen its gap with rival steelmakers. It aims to reach carbon neutrality by 2050.

The fluidized bed reduction reactor is based on an original fine iron ore reduction technology which produces direct reduced iron (DRI) by combining iron ore fines and hydrogen.

The cost of transforming to hydrogen-based steel production is estimated at up to 40 trillion won ($30 billion), including sunk costs for blast furnaces and investments, according to the company.

Source: Steel Times International Weekly News, 7th June, 2023

POSCO Selected as the Sustainability Champion

POSCO was selected as the Sustainability Champion for two years in a row at the first half of the year member's meeting of the World Steel Association.

POSCO was credited highly for its efforts and achievements for ESG management, including the joint efforts for the development of HyREX, the declaration of carbon neutrality in 2050, the establishment of an advanced governance structure, etc.

The World Steel Association has been selecting companies that lead the carbon neutrality of the steel industry and the field of environmental, social and corporate governance (ESG) as Sustainability Champions, among over 140 member countries every year since 2018. Ten companies registered their names on the Sustainability Champions this year, and POSCO held the honour to be selected as the Sustainability Champion both last year and this year.

To be the Sustainability Champion, the following four conditions should be satisfied:

△ Being selected as a member excellent in sustainability,
△ Being a finalist in the Steelie Awards or Safety & Health Recognition,
△ Issuance of a Sustainability Report, and
△ Submission of the sustainability data and the Life Cycle Inventory (LCI) data for each material and process.

The steel company which has been selected as the Sustainability Champion will be recognized as the global best practice for ESG management worthy of its name.

Source: Steel Times International Weekly News, 7th June, 2023

Electric Vehicle Battery Components Unit

Epsilon Advanced Materials (EAM) has announced that it would invest $650 million in an electric vehicle battery components facility in the US.

The company is planning to establish a 50,000-TPA synthetic graphite anode manufacturing facility in the US to supply high-capacity anode materials produced through green technologies.

The facility is expected to generate more than $500 million at full capacity by 2031. The unit will generate more than 1,500 direct and indirect employment opportunities and is expected to be commissioned by 2026. The facility is also expected to provide critical battery materials to power more than 1 million EVs. The company is evaluating locations across the US for the proposed facility.

The battery value chain is a critical enabler to electric mobility adoption.

Source: live mint, 26th June 2023

Graphene

What Artificial Intelligence (AI) is to software and quantum computing is to computers, graphene is to materials. These three emerging technologies will disrupt the existing human-machine interface in the next couple of decades. While India is among the leaders in AI and a potential challenger in quantum computing, it needs to catch up in the area of graphene.

Graphene is the world's thinnest, strongest, and most conductive material of both electricity and heat. It conducts electricity better than copper. It is 200 times stronger than steel but six times lighter. It is almost perfectly transparent as it absorbs only 2% of light. It is impermeable to gases, even those as light as hydrogen and helium. It has the potential to revolutionise electricity, conductivity, energy generation, batteries, sensors and more. Also, when added to other materials, graphene even in small quantities produces composite materials with dramatically transformed qualities. Graphene

composites are used in aerospace, automotive, sports equipment and construction. It is used for high-performance batteries and super-capacitors, touchscreens, and conductive inks. Graphene-based sensors are used for environmental monitoring, healthcare and wearable devices. Graphene oxide membranes are used for water purification and desalination. Graphene-based masks were made during COVID.

Graphene is important for defense and aerospace as well. Its exceptional strength makes it promising material for armour and ballistic protection. Graphene has the potential to absorb and dissipate electromagnetic waves, making it valuable for developing stealth coatings and materials that reduce radar signatures and electromagnetic interference. Graphene is highly sensitive to environmental changes, which makes it an excellent candidate for sensing chemical and biological agents, explosives, radiation, and other hazardous substances. Besides, graphene-based materials can also protect us against chemical and biological attacks. Better energy storage and electronics properties make graphene attractive in defense and aerospace as well as in civil and commercial applications.

Never has one material had such an impact on so many sectors. Materials define an age – the stone age, iron age, plastic age and silicon age. There are reasons to believe that we are entering the graphene age. The global graphene market size was valued at $175.9 million in 2022 and is expected to grow at a CAGR of 46.6% between 2023 and 2030.

