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IIM Delhi Chapter organized an International Conference on **"Resource Efficiency and Circular Economy in Mineral & Metal Sectors"** at Pragati Maidan, New Delhi from 25th to 27th August 2022.

Some of the visuals of the Conference are as under:


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State-of-the-Art JSW Technology Hub for Steel Manufacturing in India

The JSW Group, a US$22 billion business conglomerate with interests in steel, energy, infrastructure, cement, paints, E-commerce, sports and venture capital, has entered into an exclusive strategic agreement with IIT Bombay, India's premier engineering and technology institute, with a view to establishing a state-of-the-art JSW Technology Hub, for steel manufacturing in the country.

JSW has created the Centre of Excellence in Steel Technology (CoEST) with the support of the Ministry of Steel, Government of India, and other industry partners. The aforementioned JSW Technology Hub will be established within CoEST and the key objective is to achieve a rapid expansion of quality steel production while maintaining carbon emissions within the target levels.

JSW believes that partnering with IIT Bombay will allow the leading Indian steelmaker to undertake and intensify R&D efforts in the steel sector to develop competent capabilities in the area of steel technology for the Indian conglomerate.

The Hub will be the nodal point for JSW Group's research activities beyond the steel domain with JSW providing financial and technical support to establish and build the facility with state-of-the-art infrastructure to undertake a wide range of R&D for steel manufacturing and its use. This powerful combination will jointly leverage IIT Bombay’s knowledge-rich faculties and JSW’s technical capabilities to develop novel industrial applications for steel manufacturing with focus on low carbon emissions. This partnership will also initiate new academic courses while consolidating existing courses, and also provide academic and technical leadership in broad areas of research while working towards increasing steel consumption in the country.

Both IIT Bombay and JSW Group will leverage the JSW Technology Hub to conduct inter-disciplinary research projects and technical activities on various aspects of steel production. Such collaboration will enable the development of patented industrial applications and solutions which could be operationalized and/or commercialized going forward.

IIT Bombay plans to establish the Sajjan Steel Professor Chair, which would help IIT Bombay to adopt an interdisciplinary, collaborative, synergetic and translative approach to advance R&D and address application-oriented demands from industry, society and government.

Source: Weekly News from Steel Times International, 18th August, 2022

Tata Steel Netherlands Presents Low-CO_2 Steel Brand

Tata Steel Netherlands (TSN) presented a new brand for lower CO_2 steel. It will enable its customers to achieve savings in their scope 3 emissions through purchasing “green certificates”.

On July 12, 2022, Tata Steel Netherlands presented *Zeremis Carbon Lite brand*, which represents the steel with CO_2 emissions reduction starting from 30% compared to the Europe’s average (1.54 t CO_2/t versus 2.2 t CO_2/t). Additional CO_2 reduction certificates (up to 100%) are available should customers eye higher reduction targets. The savings are verified by DNV, an international certification body.

TSN is accelerating projects to save carbon emissions, capture these savings in a carbon bank and launch a carbon balanced green steel offering based on certificates. The new project will meet the growing demand for low-carbon steel in consumer-oriented industries such as the automotive, packaging and white goods sector.

Tata Steel plans to reduce CO_2 emissions by 30% by 2030 and reach carbon neutrality by 2050. It has chosen the hydrogen route for the transformation. TSN will start from the replacing BF No.6 with a 2.5 million tpy DRI plant, operating on the 100% natural gas until the green hydrogen is available in required amounts and at a reasonable price. It plans to complete this first phase before 2030. Then, presumably not later than by 2037, Tata Steel will replace BF No.7 with either one big 3.5 million tpy DRI unit or of two smaller installations depending on technical developments.

TSN will conduct research to provide further improvement of the environmental situation by 2030 and consider earlier closure of some facilities such as the coking and gas plant. In the Netherlands, Tata Steel is currently operating two BFs with a total designed capacity of 6 million tpy.

Tata Steel Netherlands Decarbonisation Plan

	2018-2028	**2028-2033**	**2033-2038**	**2050**
CO_2 Reduction*	not specified	30-40%	60-70%	up to 100%**
Green Steel Production Volume,*’000 tpy*	50-200	1,800	4,000	6,000

** – compared to 2019*
*** – more than 12 million t CO2*

Source: Metal Expert, Green Steel Weekly, Issue 24, July 19, 2022

Transition to Gas-based DRI-EAF Route in Jeopardy as Energy Crisis Aggravates

European steelmakers have been actively developing plans for the last few years how to decarbonise most of the EU's integrated steel production process, relying on a transition to a natural gas-based DRI route as a temporary solution in the medium term. The energy crisis in Europe that began in the autumn of 2021 and has been only escalating since then could force manufacturers to rethink their strategies as Europe is preparing to face a severe gas shortage.

