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Editor-in-Chief
S C Suri

Performance of Indian Steel Industry: 2022-23

Production and Consumption

- Domestic finished steel production: 122.276 mt (up by 7.6%)
- Domestic finished steel consumption: 119.864 mt (up by 13.3%).
- Per capita consumption: 86.8 Kg /Tonne (around 77-78 Kg/per Capita in FY'22)

Item	Performance of Indian steel industry		
	April-March 2022-23*(mt)	April-March 2021-22(mt)	% change*
Crude Steel Production	126.258	120.293	5.0
Hot Metal Production	81.099	78.223	3.7
Pig Iron Production	5.882	6.262	-6.1
Sponge Iron Production	43.557	39.200	11.1

*provisional

Source: Provisional JPC Data

Tata Steel Jamshedpur Injects Hydrogen in Blast Furnace

Tata Steel has commenced the trial injection of hydrogen gas using 40% of the injection systems in 'E' Blast Furnace at its Jamshedpur Works. It is claimed that this is the first time in the world that such a large quantity of hydrogen gas is being continuously injected in a blast furnace.

The trial started on April 23,2023 and continued for 4-5 days on a continuous basis. Itl provided valuable insights into operating blast furnace with greener fuel injectants, reducing fossil fuel consumption and subsequent CO_2 emissions from the blast furnace. The endeavour is aligned with the Company's vision of becoming Net Zero by 2045.

The trial has the potential to reduce the coke rate by 10%, translating into around 7-10% reduction in CO_2 emissions per ton of crude steel produced.

The successful completion of this trial demonstrated Tata Steel's capability to design, fabricate and commission the injection system, develop and establish necessary general and process safety protocols, and provide process control insight for pure hydrogen injection into the blast furnace.

This trial will help identify the next steps towards achieving goal of a leaner carbon future.

For a long time, hydrogen has been earmarked as an alternative to fossil fuels as an important reductant of iron ore in blast furnace. Given the imperative to make industrial processes greener, hydrogen fuel utilisation is gaining a lot of traction and is being embraced on a scale like never before.

Tata Steel is committed to contributing to India's journey towards industrial decarbonisation and has already taken several steps in this regard including conducting a trial of continuous Coal Bed Methane (CBM) injection in early 2022, installation and continuous operation since September 2021 of 5 tonnes per day (TPD) industrial plant

for carbon capture and utilisation from blast furnace off-gas, reducing freshwater consumption, developing sustainable supply chains, and imbibing circular economy.

Source: The Avenue Mail, April 24, 2023

Top 10 Steel Consuming Countries in 2022

	million tonnes			y-o-y growth rates, %		
Countries	**2022**	**2023 (f)**	**2024 (f)**	**2022**	**2023 (f)**	**2024 (f)**
China	920.9	939.3	939.3	-3.5	2.0	0.0
India	114.9	123.3	130.9	8.2	7.3	6.2
United States	94.5	95.8	98.2	-2.6	1.3	2.5
Japan	55.0	57.2	57.9	-4.2	4.0	1.2
South Korea	51.2	52.7	53.8	-8.6	2.9	2.0
Russia	41.7	39.6	36.9	-5.0	-5.0	-7.0
Türkiye	32.5	35.4	37.6	-2.6	9.0	6.0
Germany	31.6	30.9	34.0	-11.0	-2.2	10.0
Italy	25.1	24.9	25.8	-5.6	-0.9	3.5
Mexico	24.8	25.4	26.1	-2.8	2.5	2.6

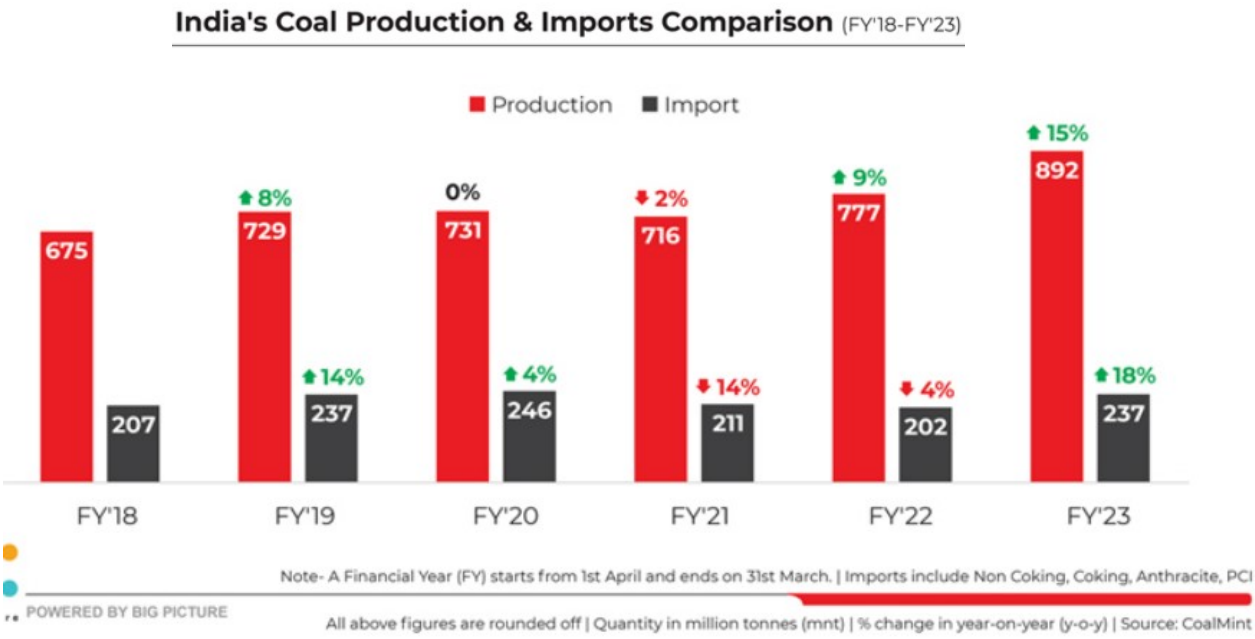
f - forecast

After growth of 8.2% in 2022, demand is expected to show healthy growth of 7.3% in 2023 and 6.2% in 2024.

