Annual Issue

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Dr. Mukesh Kumar

Green Steel technological advances to improve the productivity and minimise carbon emission by 40-50%

- **Data analysis to play an important role in 4th Industrial Revolution (4IR)**
- **ESG to play important role in Mining sector**
- **Quality lubrication with smart servicing for the steel industry**
- **Coal Gasification an Indigenous and sustainable solution for India's industrial energy demands**

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Devoted to Iron & Steel Industry

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D. A. Chandekar
Editor

Dear Readers,

Since many years, 'Steelworld' has been following the tradition of publishing an annual issue and I am very happy to hand over a copy of the same for the year 2022.

The last year was indeed a very eventful year for the global economy as well as for the iron & steel sector. By June 2021, good amount of covid vaccination was already done and the pandemic too had almost calmed down. The global economy, which had suffered a tremendous jolt during the previous year, had gradually started to stabilize. The logistics disruptions started getting corrected. The situation in iron & steel sector was no different. The steel demand, which had substantially dipped during the previous year, started heading north. Raw material and finished steel linkages were getting re-established. Overall, the situation and also the industry sentiment was heading towards normalcy and suddenly it happened !

As such the relations between Russia and Ukraine, for various reasons, were strained since a long time and the situation was gradually heading towards a war. Finally Russia started full scale military operations in February 2022 and again the global economy so also the iron & steel sector got destabilized. Ukraine was a big exporter of semi finished and finished steel to the world which suddenly halted. Also due to war, logistics (sea routes) of many raw materials got affected which resulted in decreasing the availability and increasing the prices of raw materials. Further, the movement of finished steel got disturbed due to some sea routes getting blocked by the war situation. All this naturally affected the steel demand which started moving downward. Thus with increased prices and reduced demand, the steel industry was again seen in an unstable and vulnerable situation. As such the war is being fought between only two countries, Russia and Ukraine, but many countries are politically involved in it and yet many other are being economically hit by it. This prompted many governments to take measures to protect their own industry and the markets. Indian government too has introduced new export duty structure in order to increase the availability of steel in the domestic markets and also to reduce the price to some extent. I think both the objectives were more or less achieved.

Now the situation has gradually started normalizing. Even if the war has not yet ended, the world including the steel industry has learnt to live with it. Also the experts are predicting that it will soon end. Their hypothesis is that Europe can not fight the winter without Russian gas and has to make truce. Ukraine has exhausted its resources and even Russian economy has started going down. Of course there are many more dimensions to this issue but ending of war seems the only solution to come out of this difficult situation.

Let's see how the situation unfolds !

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Content

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Green Steel technological advances to improve the productivity and minimise carbon emission by 40-50%

Dr. Mukesh Kumar, Director, Steel Research and Technology Mission of India-SRTMI is having around four decades of experience in Metallurgy, Oil & Gas, Technology Development, and Project Management in India and abroad. He is an expert member of various committees of the Government of India like Coal to Hydrogen, Coal Gasification, E-waste Management, Resource Efficiency and Circular Economy in the Mining and Metal sector, R&D Committee of the Ministry of Steel, etc. He is associated with various sustainability-related projects including the use of Hydrogen and Carbon Capture Utilization.

He is also Chairman of the Indian Institute of Metals, Delhi Chapter. He was associated with Engineers India Limited (EIL), for 26 years and was involved in a number of green field and brown field projects in the field of Metallurgy and Oil &; Gas in India and abroad. He was involved in the development of Technologies like Titanium sponge, Geo-Polymer Cement, Special Grade Alumina and Hydrate, Vanadium extraction, Red Mud Filtration, Zinc Recovery from EAF/IF Dust, etc.

Also, worked with Vedanta Group for about 10 years as President & COO of Aluminium & Power business and later as a President & Group Head –Technology & Innovation for the entire group. Involved in the development of a number of innovative technologies.