Although graphene was discovered in 2004, it was difficult to produce high-grade large-scale graphene. However, things are changing fast. At least one graphene-enhanced product was launched every week in 2022. Over 300 companies are now producing graphene or its derivatives.

Among the leading countries in graphene research are China, the US, the UK, Japan, South Korea, Russia and Singapore. Till 2012, graphene-related patent filing was dominated by the US. From 2013 to 2016, South Korea and China matched the US. After 2017, China surged ahead. In 2018, China filed 218 patents while the other leading countries together filed 79. India had eight filings.

China and Brazil are global leaders in the commercial production of graphene. At the Beijing Graphene Institute, set up in 2018, several companies produce industry-grade graphene products.

India's progress

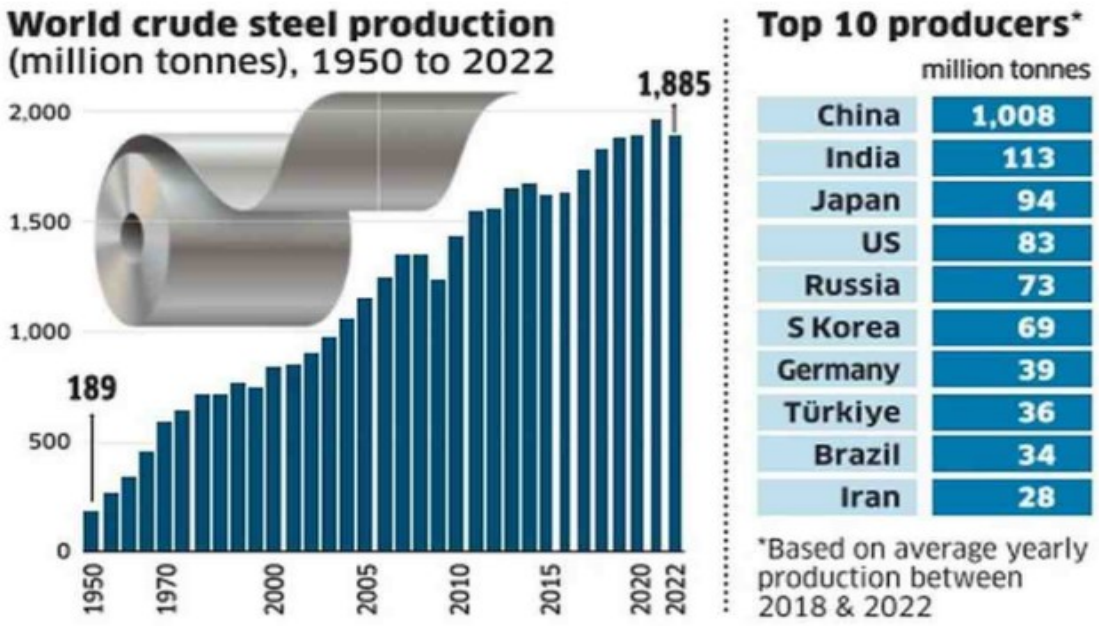
India produces about one-twentieth compared to China and one-third compared to Brazil. But India's progress has been better than many nations. The Centre for Nano Science and Engineering at IISc Bangalore along with KAS Tech produced a graphene-based system several years ago. Some start-ups and foreign subsidiaries have started graphene or graphene derivatives in India. Notably, Tata Steel has succeeded in growing graphene (about 50 micrometers large domains) using annealing and extracting atomic carbon from steel surface. It has also mixed graphene with used plastic products to recycle them as new. India's niche is going to be innovation using graphene. It figured out how graphene oxide-based wrappers loaded with preservatives can increase the shelf life of fruits and vegetables. The IIT Roorkee-incubated Log 9 has patented a technology for graphene-based ultra-capacitors, and the IIT Kanpur-incubated RF Nanocomposites has developed EMI shielding and stealth technology using graphene-based nanotubes. But this trickle needs to be converted into a torrent. A laudable step in this direction was the setting up of the India Innovation Centre for Graphene in Kerala. It is being implemented by the Digital University Kerala in partnership with Tata Steel and C-MET, Thrissur. The Centre needs to become the nodal point to spur large-scale innovation activity around graphene.