Source: WSA Short Range Outlook, Finished Steel Product, April 2023

India's Coal Imports in FY2023

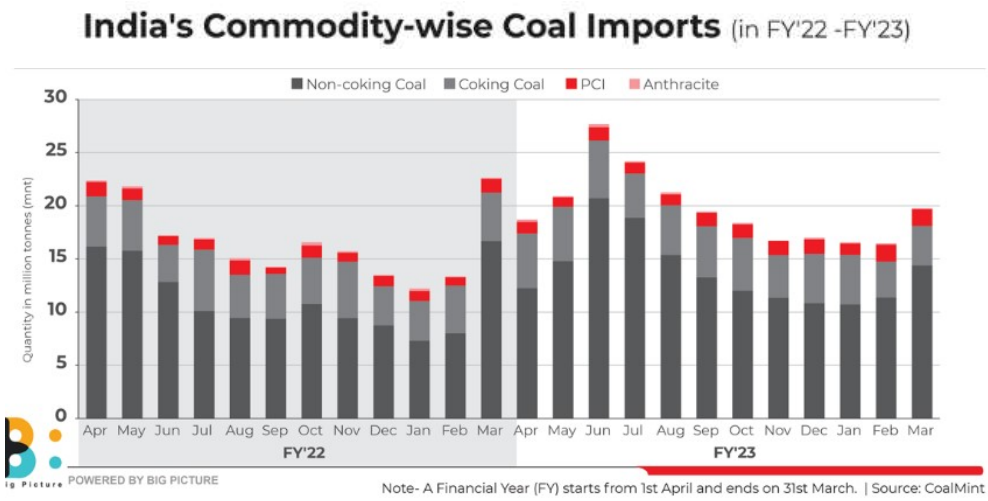
India's coal imports increased around 18% y-o-y to over 237 million tonnes (mnt) in FY23 from 202 mnt in FY22. Imports surged despite record domestic coal production in FY23. The country recorded historic growth in its coal output at 892.21 mnt in FY23. Total coal production was 15% higher from 777 mnt in FY22. Shipments from Indonesia, Russia increased sharply. Imports are likely to remain high in Q1FY24.



Imports surged despite record domestic coal production in FY23. The country recorded historic growth in its coal output at 892.21 mnt in FY23. Total coal production was 15% higher from 777 mnt in FY22.

Out of total import shipments in the recently concluded fiscal, those of non-coking or thermal coal stood at over 166 mnt, which is roughly 70% of total imports. Non-coking coal imports edged up by 23% y-o-y on higher demand from power producers and with the government mandating imports to meet peak power demand.

On the other hand, total imports in FY23 of coking coal and PCI coal stood at over 69 mnt compared with 65 mnt in FY22. While hard coking coal imports increased by just around 3% y-o-y, imports of PCI coal for usage mainly in blast furnace steelmaking rose sharply by 22% on the year.



Why imports increased?

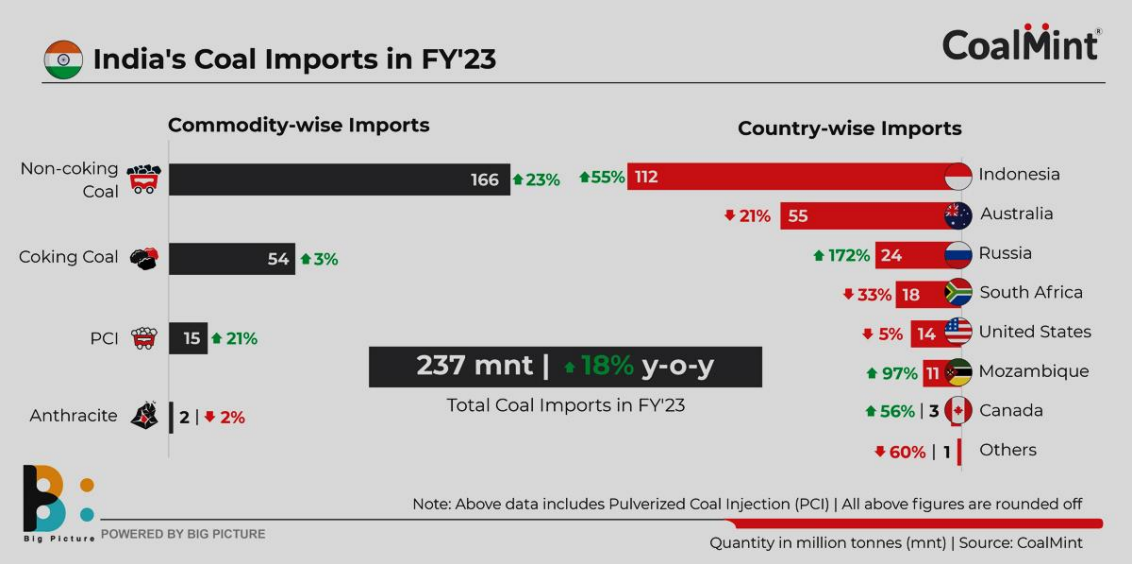
High power demand: India's power consumption surged 10% to 1,375.57 billion units (BU) during the April-February period in FY23, thereby already surpassing the level of electricity supplied in FY22. Power consumption in April-February of FY22 stood at 1,245.54 BU. In FY22, power consumption was 1374.02 BU, which is less than 1,375.57 BU recorded during the April 2022- February 2023 period. So, the imported coal-based power plants had to raise imports.