Before taking over charge of the Director-SRTMI, worked as an advisor to Hindustan Copper Limited (HCL) for revival plans for HCL, Mishra Dhatu Nigam Limited (MIDHANI) for some critical projects like Carbon Fiber, High-end Aluminium Alloys, Tungsten Powder & Carbide, and KPMG India for Aluminium Projects.

On the occasion of Steelworld Annual Issue, D Chanekar, Editor had an exclusive interaction with Dr.Mukesh Kumar to get more insights on green steel trends in iron and steel sector.

What are the emerging technology trends in the iron & steel sector?

Technological advances and innovation have played a crucial role in the growth of the iron & steel industry with continuous improvement in productivity, energy and water consumption, waste utilization, development of higher quality and value-added steel products, and addressing environmental concerns. Today, carbon emission is the biggest challenge being faced by the global iron and steel industry as it is one of the largest CO_2 emitters contributing around 7-9% of total emissions globally and around 12% in India. To address the issue, a three-fold approach is being adopted by the industry viz. carbon avoidance, carbon minimization & carbon utilization, and the majority of the emerging technologies revolving around these areas.

In the area of carbon

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avoidance, the major thrust is on the use of hydrogen and renewable power in iron & steel making. It is a known fact that hydrogen can be a good reducing agent in comparison to carbon and thus has the potential to achieve zero carbon steel making. But, due to its endothermic reduction, there are numbers of technological challenges, and most researchers are engaged in finding the most optimum solution to it. The other challenge is the high cost of hydrogen and the lack of technology for large hydrogen generation, transportation, and storage. Although some pilot projects based on hydrogen are being planned globally, the commercialization of such technologies may take a longer time. However, efforts are being made to increase the blending of hydrogen in gas-based iron making and some trials with hydrogen as high as 70% have been successfully made. The other area is increasing scrap-based production with the use of renewable power and advanced electric arc furnaces to minimize power requirements through efficient heat recovery systems. However, the availability of scrap is an issue and it is expected that scrap-based production may increase from the present level of 30% to 40% globally only by 2050 thus the industry has to look for other options. Some efforts are being made to develop disruptive technologies like molten oxide electrolysis similar to Aluminium making but through the use of renewable power.

As presently limited options are available, the major thrust is on the improvement of existing technologies like blast furnaces and basic oxygen furnaces (LD) so that carbon emissions can be minimized to the extent possible. In this area the major focus is on the use of high-quality raw material like Iron ore of grade 65%, maximizing pellet feed in BF to avoid the need for sintering and reduce coke consumption, recycling of hydrogen and carbon mono oxides rich gases like coke oven gases and BOF gases in blast furnaces, heat recovery from coke through dry coke quenching, dry slag granulation, off gases heat recovery and power generation, use of plastic waste and syn gas/ natural gas in blast furnaces, slag utilization in construction and agriculture, etc. Such technological interventions are expected to improve productivity and reduce emissions by 40-50%. Hence, companies are planning future expansion based on existing technologies but with such advanced interventions.

The other major area which will have a large impact is carbon capture and utilization (CCU) for the production of chemicals and fuels. Some of the potential applications are the use of CO_2 for the production of methanol, bio-ethanol, methane, algae oil, carbon black, carbon flakes, electrolysis to produce CO, and the use of the same through recycling, etc. Such initiatives shall not only help in mitigating carbon emission but may also help in achieving net zero carbon emission in steel making and thus fulfilling our commitment to achieve carbon neutrality by 2070 as committed by our Hon'ble Prime Minister in COP 26.

What is the concept behind 'Green Steel'?

The term “Green steel” is used by different agencies differently. Some are using it for steel produced from scrap, reused and re-manufactured steel, conventional steel with emissions offset, or steel manufactured using breakthrough technology like the use of hydrogen with carbon neutrality. There is no universal agreement yet about what the concept of “green steel” refers to. Some organizations feel that the term “green steel” should cover issues others than GHG emissions alone like social, safety, and environmental issues which are important to steel companies' investors, customers, and other stakeholders. The basic objective is to ensure zero harm to society, the environment, and the protection of stakeholder interests. They strongly advocate that any entity offering “green steel” would have to show how it addresses the range of social and environmental concerns and not only GHG emissions.