China declared graphene a priority in its 13th Plan. Europe set up the Graphene Flagship, with a budget of €1 billion in 2013. India needs to be among the leaders in graphene because we may experience the 'winner takes the most' situation here. Given the high-cost-to-volume ratio for high-grade graphene, its production may get concentrated in a few locations in the world, as in the case of semiconductors. India missed the semiconductor bus in the mid-1990s. The time to step on the graphene pedal is now.

Source: The Hindu, 1st June 2023

World Crude Steel Production 1950-2022

Although global steel production fell last year because of the lingering effect of the Covid-19 pandemic on economic activity, output has grown almost 10 times since 1950. China accounts for more than half the output followed by India



(6%) and Japan (5%). The top 10 countries make roughly 84% of the total steel.

Source: WSA Data

ArcelorMittal's 'CCU' Facility in Ghent

ArcelorMittal and LanzaTech Global Inc. announced the successful commencement of production from ArcelorMittal's commercial flagship carbon capture and utilisation ('CCU') facility in Ghent, Belgium. The €200 million 'Steelanol' facility is a first of its kind for the European steel industry, deploying technology developed by carbon utilization company LanzaTech. This was the first step toward full operation of a commercial scale facility that will capture carbon-rich waste gases from steelmaking and biologically convert them into advanced ethanol through LanzaTech's bio-based process. Unlike traditional fermentation, the process ferments gases instead of sugars and uses a biocatalyst instead of yeast. The facility was inaugurated in December 2022, with cold commissioning taking place thereafter. The biocatalyst has now been introduced into the facility (a process called inoculation) to begin growth and verify production of new molecules.

In May 2023, the first gases from the steel mill's blast furnace were safely introduced to LanzaTech's biocatalyst. After a successful inoculation, initial samples that contained ethanol were produced this week, demonstrating that the carbon in the gases is being converted into new chemical products. Commercial-scale ethanol production from the bioreactors will follow, with expected ramp up of production in the coming months. This advanced ethanol can then be used as a building block to produce a variety of products, including sustainable transport fuels, packaging materials, apparel, and even cosmetic fragrances, hence helping to advance the decarbonization efforts of the global chemical sector.

The Steelanol plant has the annual capacity to produce 80 million litres of advanced ethanol. It expects to reduce carbon emissions from the Ghent plant by 125,000 tonnes annually,

The product samples from the facility this week mark an important step toward the circular use of carbon and the end of single-use carbon, whereby gases are no longer regarded as waste but as raw materials.

The LanzaTech process implemented at this site is fully flexible: not only can it use industrial gases from today's steel production methods but also it can adapt as industry transitions to future steel production technologies with increased green hydrogen input. This versatility enables the carbon recycling application to evolve with available residue, waste streams, and green H_2. LanzaTech's process is already employed by three operational commercial facilities, and LanzaTech anticipates the launch of two additional commercial facilities, in Asia, before the end of the year.

The Steelanol facility is expected to reach full operational capacity before the end of the year.

Source : ArcelorMittal News, 14.6.23

3D-Printing of Aluminum for EV Parts

Cans, Roofs, Beer kegs, Computer enclosures and Electric vehicle components - These are five of the wide-ranging applications for aluminium, one of the world's most commonly used metals across pretty much any sector one can name.

Lightweight and strong, aluminium is produced at a rate of approximately 68 million metric tons annually (as of 2021), but a big bump in demand is coming as industries race to electrify vehicles and industrial processes, predicts the International Energy Agency (IEA). Last year, volume expanded by 4 percent, driven by a spike in production for automotive and transport applications.

Alloy Enterprises, a three-year-old 3D-printing startup from Burlington, Massachusetts, is seeking to ride that growth wave, while cutting emissions and waste in the process.

Alloy Enterprises is developing and scaling 3D-printing technology that combines laser-cutting techniques and "diffusive bonding" (a solid - state welding method) to create components for the automotive, industrial and heavy equipment sectors. It uses coiled sheets of aluminium as the raw input, rather than the powders typically required by other types of 3D metal printers. That makes for lower material costs by "an order of magnitude" at higher production volumes than has traditionally been the case for *3D metal printing*.

How much will Alloy *Enterprises*' production process reduce carbon footprints for manufacturers that use its approach? That depends on the origin of the aluminium coils used as a feedstock. Primary aluminium production accounts for about 3% of annual industrial emissions worldwide. For comparison, steel accounts for about 8%.