Govt mandates imports: To ensure adequate power availability, the Ministry of Power (MoP) has instructed power plants to import 6% (by weight) of their coal needs for blending purposes till September, 2023. A similar mandate had been issued last year too. That time, the blending ratio was kept at 10%. As a result, India's State-owned power producers as well as major miners raised coal imports till June-July 2022 although shipments fell post September as peak summer demand subsided along with monsoon-related logistical disruptions. This year, too, the government has asked the imported coal-based (ICB) power plants to carry on operations at full capacity. In addition, a tender has been floated to procure electricity from ICB plants for April-May when power availability is expected to be less than demand.

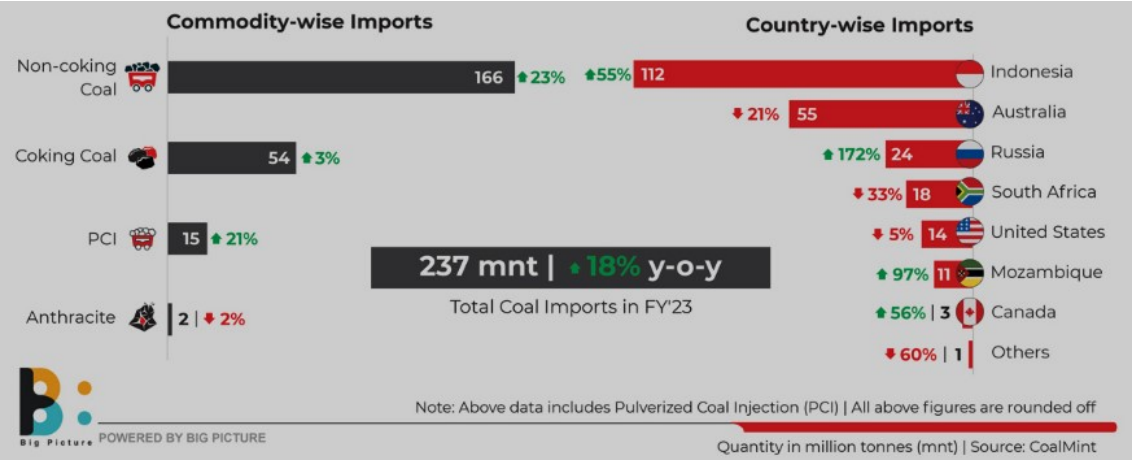
Steel production rises: India's steel production edged up to nearly 125 mnt in FY23, from around 118 mnt in FY22, an increase of 6% on the year. In the absence of quality domestic coking coal reserves, imports naturally increased. Besides diversifying import sources amid historic-high coking coal prices, Indian steelmakers also ramped up usage of PCI coal to increase furnace efficiency even while reducing the usage of costly metallurgical coke. This saw volumes from Russia increasing sharply y-o-y.

Trade flows

The top exporter to India was Indonesia, with total shipments standing at 112 mnt -up 55% on the year. Indonesia is the world's largest seaborne exporter of coal, accounting for 32.3% of the global seaborne coal market in 2022. The country has set an export target of over 500 mnt of coal in 2023. India purchases mainly high-to-low-CV non-coking coal from Indonesia.



India's Coal Imports in FY'23



With the rise in Russian supplies, it is expected that only low-CV Indonesian coal will henceforth be attractive for Indian buyers. After persistent pandemic disruptions and temporary export bans, Indonesian exports surged in FY23.

Imports from Australia, however, fell by over 20% to around 55 mnt, out of which over 36 mnt was coking coal. Even coking coal imports from Australia dropped 13% on the year as a result of India's efforts to diversify coking coal sourcing amid record-high global prices following the outbreak of the Russia-Ukraine war in February last year.

Similarly, India increased its met coal imports from the US and Canada sharply to around 10 mnt from less than 5 mnt in FY22. Marked growth in Canadian coal production and easing of disruptions in key US coal terminals supported higher shipments.

Notably, imports from Russia surged by over 170% on-year as the country stepped up shipments of cheaper cargoes to Asian consumers to amid sanctions imposed by the EU and US as well as G7 allies. Imports from South Africa, on the other hand, decreased by 33% as Mozambican and Russian exports to India surged. Imports from Mozambique rose by 97% y-o-y to nearly 11 mnt in FY23, with Indian DRI producers ramping up sourcing due to record-high South African coal prices amid global energy inflation.

However, with subsequent correction in global coal prices, trade flows seem to be returning to settled patterns.

Outlook

Power consumption is expected to grow in double digits in the coming months in view of forecasts of unprecedented high demand, especially in summer.

Following the government's mandate, NTPC, India's largest power producer, has decided to import around 5.4 mnt of coal during the first half of FY24. So, imports are expected to remain high through till July-August this year.

India's coal imports have returned to the pre-Covid levels of around 240 mnt seen in FY19 and FY20.