In absence of reaching to some consensus definition of green steel, the world steel association is advocating the use of the word “low carbon emission” steel making which can be defined as steel that is manufactured using technologies and practices that result in the emission of significantly lower CO_2 emissions. Although all the major companies across the globe including India have agreed to adopt a uniform system for carbon emission reporting covering scope 1,2

and 3 emissions, it may be advisable to evolve some consensus on the threshold limit of CO_2 emission beyond which steel can be classified as "green steel" till technologies like hydrogen-based steel making or molten oxide electrolysis with use of renewable power or other disruptive technologies are developed on a commercial scale.

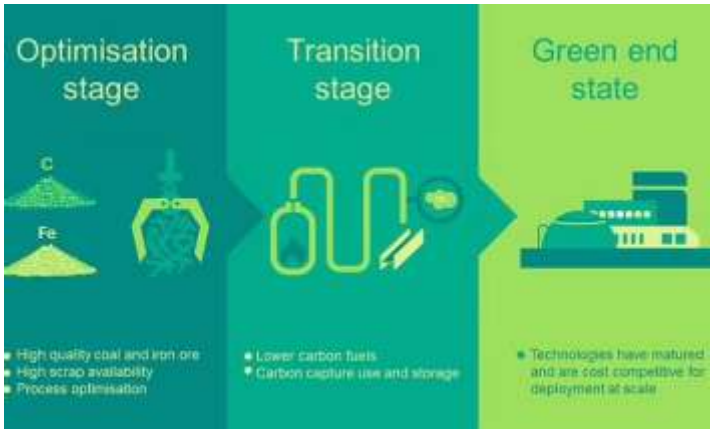
How can Industry 4.0 help the industry improve its bottom line?

Industry 4.0 means change and a "digital workforce" is a must for successful implementation so that in addition to dealing with new technologies they are also capable of identifying opportunities for improving processes or realizing new business opportunities with new technologies and improving the bottom line by increasing manpower productivity, reducing waste generation and timely addressing end users concerns. The change to Industry 4.0 has been widely accepted in countries like Japan, Korea, and Europe but major producing countries like China and India are slowly making steady progress in this direction.

It has been established in different manufacturing facilities that the adoption of Industry 4.0 can create smarter, more efficient steel plants, which in turn will help reduce emissions, improve product quality and decrease plant downtime. Due to the harsh environments often found in steel plants, sensors have been used to collect data for some time. However, only a fraction of the data collected is analyzed and used, so there is potential for significant advancements to be made through big data analytics and combining statistics from multiple areas to generate a holistic view of the steel-making process, which shall ultimately help in improving the bottom line of the steel plants.

As India is likely to increase steel production capacity from 145 million tonnes to 300 million tonnes by 2030 and with limited technical manpower available, adoption of Industry 4.0 is inevitable.

How is SRTMI helping the steel industry in the technology up-gradation process?



SRTMI has been created to support the steel industry to pursue collaborative research and facilitate the adoption of advanced technologies in various areas starting from iron ore and coal beneficiation to end product and by-products utilization including improvement in productivity, specific material and energy consumption, GHG emissions reduction and making industry self-sustainable and globally competitive. We are trying to collaborate with some of the globally best research institutes engaged in iron and steel research through various government-initiated programs as well as government-supported research products. Presently, our main focus is on carbon reduction and adopting a zero waste and zero harm approach to improve sustainability and meet global expectations. We are keeping a watch on the latest developments in various fields including the development of technologies like dry beneficiation, use of low-grade ores, non-coking coal-based technologies, coal gasification and coal to hydrogen technologies, and CCU technologies. We are supporting the industry in the evaluation of such technologies and trying to coordinate with process licensors in this area. SRTMI is also acting as a link between industry and the government on various technical issues.