Many steel manufacturers in Europe, including ArcelorMittal, Thyssenkrupp, Liberty Steel, Tata Steel, SSAB, Salzgitter, Dillinger and Voestalpine, announced plans to construct new DRI plants with designed capacities of 100-2,500 tpy to replace the existing BF-BOF routes, aiming at a substantial emission decrease. The increasingly stringent climate regulations contributed to their investment decisions greatly.

In 2020-2021, carbon prices soared by 120%, supported by an 8.2% drop in free allowances surplus within the EU ETS, incentivising steelmakers to launch wide-scale decarbonisation projects. Around 20 new DRI plants with a total capacity of more than 30 million tonnes were announced for construction by 2030. Low gas prices, hovering within EUR 25-30/MWh on average in previous years, contributed to the industry's enthusiasm along with a great potential for emission cuts. Most new DRI plants are projected to initially use natural gas as the reducing agent before 2030 when the green hydrogen will become available at an industrial scale and affordable price.

Emission Levels by Processes

Manufacturing Process		***Emissions, tCO2/t steel***
BF-BOF (coke)	:	1.9
NG-DRI (natural gas)	:	1.4
EAF (electricity)	:	0.4

Taking Germany as an example, the initially intended transition from the BF-BOF to NG-DRI/EAF (BOF) process would almost double the demand for gas in the country's steel industry to around 175 PJ. That alone could move up the overall gas industry demand by 9% across Germany and 3% in the rest of Europe, assuming that DRI plants would operate on 100% of gas when they start production in 2026.

German steel plants are the biggest gas consumer in the EU steel industry (27%), followed by Italy (17%), Spain (8%), Poland (7%), and Belgium (7%). Other top-10 countries constitute less than 7% each.

Germany is also among the countries that are the most dependent on Russian gas in the EU, which makes it even more vulnerable to the current energy crisis.

The sky-high prices for gas along with the progressing threats of its supply disruption could make many steelmakers reconsider their transition strategies, especially when even a complete cessation of Russian gas flow to Europe is not excluded. Gas delivery via the Nord Stream 1 pipeline was fully stopped on July 11 due to the maintenance, as stated by Gazprom. However, it is clear that the shutdown is dictated by the political reasons to increase pressure on the European leadership. The resumption of pumping is announced for July 21. The European Commission is determined to provide an action plan for the case of full supply disruption by July 20. In the current conditions, the number-one scenario would be an accelerated transition to green hydrogen. Some European companies have already started testing hydrogen in steel production, although not always green.

Among the most recent developments, Thyssenkrupp (Duisburg) has been expanding hydrogen use in its BF process to substitute pulverised coal, thus reducing CO_2 emissions by 20%. The company intends to use pure H_2 in combination with natural gas for both the BF and DRI pilot plant. Thyssenkrupp plans to erect four new DRI units and four melting units by 2045 at the Duisburg site.

Voestalpine (Donawitz) has started research on new low-carbon steelmaking technology based on hydrogen plasma. This will not only replace coke, coal, and gas as reducing agents but also make it possible to reduce iron ore in parallel with smelting into crude steel. However, green hydrogen in sufficient quantities with developed infrastructure at an affordable price is still a matter of the future.

In 2021, the EU produced around 86 million t of crude steel with the primary BF-BOF route. Obtaining this amount of steel by the H_2-DRI process would require more than 6 million tonnes of green hydrogen, which means 34-55 GW of electrolysis capacity. At this moment, EU intends to obtain only 10 million tonnes of domestically-produced green H_2 and 40 GW of electrolysers capacity to be ready by 2030. The acceleration of green hydrogen capacity deployment could be the preferable scenario also because high gas and carbon prices have almost equalised the cost-competitiveness of H_2 and gas-based DRI schemes. With gas at EUR 15/GJ and higher and the carbon rate approaching EUR 100/t, hydrogen technology could catch up with the gas, given that the hydrogen rate will be EUR 3/kg.

Should green hydrogen technology fail to mature soon enough, the simplest but the least effective way is to slow down the transition to DRI, which would mean postponing billions of euros of investment and focusing on local improvements, prolonging the BF-BOF route lifespan. This could make steel producers step back from their decarbonisation targets because of limited potential in emission abatement even though the potential for reducing blast furnace emissions is far from being fully exhausted.