Despite the government's aim of augmenting domestic washery capacity and achieving coking coal production of 140 mnt by FY30, imports are likely to grow parallelly with India's fast-expanding steelmaking capacity. Imports are projected to reach 75-80 mnt by 2025-2026.

Logistical bottlenecks and high freight rates have increased dependency on imports by impeding pit to plant coal transport. Total coal loading by the Indian Railways in FY23 increased by over 11% to 653.36 mnt and total freight earned rose by 22% y-o-y. The allocation of more rakes, special lines and dedicated freight corridors for coal

transportation and rationalization of freight rates are expected to increase domestic availability of coal.

There has been no let-up in India's coal imports of late and 2023 may be another year likely to witness sustained growth.

Source: Coalmint

Secondary Steel Sector's Crude Steel Production Rises

Secondary Steel Sector's crude steel production grew by 7.5% during 22-23 as compared to rise by 6.8% in crude steel production from primary producers. Secondary Sector has share of over 39% with crude steel production of almost 49 million tonnes out of total crude steel production of over 126 million tonnes in the country in financial year'23 according to the provisional data.

Source : The Hindu Business Line, 26 April 2023

Steel Imports Surge 45% to 7 mnt in FY23

Despite India being a net exporter of steel, import of the key infrastructure commodity increased by over 45 per cent year-on-year to about 7 million tonnes (mt) in FY23. This is among the highest increase in the last three years.

The rise came on the back of a sharp 500 per cent jump in shipments for semi-finished offerings; finished steel imports rose by 30-odd per cent, as per a report of the Steel Ministry accessed by Businessline.

Over the last few years-since India became net exporter of steel – the highest imports were in FY20 at 7.20 mt. It had since declined to 5.04 mt in FY21 and 4.80 mt in FY22.

For FY23, import of semi-finished steel offerings stood at 1 MT (against 0.2 MT in FY22), while it was 6 mt (4.7 mt) for finished steel.

Cheaper Option

In value terms, steel mills bought $1,313 million worth of semis (up 73 per cent) and $8,018 million of finished steel, up 29 per cent.

Total steel imports include semis such as ingots, blooms, slabs and billets, and finished steel, including alloyed, non-alloyed and stainless steel offerings. Semi-finished steel, and intermediate offering, needs further processing, and is often used for casting.

At one point, it was cheaper to buy steel from overseas markets – countries with which India has FTA and Russia – since domestic price was higher. So, some traders and smaller/secondary mills resorted to imports. Accordingly, it impacted numbers.

Russia and Korea dominated import shipments of semi (categorised under non-alloyed semis and melting scrap), displacing Japan, China and Vietnam in value terms.

Russia supplied over 100,000 tonnes (semis) worth $52 million (up from zero a year ago).

Korea supplied 210,000 tonnes, value at $68 million (also up from zero).

Finished Imports

In the finished steel category, Russia was among the top five suppliers to India, displacing Taiwan and Indonesia. Finished steel supplies (in volume terms) rose 470 per cent YoY to 0.31 mt.

Even for hot rolled coil and strips, Russia displaced traditional suppliers like Japan, China and Vietnam in FY23. At 0.23 mt supply, Russia was second only to Korea, which supplied 0.84 mt in the sub-category.

Korea was the largest supplier of finished steel at 2.2. mt (up 11 per cent YoY), followed by china at 1.4 mt (up 69 per cent YoY), Japan and Vietnam occupied the third and fourth sports with supplies to the tune of 0.8 mt (up 27 per cent) and 0.32 mt (up 324 per cent), respectively.

Source : The Hindu Business Line, 26 April 2023

Carbon Emissions Intensity in Hydrogen Production

The emissions intensity of hydrogen production varies widely depending on the production route. Today, hydrogen production is dominated by fossil fuels; emissions need to decrease significantly to meet climate ambitions.

The fuel and technology used, the rate at which CO_2 capture and storage is applied, and the level of upstream and midstream emissions all strongly influence the emissions intensity of hydrogen production. For example, production based on fossil fuels can

result in emissions of up to 27 kg CO_2-eq/kg H_2, depending on the level of upstream and midstream emissions. Conversely, producing hydrogen from biomass with CO_2 capture and storage can result in negative emissions, as a result of removing the captured biogenic carbon from the natural carbon cycle.

The average emissions intensity of global hydrogen production in 2021 was in the range of 12-13 kg CO_2-eq/kg H_2. In the *IEA Net Zero by 2050 Scenario,* this average fleet emissions intensity reaches 6-7 kg CO_2-eq/kg H_2 by 2030 and falls below 1 kg CO_2-eq/kg H_2 by 2050. The emissions intensity of hydrogen produced with electrolysis is determined by the emissions from the electricity that is used. Using the methodology developed by the *International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE)*, renewable electricity generation has no associated emissions, resulting in 0 kg CO_2-eq/kg H_2. In the case of grid electricity, the emissions intensity varies greatly between peak load and baseload hours, depending on which technology is used to meet additional demand for the electrolysers. To reduce emissions, it is therefore important to ensure that grid connected electrolysers do not lead to an increase in fossil-based electricity generation.