SRTMI is also actively working with the secondary steel sector as no major R&D facilities are available in this sector. Several new innovative approaches have been discussed with the industry and these have started yielding good results. We are confident that in time to come, SRTMI shall achieve its goal of becoming a renowned platform for encouraging collaborative research on the development of technologies in the field of Iron and Steel for the wider usage of all the steel players and minimizing dependency on outside support as well as efficient utilization of domestic resources. ■

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Data analysis to play an important role in 4th Industrial Revolution (4IR)

About a decade ago we stood on the brink of a technological revolution that was to fundamentally alter the way we live, work & communicate. With the benefit of hindsight, we can clearly see how the change has manifested and impacted all our lives. An electricity-conducting-material-coated-glass surface (read touchscreen) manages our lives and livelihoods with aplomb. The lines between the physical, digital, and biological have been substantially blurred by a fusion of technologies that are enabling the 4th Industrial Revolution. Unlike previous Industrial Revolutions, the 4th one has the scale and speed & scope that have not been seen or experienced earlier. Having said that, the basic element that's enabling this transformation is not unknown to us, it is Data.

Data is fueling the 4th Industrial Revolution (4IR). The ability to generate, store, process, and consume data has grown exponentially. The proliferation of smart sensors, digital apps, high speed & inexpensive connectivity, near-unconstrained computing capacity & human ingenuity are propelling humankind towards an era that will be integrated across time & space, an era that will eliminate information & knowledge asymmetry and an era underpinned by sustainable living. For industries, it has held the promise of unparalleled efficiency & productivity gains across the value chain, at a fraction of the investment. To be sure that these are not components of a sci-fi thriller, all we need is to look around. With the onset of Covid, the rate of this transformation has only

T. V. Narendran
CEO & MD, Tata Steel

accelerated, and every aspect of our daily lives today is enabled by digital technologies – communication, travel, shopping, working, and learning, to list a few. Organisations cutting across industries & purposes are riding this wave of change with varied degrees of success. The ones who were the early adopters have been able to tide over the pandemic-induced economic environment with far better results than the rest, who are now scampering to catch up.

For those who are starting off now on this journey, the need of the hour is clear, and the proof of concept and value is there to be seen across industries. Others like us, who began early, had to go through a long process of creating a belief system and altering our mindset toward the new technologies and needed to test and demonstrate for themselves the proof of concept and value. Having done that, the first step was to assess and access the right mix of technologies that would be value accretive to the business.

The no-regret move was, and still is, to strengthen the organisation's ability to generate, capture, store, secure & process Data, within all regulatory stipulations, of course. These foundational elements entail a judicious investment in sensorisation, cloud computing, connectivity & cybersecurity followed by simplification & synergizing of IT applications to break data, as well as process silos. Today, there are industrial startups that would help one do all of that and more to accelerate one's 4IR journey, limited only by the organisation's appetite & agility to transform.

The second critical component of the transformation is talent. Since these technologies are here to stay, it would make sense to build a critical mass of certain capabilities in-house but that would be time taking hence, to begin with, it's ideal to partner with organisations who can fill the talent gaps to kick start the transformation. Organisations must also be discerning on what capabilities they would want to build and retain while buying the others as services, given that these skill sets are high in demand and often hard to acquire and retain in a market that would remain short on supply for the foreseeable future. Skills like Data Engineering, Data Science, Data Visualisation & Business Process Re-engineering with digital as the core enabler, are in high demand as businesses across industries are awakening to the possibilities. While these niche and deep tech skills are necessary for the transformation, they are however not sufficient. For the transformation to be sustainable and irreversible, it is also crucial that the consumers of the technologies are also reskilled, hence a broader capability-building exercise needs to be undertaken to

bring about a better understanding and appreciation for digital technologies across business functions.

The third and possibly the most critical component of the transformation is Business centricity. Business goals must always remain the focus of the transformation, while not getting distracted by the pace and scope of technological prowess, as technology is only a means to the end – a smart, intelligent & agile business. For this to happen, Leadership would need to lead from the front while fueling bottom-up ideation & innovation. A concept like Reverse Mentoring, which was recognised as an industry best practice by the World Economic Forum (WEF), can help stimulate leadership thinking. Under this program, a Senior Leader is mentored by a Millennial/Zoomer (Gen Z) on the possibilities of how digital technologies can be used in business functions. Additionally, robust program governance brings in the required amount of time and mind share of the leadership to build and sustain the momentum for change.