There is a lot of room for decarbonisation on the BF, pellet plant and sinter plant. There is a potential of 30-40% lower carbon intensity. On sinter and pelletising plants, there is a 25% potential to decarbonise, while the blast furnace has even more potential – up to 40%. Finally, the carbon emissions from BOF can be reduced by 25%.

One more scenario is to operate the existing blast furnaces, shifting the investments to carbon capture, utilization, and storage (CCUS) technologies. In this case, steelmakers could reduce emissions substantially, though facing public opposition as well as difficulties in obtaining permits, which vary greatly by region. Large-scale CCUS facilities normally require appropriate geological and safety conditions for storage and mature transportation infrastructure. However, many see the deployment of CCUS as inevitable for substantial decarbonisation of the industry in the long term. Moreover, the construction of CCUS systems normally takes 5-10 years minimum and requires huge investments.

Finally, the shift from the primary to the circular steel route is also possible. Manufacturers may skip the DRI technology in favour of a fully scrap-based EAF process. However, this option is unlikely to be suitable for manufacturers of flat products unless a high-quality scrap supply is guaranteed.

Source: 2022 Metal Expert, Green Steel Weekly, July 12, 2022

Shoe Made from Carbon Emissions

Swiss performance sportswear brand ***On*** has found a way to make a shoe from carbon emissions. Together with tech company *Technip Energies*, chemical company *LanzaTech* and plastic solutions provider *Borealis*, ***On*** presents *Cloudprime*, a shoe made from *CleanCloud EVA (ethylene vinyl acetate) foam*.

Cloudprime is part of *On's* efforts to move away from fossil fuels and use alternative materials to create high-performance sports products. This makes the Swiss company the first in the footwear industry to use carbon emissions as the primary raw material for the midsole of a shoe.

The Swiss company has set itself the goal that every *On* product should be free of fossil fuels and completely circular. *CleanCloud* is the result of five years of work that started with finding the best possible partners.

LanzaTech's technology captures carbon monoxide from industrial sources such as steel mills before it is released into the atmosphere. These emissions then enter a patented fermentation process. Thanks to specially selected and naturally occurring bacteria, the carbon-rich gas ferments naturally and is converted into ethanol. This natural fermentation process is similar to that of conventional alcohol production - brewing beer, for example. The ethanol is then dehydrated by *Technip Energies* to produce ethylene, which is then polymerised by *Borealis* into EVA (ethylene vinyl acetate) in the form of solid plastic pellets. And with this versatile and lightweight material, *On* can begin producing a high-performance foam for footwear.

LanzaTech uses a combination of cutting-edge genetic engineering, the latest biotechnology, artificial intelligence and innovations in mechanical and chemical engineering to produce chemicals with a process that soaks up carbon waste instead of expelling it.

Technip Energies is responsible for the energy transition and for the process of dehydrogenating liquid ethanol into the gas ethylene, which is a monomer and the main building block of widely used plastics, while *Borealis* is instrumental in the production of easy-to-process EVA foam for *CleanCloud*.

On has collaborated with circular start-up *Novoloop* on the *CleanCloud* outsole, which uses the world's first chemically upcycled TPU (thermoplastic polyurethane) made from plastic waste. The outsole has undergone rigorous testing in the laboratory and by athletes, and meets specifications comparable to those of fossil derived TPUs, but with a significant reduction in the carbon footprint. For the upper, *On* is working with French start-up *Fairbrics* to develop a polyester-based textile made from carbon emissions.

To scale this technology, across the industry, it will require enthusiasm and investment not only from fellow brands within the industry and consumers as well. *On* is working to incorporate the *CleanCloud* technology into footwear and apparel within the next three to five years.

Source: Simone Preuss, 15 Sept. 2022

ResponsibleSteel Announces It's Revised Standard 2.0

ResponsibleSteel is an international, non-profit multi-stakeholder membership organisation. Businesses from every part of the steel supply chain, civil society groups, associations, and other organisations with an interest in a sustainable steel industry from anywhere in the world are the members of ResponsibleSteel.

ResponsibleSteel's vision is that steel's contribution to a sustainable society is maximised. Its mission is to enhance the responsible sourcing, production, use and recycling of steel by:

- Providing a multi-stakeholder forum to build trust and achieve consensus;
- Developing standards, certification and related tools;
- Driving positive change through the recognition and use of responsible steel.