Carbon capture and storage technologies can reduce direct emissions from fossil-based hydrogen production but measures to mitigate upstream and midstream emissions are needed. Hydrogen production from natural gas results in an emissions intensity in the range of 10-14 kg CO_2-eq/kg H_2, with upstream and midstream emissions of methane and CO_2 in natural gas production being responsible for 1-5 kg CO_2-eq/kg H_2. Retrofitting existing assets with capture of CO_2 from the feedstock-related use of natural gas (capture rate around 60%) can bring the emissions intensity down to 5-8 kg CO_2-eq/kg H_2. Higher capture rates (above 90%) can be achieved with advanced technologies, reducing emissions intensity to 0.8-6 kg CO_2-eq/kg H_2, although no plants using these technologies are in operation yet. At high capture rates, the emissions intensity of hydrogen production is dominated by upstream and midstream emissions, which account for 0.7-5 kg CO_2-eq/kg H_2, underscoring the importance of cutting methane emissions from natural gas operations.

Source : Towards hydrogen definitions based on their emissions.; IEA

High-Strength Line Pipe Steel for Hydrogen Transmission

EVRAZ North America (ENA) announced the successful development and qualification of a high-strength, high-frequency welded (HFW) line pipe for high-pressure, 100 percent hydrogen transmission. ENA is the first North American line pipe producer qualified for

high-pressure, 100 percent hydrogen pipeline transportation. In achieving this industry milestone, ENA conducted a full-scale mill trial and produced 20" OD x 0.500" X65 HFW pipe. All pipe samples were produced in Regina, Saskatchewan with steel from ENA Regina Steel, the Company's Canadian EAF mill. Body, weld, and heat-affected zone (HAZ) specimens from four different heats were tested successfully for 'Fracture Toughness' in accordance with ASME B31.12. After 1,000 hours under 100 percent gaseous hydrogen environment at 100 bar (~1500 psi), all specimens met the qualification requirement with no crack extension for very high applied load (KI, app). In addition, the pipe samples passed all API 5L PSL2 mechanical property tests, as well as NACE standard HIC and SSC-4PB tests. These results confirm previous testing outcomes and further demonstrate superior fracture toughness and resistivity to hydrogen embrittlement of line pipe product with KIH values well exceeding ASME B31.12 criteria under Option B. In October 2022, ENA announced the successful completion of 'Fracture Toughness' testing on API 5L X65 Sour Service line pipe steel in accordance with ASME B31.12. Both body and weld specimens likewise demonstrated superior fracture toughness and resistance to hydrogen embrittlement at 100 bar (~1500 psi) and 200 bar (~3000 psi) in 100 percent gaseous hydrogen environment.

Hydrogen is a core component of ENA's alternative energy strategy, which also includes carbon capture, utilization, and storage (CCUS), geothermal, and wind energy. The R&D team continues to focus on several projects including new product development for the transmission and storage of hydrogen and CO_2, solutions for geothermal drilling, new standards development, and welding research. ENA is also working to establish a U.S. based Centre of Excellence primarily intended for testing and research and development in line with hydrogen and CO_2 advancements.

Source: Press Release, Evraz North America, April 11, 2023; *www.evrazna.com*

By-product Gas-to-Value Technology

Utility Global, Inc. ("Utility") and Stelco Inc. ("Stelco"), announced an agreement to test certain of Utility's advanced decarbonization technologies at Stelco's Lake Erie Works integrated steelmaking site located in Nanticoke, Ontario, Canada. Utility's eXERO™ technology is uniquely suited to processing by-product gases from hard-to-decarbonize industries, particularly steelmaking, and converting these gases into high-value hydrogen.

Following the successful completion of Utility's pilot program in February 2023, Utility is installing a field demonstration facility at the Stelco site. This will demonstrate Utility's

technology and capability to produce reliable and cost-effective hydrogen under actual site conditions. Scheduled for operation in the second-half of 2023, it is the next key milestone in commercializing this disruptive *by-product gas-to-value technology*, and its unique ability to decarbonize hard-to-abate sectors.

This critical energy transition initiative and the differentiated technology, not only gives existing infrastructure a new lease on life in the journey to net-zero but enables a true renaissance for these tried and tested manufacturing processes.

Source: AIST Steel News Rewind, April 13, 2023

Bacteria Breakthrough: Recycling Rare Earth Metals with Biomass

Rare Earth Metals are indispensable for a wide variety of modern technologies and numerous high-tech applications: wind power turbines, catalytic converters, optical cables, plasma monitors, and much more. These valuable metals are depleted due to rising demand and limited deposits. As world progresses towards green energy transition, the demand for these metals will soar. Most of the countries largely depends on China for their rare earth imports, making them vulnerable. Two paths to solutions are: exploring and mining new deposits and recycling.

Researchers at the Technical University of Munich have discovered the potential of *cyanobacteria strains* in recycling Rare Earth Metals from aqueous solutions. The breakthrough by researchers at the Technical University of Munich (together with the University of Applied Sciences Kaiserslautern) presents a game-changing process for recycling rare earth metals using cyanobacteria strains. Cyanobacteria, a previously un-investigated biomaterial, can successfully adsorb these metals from aqueous solutions. The process offers eco-friendly benefits since it is reversible, enabling the washing of metals from the solution and reusing biomass. This innovative approach could help recycle rare earth metals from industrial wastewater generated in fields such as mining, electronics, and chemical catalysts.

European projects like *REEgain*, funded by the European Regional Development Fund, actively demonstrate the feasibility of absorbing rare earth metals using bacteria, algae, and fungi. By developing new recycling strategies, self-sufficiency in critical materials required for the green energy objectives could be gradually increased.

In the United States, researchers from the Critical Materials Institute have created a novel process to extract rare earth metals directly from shredded electronic waste.

The global rare earth metals recycling market has a projected worth of $422 million by 2026, demonstrating a compound annual growth rate of 11.2% from 2021 to 2026.