Aluminium refining and smelting account for about 90 percent of the carbon dioxide emissions related to its production, while recycled production, anode production and casting account for the rest. *Alloy Enterprises*' impact will fall into that latter category, so its process addresses just a small fraction of the reduction potential.

Over the past decade, plenty of efforts have gone toward reducing the emissions impact of primary aluminium production and in promoting aluminium's reputation as an "infinitely recyclable" material.

Source: Climate Tech, June 14, 2023

XCarb™: Recycled and Renewably Produced (RRP) Steel

ArcelorMittal North America will supply General Motors (GM) with XCarb™ recycled and renewably produced (RRP) steel, offering 'significantly reduced CO_2 emissions compared to much of the carbon steel available in North America. Material will be supplied from ArcelorMittal Dofasco in Hamilton, Ontario and shipments are expected to begin later this year.

ArcelorMittal North America's XCarb™ RRP steel is made via the EAF route and contains a stated minimum of 70% scrap, with up to 90% scrap, and does not use carbon offsets to achieve the reduced carbon intensity, according to the company.

ArcelorMittal is currently aiming to reduce the carbon intensity of the steel it produces by 25% globally by 2030 and to achieving carbon neutrality by 2050.

Source: Steel Times International, Weekly News, 15.6.2023

Mercedes-Benz AG and H_2 Green Steel Secure Supply Deal

Mercedes-Benz has signed a supply agreement with Swedish start-up H_2 Green Steel (H_2GS) over approximately 50,000 tonnes almost CO_2-free steel per year for its European press shops and deepened its partnership through a MoU with the aim to establish a sustainable steel supply chain in North America.

Mercedes-Benz took an equity stake in H_2GS in 2021; the new supply agreement enables Mercedes-Benz to bring almost CO_2-free steel into series production. The partner plans to start its production during 2025.

As part of a broader effort to decarbonize the supply chain, Mercedes-Benz and H_2GS agreed to aim to establish a supply chain for green steel produced in North America for local Mercedes-Benz manufacturing plants. Extending the strategic partnership with H_2GS to North America marks another important milestone in increasingly pursuing the strategy of procuring close to Mercedes-Benz production sites.

By using a new, innovate manufacturing process, the production of steel at the H_2GS production site is almost CO_2-free. By contrast, steel produced using a classic blast furnace emits an average of more than two tons of CO_2 per ton. In

the new process, the supplier uses hydrogen and electricity from 100% renewable energy sources instead of coking coal in steel production. The hydrogen serves as a reduction gas, which releases and binds the oxygen from the iron ore. Unlike the use of coking coal, this does not produce CO_2, but water vapor. H_2GS aims to achieve a footprint of 0.4 t CO_2 per ton of steel at start of supply.

Mercedes-Benz is working with all its suppliers towards a net-carbon neutral supply chain from 2039 at the latest. To achieve its climate goals, the luxury carmaker is retooling its supply chain to focus on the prevention and reduction of CO_2 emissions rather than off-setting. Already, the brand has introduced low-CO_2 steel made from scrap into four series models. This allows CO_2 emissions for the respective steel grades to be cut by more than 60%.

Moreover, Mercedes-Benz recently announced to bring aluminium with almost 70% CO_2-reduction compared with the European average into series production as the lightweight material is becoming increasingly important for electric vehicles. At the same time, Mercedes-Benz aims to increase the share of secondary raw materials in its passenger car fleet to an average of 40%. Mercedes-Benz and H_2GS agreed to collaborate on levers to increase the scrap content accordingly.

Source: Steel Times International, Weekly News, 15th June, 2023

Carbon Recycling Project of ArcelorMittal and Sekisui Chemical

ArcelorMittal and SEKISUI CHEMICAL have been partnering on a project to capture and reuse CO_2 emitted during steelmaking. As part of this partnership, the two companies have been supported by the New Energy and Industrial Technology Development Organization (NEDO), Japan's national research and development agency, and have launched an "International collaboration on CCU for circular carbon in Steelmaking" scheduled for three years from 2021.