The ResponsibleSteel Standard is designed to support the responsible production of steel, as a tool for the achievement of ResponsibleSteel's vision. Created by ResponsibleSteel members, including some of the world's largest steel companies and most respected social justice and climate NGOs, the Standard aims to play a pivotal role in driving down GHG emissions and driving up standards in the steel supply chain, helping steel companies transition to a responsible, decarbonised future.

After years of hard and complex work, ResponsibleSteel announced its revised Standard 2.0. As the world grapples with the impact of climate change, the new ResponsibleSteel Standard, launched on 14 Sept. 2022, focuses more deeply on reducing GHG emissions and now enables buyers of steel for the first time to specify what green procurement means in a credible way.

Leading steel companies including ArcelorMittal, Tata Steel, US Steel, thyssenkrupp, POSCO, BlueScope, and voestalpine worked with others along the steel value chain to support the standard's development, as well as leading environmental NGOs - the Climate Group, Ceres, the Clean Air Task Force, and Mighty Earth. The launch of this Standard will provide leaders in the steel industry with an immediate opportunity to showcase how they are driving down emissions, whilst tackling other urgent issues such as the impact of mining, water use, labour rights, air pollution, and diversity. It’s an expert yet practical road map for radical and innovative change in the world of steel.

The steel industry, business and civil society and associate members have worked together to produce a breakthrough standard. It is a workable standard to certify steel products which meet the highest possible sustainability metrics. Steel customers can now be confident in specifying ResponsibleSteel certified steel products. The Standard sets a new high watermark for steelmakers, their supply chain and customers who want to address essential issues like biodiversity, GHG emissions, labour rights, water, and waste.

The ResponsibleSteel Standard is unique in addressing not only climate change but other issues also across the whole ESG spectrum. It has taken years of expertise and cross sector buy-in to create the new revisions which are even more exacting than before and pertain specifically to GHG emissions and the responsible sourcing of input materials. ResponsibleSteel’s new International Standard comes at a critical time, with the unfolding energy crisis alongside the climate crisis only magnifying the need for a global scale transition to a decarbonised economy. By providing a practical tool for both steelmakers and all their stakeholders to measure and reward progress, it paves the way for society to work together on this gargantuan challenge. The Standard enables anyone that’s either buying or making steel to demonstrate they are not only driving down emissions, but also thinking responsibly about impacts on people and nature right across the value chain.

The publication of this Standard will send a clear signal to steel customers, the market, investors, policy makers and government leaders that this is a Standard the world can trust, is wholly transparent, will push back against greenwashing and will ultimately pave the way towards a net zero steel industry with sustainability at its core.

ResponsibleSteel has been making good progress in terms of both enhancing the scope and diversity of its membership base and strengthening the rigour and extent of its certification process. Its members now include an impressively broad range of companies across the steel value chain as well as civil society actors. Revamped standard v2.0 not only improves the existing site level certification standard but introduces a product standard for the first time. The ResponsibleSteel Standard and certification program is an important example of multi-stakeholder collaboration for sustainable change across the steel value chain. Driven by the collaborative effort of industry and civil society, it has been designed to give customers, stakeholders and consumers confidence that the steel they use has been sourced and produced responsibly. Tangible action to decarbonise the steel industry is ramping up with the finalisation of the ResponsibleSteel Standard V2.0. As the Standard forms a key part of SteelZero commitment, these additional requirements will strengthen and clarify the collective voice of members, boosting the demand signal for low emission and net zero steel and accelerating the net zero transition of one of the highest emitting sectors.

This will soon become the global standard for low-emission and responsibly sourced steel. Choosing ResponsibleSteel-certified materials will send a strong message to steelmakers that investing in renewable energy-powered steelmaking makes sense economically and environmentally. This standard goes beyond greenhouse emissions and also includes critical environmental safeguards, ensuring that deforestation has no place in the steel industry's future.

The IEA says that if the international community is to meet its pledges to limit warming to near 1.5 degrees C, the steel industry needs to reduce its CO_2 emissions by more than 90% by 2050. Time is short in other words and for the industry to be on track this will require substantial emissions reductions within this decade.

Global steel production today stands at about 1.8 billion tonnes – and is one of the most utilized materials available to humankind. Steel is also seen as one of the most essential resources for tomorrow. Much of what the systematic transformation of the climate challenge requires will be made from steel. And in the developing world, extensive infrastructure projects will be required to improve the quality of life. By 2050, the world is likely to be producing 2-2.5 billion tonnes of steel.