Recycling rare earth metals by means of biological absorption techniques could significantly help in becoming more self-sufficient and reduce reliance on external suppliers. However, this method is still in its early stages and requires further optimization.

In Sweden, recent discoveries of over one million tonnes of rare earth elements, including crucial heavy elements such as Dysprosium, Yttrium, and Terbium, are believed to be pivotal for the global clean energy transition.

As the global transition to clean energy accelerates, innovative recycling technologies may hold the key to a more sustainable and secure future.

Source: https://innovationorigins.com/en/laio/bacteria-breakthrough-recycling-rare-earth-metals-with-biomass/

Outokumpu to Consider Nuclear as a Way to Power Steelmaking

Outokumpu, stainless steel producer, and *Fortum*, a leading Nordic clean energy company, have signed a Memorandum of Understanding (MoU) to explore the decarbonization of Outokumpu's steel manufacturing operations with emerging nuclear technology – Small Modular Reactors (SMR). The agreement initiates a long-term process with the aim to access potential construction of a SMR in Finland. In the first phase, the goal is to identify potential business models and technical solutions for further development. Any potential investment decisions will be made at a later stage. One possible option for the location would be Tornio region in Finland, where Outokumpu's largest mill is situated.

Outokumpu has committed to the Science-Based Targets initiative's 1.5°C climate target. Maintaining and increasing the share of low-carbon energy is important to achieving the company's ambitious sustainability goals.

Outokumpu is Finland's largest electricity buyer. In order to remain competitive in Finland, they need to have a sufficient amount of low-carbon and cost-effective energy. In line with its strategy, Fortum wants to drive decarbonisation and growth for Nordic industries by providing clean energy and CO_2-free solutions to its customers.

Decarbonizing heavy industries is a prerequisite for reaching carbon-neutrality and this requires significant amounts of clean energy.

Source :Outokumpu Oyj Press Release, March 23, 2023

Is There Enough Lithium to Make all the Batteries?

Lithium is one of the key components in electric vehicle (EV) batteries, but global supplies are under strain because of rising EV demand. The world could face lithium shortages by 2025, as the demand could treble between 2020 and 2025, meaning "supply would be stretched".

About 2 billion EVs need to be on the road by 2050 for the world to hit net zero. Lithium supply faces challenges not only from surging demand, but because resources are concentrated in a few places and over half of today's production is in areas with high water stress.

Lithium, a non-ferrous metal known as "white gold", is soft, silvery-white metal required for the world to go green. The world has nowhere near enough of it to power all the electric vehicle (EV) batteries it wants – and needs. Lithium is one of the key components in EV batteries, alongside nickel and cobalt. Rising demand for Electric Vehicles is straining global lithium supplies. Global EV purchases jumped to 6.6 million in 2021 from 3 million a year earlier, meaning that EVs made up 9% of the market, according to the International Energy Agency (IEA). They accounted for all the growth in worldwide car sales, which rose to 66.7 million last year, up from 63.8 million in 2020. This implies that non-EV sales fell by 700,000.

How much lithium does an EV need?

A lithium-ion battery pack for a single electric car contains about 8 kilograms (kg) of lithium. Global lithium production totalled 100,000 tons (90.7 million kg) last year, while worldwide reserves stand at about 22 million tons (20 billion kg).

Dividing lithium production by the amount needed per battery shows that enough lithium was mined last year to make just under 11.4 million EV batteries. This is a level that annual electric vehicle purchases could hit soon, after first-quarter sales rose by 75% on the year to touch 2 million, according to IEA figures.

In 2030, the global demand for lithium is expected to surpass two million metric tons of lithium carbonate equivalent, more than doubling the demand forecast for 2025.

Increases in battery demand for electric vehicles will be a strong driver of lithium consumption in the next decade.

Future developments with batteries or manufacturing methods could eventually alleviate some lithium shortages.

Blog, World Economic Forum, Jul 20, 2022

BHP and HBIS Agree to Trial Carbon Capture Tech

BHP has signed an agreement for piloting of carbon capture and utilisation technology with China's HBIS Group Co., Ltd (HBIS), one of the world's largest steelmakers and a major iron ore customer of BHP.

As part of this project, HBIS and BHP will trial pilot-scale demonstrations of carbon capture and utilisation technologies at HBIS' steel operations in China. The trial will develop and test technologies that can be integrated into steel production processes to reduce the CO_2 emissions. These include Vacuum Pressure Swing Adsorption, VPSA, an alternative technology to capture the CO_2, and two utilisation technologies (slag mineralisation and biological conversion to protein) to sequester the CO_2. In addition, BHP will support HBIS in developing and deploying absorptive desulfurisation at HBIS ZXHT Hydrogen Metallurgy Demonstration Project in Xuanhua, Hebei, intended to enable the utilisation of ~ 60,000 tonnes per year of captured CO_2 from the Direct Reduced Iron process in the food or industrial sectors.

Carbon Capture for Production of Sustainable Aviation Fuel

United Airlines announced a $5 million investment in carbon capture technology company *Svante*, which provides materials and technology as part of the value chain that has the potential to convert CO_2 removed from the atmosphere and from industrial emission sources into sustainable aviation fuel (SAF).

Carbon capture technology has the potential to be a critical solution in the fight to stop climate change and has the added benefit of helping scale the production of SAF.

This investment will fund and support Svante's commercial-scale filter manufacturing facility in Vancouver, BC, Canada.