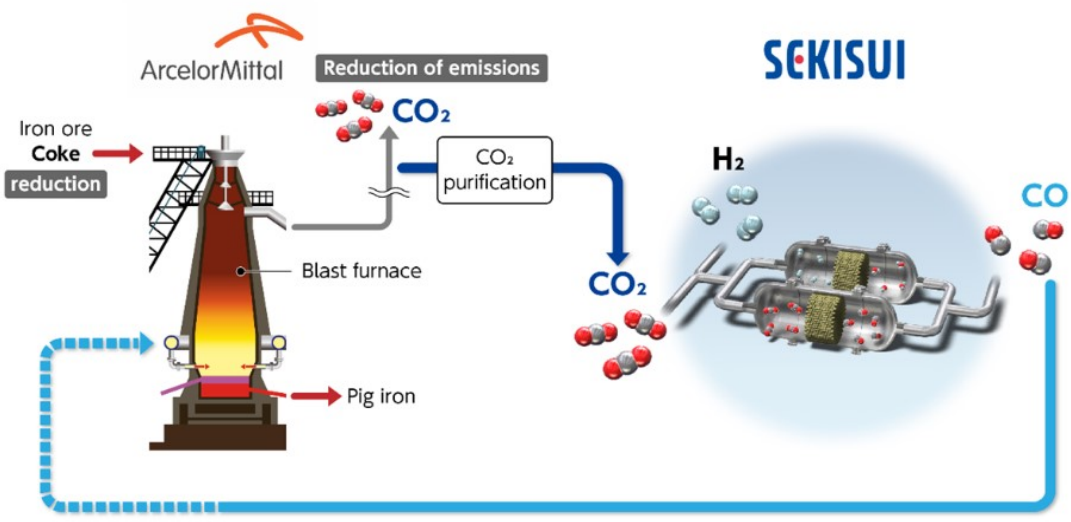
One of the research topics is to develop a fundamental technology for Synthesis Gas (carbon monoxide and hydrogen) production using Sekisui Chemical's unique chemical looping technology.

Through tests using actual blast furnace gas at ArcelorMittal's plant in Asturias, Spain, a CO_2 conversion rate of 90% and a hydrogen conversion rate of 75% has

been achieved, higher than the project target of a CO_2 conversion rate of 85% or higher and a hydrogen conversion rate of 60% or higher using this technology. To obtain these results, it was important to carry out a CO_2 capture process reaching 90% of CO_2 purity.

As a next step, the two companies will further optimise the conditions, replace the catalyst with a high-performance one, and conduct a long-term test with a higher reaction yield by December 2023. At the same time, they will consider new projects to demonstrate the ability to scale up the new technology.

Steelmaking accounts for 7-9 percent of global CO_2 emissions. The blast furnace process in particular, which produces pig iron from iron ore, accounts for about 70% of CO_2 emissions in the steel industry, and therefore reducing these emissions is a major challenge for the steel industry. In this process, CO_2 separated and captured from blast furnace gas is converted to Synthesis Gas (a mixture of CO and H_2) through a chemical process. The converted syngas is introduced into the blast furnace as a reduction agent to replace coke (CCU for carbon circulation in steelmaking). Through the project, the companies will demonstrate technologies that contribute to the effective use of CO_2 and CO_2 reduction.



In addition to completing this project, both companies aim to launch a new project to demonstrate the ability to scale up for commercialization.

Source: Arcelor Mittal Announcement, 19 June 2023

Geoengineering

Geoengineering is the intentional large-scale intervention in the Earth's climate system, specifically to counter climate change via climate-altering technologies and measures. These technologies fall into two camps: *carbon geoengineering* and *solar geoengineering*. *Carbon geoengineering* is the removal of carbon dioxide from the atmosphere. Carbon tech, a sector, falls within this category - a.k.a. carbon capture and storage (CCS) and direct air capture (DAC) technology. *Solar geoengineering*, or solar radiation management (SRM), is far less common and minimally commercialized, as it seeks to reflect sunlight away from Earth's surface into space to cool the planet. SRM is often broken down into four distinct methodologies: stratospheric aerosol scattering; marine cloud brightening; space-based technologies; and cirrus cloud thinning.

Overall, geoengineering is a multifaceted topic that is likely to grow as we fail to stop warming past levels of 1.5 degrees Celsius. While carbon tech is commonplace, SRM still requires years of research and testing before it can be a viable tool to mitigate the impact of climate change.