ResponsibleSteel will help drive certification of steel sites. Previous Standard has been revised to be even more exacting. To date, 41 sites across 4 continents have been certified to the previous ResponsibleSteel Standard, producing between them about 48 million tonnes of steel annually. It is anticipated that this will rise rapidly in the coming years. A host of other sites from across the globe are in the certification pipeline, if those in public audit stages achieve certification, they would together represent over 100 million tonnes of steel annually and around 150,000 workers.

Source: ResponsibleSteel Newsletter, Sept. 2022

Decabonization Glossary

Calcium looping: It is a carbon capture scheme using solid CaO-based sorbents to remove CO_2 from flue gases, producing a concentrated stream of CO_2 (~95%) suitable for storage. The scheme exploits the reversible gas–solid reaction between CO_2 and CaO(s) to form $CaCO_3$(s).

Carbon capture: A process that captures carbon dioxide emissions from sources like steel plant waste gases, coal-fired power plants.

Carbon content: The physical quantity of carbon in a product.

Carbon footprint: See embodied carbon

Carbon intensity: The amount of carbon, carbon dioxide or carbon dioxide equivalents by weight emitted per unit of energy or mass consumed.

Carbon intensive: Very high carbon intensity.

Carbon neutral: Achieving net-zero carbon dioxide emissions. This can be done by balancing emissions of carbon dioxide with its removal (often through carbon offsetting) or by eliminating emissions.

Carbon sink: Any reservoir, natural or otherwise, that accumulates and stores some carbon containing chemical compound for an indefinite period and thereby lowers the concentration of CO_2 from the atmosphere. Globally, the two most important carbon sinks are vegetation and the ocean.

Carbon storage (or sequestration): A process that takes captured CO_2 and stores it so it will not re-enter the atmosphere. CO_2 storage in geologic formations includes oil and gas reservoirs, un-mineable coal seams and deep saline reservoirs.

Carbon utilization: A process that can take the carbon that has been captured and utilizes it as a feedstock material.

Clean energy: Energy produced from low- or no-carbon sources.

Clean hydrogen: Hydrogen produced from low- or no-carbon sources of energy and feedstocks. Hydrogen produced using nuclear, renewable, or low-carbon process.

CO_2 trunk lines: Major CO_2 pipeline network that conveys CO_2 between sources and storage areas.

Clusters: Industrial clusters, or geographic areas where there is a high concentration of industry.

Direct separation: The process of providing indirect heat in the pre-calciner which allows production of a concentrated stream of CO_2 suitable for CCS.

Embodied carbon: Embodied carbon is the carbon footprint of a material. It considers how many greenhouse gases (GHGs) are released throughout the supply chain and is often measured from cradle-to-(factory) gate, or cradle-to-site (of use). Embodied carbon may also be measured with the boundaries of cradle-to-grave, which is the most complete boundary condition. This boundary includes the extraction of materials from the ground, transport, refining, processing, assembly, in use (of the product), and finally its end of life profile.

Electrochem: Electrochemistry.

Electrolysis-hydrogen: Hydrogen produced through electrolysis.

Electrowinning: The low-temperature electrolysis of iron ore.

Embodied carbon methodology: Processes, methods, protocols to evaluate the carbon footprint of products.

Flash ironmaking: A process that uses natural gas and/or hydrogen to both heat the iron ore concentrates in the furnace and to remove oxygen, converting the ore to iron metal.

HIsarna: A direct reduced iron process for iron making in which iron ore is processed almost directly into liquid iron (pig iron).

Low-carbon: A technology, fuel, or process, with low net GHG emissions to the atmosphere, as opposed to the carbon content of the fuel or energy source being utilized.

Low-net-carbon: A product or process that emits slightly more carbon than it removes, not quite achieving carbon neutrality.

Lower-carbon: Lower carbon intensity than for conventional products or processes

Modularization: Separating and recombining components of technologies or processes to advance efficiency.

Near zero carbon: Very low, almost zero carbon intensity

Negative emissions technologies: Technologies and activities such as (1) afforestation and reforestation, (2) land management to increase and fix carbon in soils, (3) bioenergy production with carbon capture and storage (BECCS), (4) enhanced weathering, (5) direct capture of CO_2 from ambient air with carbon storage (DACCS), or (6) ocean fertilization to increase CO_2 removal.

Net-zero carbon: See carbon neutral

No-carbon: Zero carbon intensity

Technology maturity: Instead of identifying specific technology readiness levels by number, this more generally categorizes technology readiness as low, medium, or high technology maturity.

Top gas recirculation: Top-gas recycling in blast furnaces with CCS.