Svante is a leader in second-generation solid sorbent-based carbon capture and removal. The company's scalable, eco-friendly, and commercially available carbon

capture and removal technology employs structured absorbent beds, known as filters. These filters can capture 95% of CO_2 emissions from industrial sites as well as CO_2 that's already in the air. Once the CO_2 is captured, it is concentrated and can be used in the creation of SAF or other products. It can also be safely transported and stored underground.

Svante's manufacturing facility is anticipated to produce enough filter modules to capture millions of tons of carbon dioxide per year across hundreds of large-scale carbon capture facilities.

SAF is an alternative to conventional jet fuel that, on a lifecycle basis, reduces GHG emissions associated with air travel compared to conventional jet fuel alone. SAF is made from used cooking oil and agricultural waste, and, in the future, could be made from other feedstocks, including household trash, forest waste, or compressed CO_2,

Source: Weekly News, International Centre for Sustainable Carbon, 03 April 2023

EAF Capacity Expansion Replacing BF-BOF in North America

A steady stream of investments in new or additional EAF capacity has been announced in the U.S. and Canada in the past five years. Though, despite encouraging levels of investment, steel production in the U.S. has not deviated from the range of 80 million to 89 million metric tons per year (tpy) in the past 12 years.

EAFs now account for 70 percent of steel production in the U.S. The gains in scrap-based EAF sector have largely have come at the expense of the blast furnace/basic oxygen furnace (BOF) steelmaking method.

The story of North American BOF steel capacity has been one of decline in the last 40 years, with large-tonnage locations in places such as Bethlehem, Pennsylvania; Sparrows Point, Maryland and Geneva, Utah, all fading into memory.

Among North America's large-tonnage steel mills, 10 BOF locations are listed in the U.S. and three are in Canada. However, two of the three Canadian BOF locations have embarked on major capital investment projects to retire their blast furnaces and convert to EAF production. ArcelorMittal has committed to installing a 2.4-million-tpy EAF system in Hamilton, Ontario, and Algoma Steel, also in Ontario, is getting ready to idle its blast furnaces so it can produce 3.7 million tpy of EAF steel.

The situation in Canada mimics one that has been underway in the U.S. for a long time, where EAF steelmakers including Nucor Corp., Steel Dynamics Inc. (SDI) and Commercial Metals Co. (CMC) steadily have been nabbing market share from BOF producers until reaching the current 70 percent level.

In its most recent earnings report, U.S. Steel—one of two remaining blast furnace operators in the U.S.—does not list its Great Lakes Works blast furnaces in Michigan as part of its operating footprint. That indicates the Pittsburgh-based producer now has just eight blast furnaces remaining in three locations. One of those, in Granite City, Illinois, is marked as permanently idled.

The other U.S.-based BOF operator, Cleveland-Cliffs, announced last year it planned to permanently idle one of its two blast furnaces in East Chicago, Indiana, in part to reduce CO_2 emissions.

While continuing to scale back its BOF footprint, U.S. Steel also has invested in increasing its EAF production. The company's "Best for All" capital investment plan does not centre on using ferrous scrap as feedstock but presents one more indication that the EAF method is front and centre in the steel industry's sector to reduce its carbon footprint.

U.S. EAF steelmakers frequently have begun to tout their well-below-global-average greenhouse gas (GHG) emissions track records, including North Carolina-based Nucor, Indiana-based SDI and Cleveland-Cliffs.

Nearly every recent EAF project announcement has included references to recycling and the circular economy. Beyond that, companies tend to mention using scrap or metallics such as direct-reduced iron (DRI) that offers a lower emissions route to steelmaking compared with using coal, coke, sintering plants and blast furnaces.

Texas-based CMC has been investing to make scrap-fed EAF "micro-mills," with its first unit in Arizona. The company has added another scrap-based EAF facility in Oklahoma, and work is nearly complete on a second micro-mill system adjacent to the current one in Mesa, Arizona.

It is clear that new EAF capacity is starting to arrive, and more is on the way.

Other announcements include JSW Steel USA's 2.5 million tpy of EAF capacity planned in Ohio and Texas and U.S. Steel/Big River Steel 1.6-million-tpy mill in Brownsville, Texas, the 3.7-million-tpy Algoma Steel EAF conversion, 2.4-million-tpy ArcelorMittal

conversion project in Canada, Nucor's 3-million-tpy EAF steel sheet mill in West Virginia near the Ohio border.

Nucor has started operations at a 1.2-million-tpy mill in Kentucky and SDI has ramped up operations at its 3-million-tpy mill in Sinton, Texas. A 900,000-tpy EAF furnace at the U.S. Steel Tubular business unit in Fairfield, Alabama, also is operating. A new name in the EAF sector is Highbar LLC.

A larger EAF steel sector in the U.S. and Canada almost certainly would be good for scrap processors in North America. To what extent major shifts in the U.S. and global economies will make new EAF capacity additional (rather than replacement) capacity will play out over the course of several years.

Source: Recycling Today, March 2023

Whyalla CN30 (Carbon Neutral by 2030)

LIBERTY Steel in Whyalla announced the phase out of coal-based steelmaking with low carbon emissions electric arc furnace. Coke ovens and blast furnace at its Whyalla steel works in Australia are planned to be replaced with a direct reduction plant and electric arc furnace (EAF). The 160-metric-ton EAF will be equipped to accept electricity directly from renewable sources. The company also will build a 1.8 million metric ton direct reduction furnace that will convert local magnetite to iron. At first, the plant will consume both natural gas and green hydrogen, but will transition fully to green hydrogen as it becomes available at scale. Engineering work is already well underway. Construction is expected to be completed in 2025. New state-of-the-art low-carbon iron and steelmaking technologies will not only support Australia's climate ambitions, but will help to decarbonize steel supply chains globally. The company intends to grow magnetite production to 15 million metric tons annually, providing the feedstock for 10 million metric tons of annual green direct reduced iron DRI production. The output would support Australian green steel production as well the export markets, feeding its network of EAFs in Asia, Europe, and the U.K. To get there, the company will overhaul operations, adding sophisticated mineral processing techniques at the mines, with state-of -the-art iron- and steelmaking facilities, large-scale hydrogen production and storage facilities all connected to renewable electricity generation.