Immersive Technologies

Immersive technologies aim to create digital experiences that are more interactive, engaging and realistic, with a greater degree of sensory immersion and spatial interaction, compared with other online experiences. A hallmark of some immersive technologies is that they integrate with and blur the boundaries between digital and physical experiences. Immersive technologies differ in the use cases and the experiences they offer. Virtual reality (VR) describes computer-generated simulations of three-dimensional environments where users with connected devices like headsets, goggles, or gloves can interact with the environment and with one another. Other immersive technologies, like mixed or augmented reality, allow users to see and hear the physical world with a digital layer, and often integrate digital objects seamlessly into real-world contexts. For example, in medical training, mixed reality can simulate surgical procedures by overlaying virtual anatomy over a physical training mannequin. Advancements in computing capabilities, artificial

intelligence-enabled computer vision and photogrammetric techniques widen the applications of immersive technologies, including their potential economic and social effects. These advancements correlate with significant increases in venture capital investments in virtual and augmented reality start-ups, which passed USD 12 billion in 2021, a more than fivefold increase since 2016.

Technology Deep Dives Immersive Technologies Key Messages

Transforming reality: Immersive technologies enable digital experiences that are more interactive, engaging and realistic, with a greater degree of sensory immersion and spatial interaction, than other online experiences.

A range of applications: While entertainment applications are the most advanced, immersive technologies have important use-cases in health, industry, education and training.

Responsible, values-based and rights-oriented technology: Immersive technologies are associated with potential risks for privacy, security and online safety, including for children.

Contributing to sustainable development: Immersive technologies can be leveraged to help global sustainability goals but like other digital technologies, they could have environmental impact throughout their life cycle, including through increased energy use and e-waste.

Technology divides: Immersive technologies could let more people access experiences that are otherwise expensive, dangerous or out of reach. However, immersive technologies also rely on enablers that are not evenly distributed, especially connectivity and computational power. A small number of players currently account for most virtual reality hardware sales.

Emerging benefits and applications of immersive technologies: By simulating reality, augmenting perceptions of physical reality, and providing a greater degree of sensory immersion and spatial interaction, immersive experiences offer advantages over both traditional online experiences and physical experiences. Immersive technologies can provide more realistic training and education experiences than traditional two-dimensional online training, and can substitute for physical experiences that are otherwise costly, dangerous, impossible or impractical. For example, virtual reality provides a safer,

controlled, cheaper, repeatable, and reproducible environment, which has been found to be effective for mental health treatments that reduce anxiety and treat phobias. Immersive technologies can also enable new forms of social interaction. Social virtual reality platforms where users can connect and share virtual activities and experiences, such as concerts and movies, already exist. In workplace settings, immersive technologies can facilitate more realistic and engaging virtual meetings and conferencing. In industrial contexts, immersive technologies can support dynamic virtual versions of physical places or objects, known as "digital twins". These digital twins can model complex systems, to enable dynamic, real-time design and collaboration. For example, they can enable distributed workforces to co-design complex equipment and experiment with potential product changes before execution. Potential policy implications While immersive technologies are rapidly maturing, their potential policy implications are slowly coming into focus. Other issues include, in particular, concerns around privacy and online safety – especially of vulnerable groups such as children – which may also impact the trust needed for broader uptake. Unlike other digital experiences, some immersive technologies enable, and can sometimes rely on, the collection of data that is largely non-voluntary and difficult for users to control, like pupil dilation.

One estimate from the Stanford Virtual Human Interaction Lab found that 20 minutes in a VR simulation result in almost 2 million unique recordings of body language. Research further highlights that users can be uniquely identified with almost 95% accuracy with just 100 seconds of VR data. Meanwhile, the sensory, realistic and immersive nature of these technologies heightens the effect of exposure to inappropriate content, notably for children. Some predict that immersive technologies will soon dominate most online experiences. However, there are currently few players in some immersive markets. For example, 90% of VR headsets available today are sold by just two companies. To encourage competition and avoid lock-in, it could become increasingly important to enable firms and consumers to easily switch between different immersive technology providers and environments. Common standards for applications in immersive environments, from digital twins to 3D assets, might encourage interoperability and help in this regard. Ensuring benefits can be realised depends on the diffusion and uptake of immersive technologies. As with other emerging digital technologies, immersive technologies rely on key enablers like connectivity and computational power that are not evenly

distributed. As with other technologies, we are on the cusp of understanding the net impact of immersive technologies on sustainability and climate change. For example, while digital twins show promise in reducing industrial energy use and greenhouse gas emissions, immersive technologies have other environmental impacts throughout their life cycle, including e-waste and energy use.

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