Leading the GREENI RON and GREEN STEEL charge

- Modern 160t Electric Arc Furnace, equipped to accept electricity directly from renewable sources

- A 90% reduction in direct CO_2 emissions from steelmaking expected by 2025
- 1.8 mtpa Direct Reduction Plant (DRP) to process locally mined magnetite using natural gas before transitioning to green hydrogen

Electric Arc Furnace Investment

160-tonne low carbon emissions (low carbon*)* electric arc furnace will lift steelmaking capacity at Whyalla from 1 million tonnes per annum (mtpa) to over 1.5 mtpa. The cutting-edge electric arc furnace will initially be fed by domestic steel scrap and other Fe-bearing materials to deliver an expected 90% reduction in direct CO_2 emissions compared with traditional blast furnace production. Danieli's patented Q-One technology, the first of its kind, provides capability for a direct feed from renewable power sources which could help to eliminate indirect emissions from Whyalla's new steelmaking facility. Engineering work is already advanced and construction is expected to be completed in 2025 replacing the existing Coke Ovens and Blast Furnace.

Direct Reduction Iron Plant

1.8 mtpa Direct Reduction Plant (DRP) can process local magnetite ore to produce low carbon iron (DRI). The DRP 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 low carbon DRI can then be fed into the electric arc furnace in combination with scrap to produce high quality steel grades, and to serve the growing global demand for low carbon DRI. The development follows the successful trials for upgrading Whyalla's magnetite pellets production to direct reduction grade.

Whyalla CN30 (Carbon Neutral by 2030)

These developments are important building blocks in *Whyalla's CN30 Plan* - decarbonisation strategy to be carbon neutral by 2030. Low carbon and green DRI made in Whyalla will feed LIBERTY's network of electric arc furnaces in Australia, Asia, Europe, and the UK helping to decarbonise steel supply chains across the world. Whyalla's CN30 Plan aims to grow magnetite production to 1 5 mtpa to convert into 10 mtpa of green DRI for export and domestic green steel production. Operations will be overhauled with sophisticated mineral processing techniques at the mines, with state-of - the-art iron and steel making facilities, large scale hydrogen production and storage facilities all connected to renewable electricity generation.

Whyalla has some of the best conditions to make low carbon iron and steel anywhere in the world and with the magnetite expansion plans, coupled with South Australia's

endless resource for renewable energy and green hydrogen, the potential for Whyalla has no bounds.

Source: AIST Steel New 6 April 2023 Rewind

An Alternative to Copper that's Less Carbon-intensive

The climate tech press often bemoans shortages of lithium, a metal crucial for the development of electric vehicle batteries. Far less digital ink has been spilled over the scarcity of another metal that one can argue is even more crucial to the clean energy transition: Copper, the "metal of electrification."

Copper is an integral component not just of transmission wires, it's also crucial for scaling up production of solar panels, wind turbines and EVs.

So what if you could commercialize a material that possesses the conductivity of copper and is stronger than steel and lighter than aluminum? That's the moonshot vision of DexMat, a Houston-based carbon nanotube startup born at Rice University and built on patents by the late Nobel Prize winner in chemistry Rick Smalley and his collaborator Matteo Pasquali, the startup's founder and chief science adviser.

DexMat has already benefited from more than $20 million in non-dilutive funding in the form of grants from two U.S. Air Force research agencies, the Department of Energy, NASA, the National Science Foundation and Advanced Functional Fabrics of America. That money has helped develop niche applications that are already generating commercial revenue for the company, such as wiring in plane wings that can help de-ice them electrothermally rather than through the glycol-based chemicals currently used to handle this.

In early March, DexMat snagged $3 million in seed funding from Shell Ventures, Overture Climate VC, Climate Avengers and some other unidentified backers to commercialize its technology and explore potential applications in the energy, automotive, aviation and wearables sectors. One would-be killer application: lighter wind turbine blades. The company claims its material, called *Galvorn*, has the potential to "displace" three gigatons of industrial carbon dioxide emissions annually not only by supporting clean energy additions to the grid but also by reducing the production impact of steel, aluminum and Kevlar.

Galvorn is made by splitting hydrocarbons, chiefly found in the combustion of petroleum and natural gas. The material acts as a form of carbon storage and takes several forms,

including a mesh that could be used in composite panels, electrodes and garments; a fiber for conductive wire, power lines and motor windings; and a film for electromagnetic shieldings, batteries and antennas.

More efficient and lighter weight vehicles and aircraft can extend range and reduce fuel consumption. Higher electrical conductivity in batteries and supercapacitors can improve performance in wind and solar and storage. DexMat can displace steel cores in utility transmission lines with a stronger and lighter substitute that is also more conductive, which can help move utility towers farther apart and drive down the cost of deploying new transmission lines. In the built environment, incorporating these fibers in the production of concrete and other building materials can create stronger and more durable buildings that extend lifespan.

Source : Green Biz Newsletter, 5 April 2023