Organisations would need to get their Technology, Talent & Governance strategies right to be able to ride the ensuing wave of Industry 4.0 and reap timely and meaningful benefits. So, what are these benefits that the businesses must target to achieve? The key to success for any business is the ability to get decisions right, and on time, and for that to happen it is imperative that the decision makers across levels have access to the right information and insights at the right time. Digital technologies allow us to do just that. Quality and quantity of Data coupled with Data Science techniques provide decision makers with insights from the past as well as reasonably accurate predictions. Hence, the differentiator for businesses today and going forward will be their ability to harness the latent strength of Data. It has the potential to significantly uplift operational efficiency, productivity, throughput, and organisational agility to deliver a seamless & hyper-personalized experience to all its stakeholders through its products and services. As we continue to progress on this transformation journey, it is also recommended to get an outside-in view via benchmarking exercises, like the WEF's 4IR Global Lighthouse assessment. We at Tata Steel have been fortunate to receive this recognition for three of our sites at IJmuiden, Kalinganagar, and Jamshedpur over the last four years, which has helped validate our strategies and motivated the organisation to continue this journey.

As we continue to leverage the power of Data and ride the 4th wave of the Industrial Revolution, it is increasingly becoming apparent the steps businesses need to take to stay relevant and be more conscious in their business processes and dealings. Whether it is environmental sustainability or people-centricity, a sustainable and profitable business would need to assimilate further into the conscience of the community they operate in, all of which are possible through the application of Industry 4.0 technologies. These aspects of sustainability and community centricity coupled with harmonized human-machine interface and responsible usage of digital technologies would be the defining themes for the 5th Industrial Revolution. While the jury is still out on how the rest of the story will unfold, the subsequent phases of the revolution promise to usher in a world with greater economic prosperity and better standards of living.

First published in 'Business Today' dated Feb. 20, 2022.

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ESG to play important role in Mining sector

India's reforms in the mining sector are providing the right fillip to the Indian economy. The government is fully committed to provide the right platform for geoscientists from across the globe to formulate more effective tools in the field of sustainable development.

There is no doubt that Mining brought employment, and the demand for labor helped increase the local population, which became the driver of the surge in economic activities. An increase in services comes with rapid population growth, promoting business growth, including the backward and forward linkages of the mining operation.

Nonetheless environmental issues should be taken into consideration alongside countryside development.

Growing consumption demand, theoretically, translates to additional pressure to exploit natural capital. This scenario brings a dilemma, which pits conserving biodiversity against land development. Otherwise, the communities will have to outsource their consumption demand," the report said. Growing consumption demand, theoretically, translates to additional pressure to exploit natural resources. I would urge more inclusive mines development so that the host-communities themselves benefit from mining activities.

Haresh Melwani
Mine Owner

While, to some extent, mining contributes to regional GDP, experts saw initial indications of slow

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local economic growth because most of the commercial transactions by residents or the use of their factor income are often done outside the host-

localities.

According to the official government data, India produces over 85 minerals including coal, lignite, bauxite, chromite, copper ore and concentrates, iron ore, lead and zinc concentrates, manganese ore, silver, diamond, limestone, phosphorite etc. India is the second-largest producer and importer of coal in the world.

The expenditure of mining income is captured by highly urbanized cities or municipalities that provide for the consumption needs of nearby host-community residents.

Thus, mining companies are advised to invest part of their CSR (corporate social responsibility) in promoting enterprise development to promote local business development that will capture residents' mining income expenditures.

Further, a social development and management program must also support local enterprises leading to sustained creation of local wealth or alternative manufactured capital to substitute the depletion of non-renewable and renewable capitals. Other non-traditional sources of production must be explored,

It is recommended that an annualized budget be prepared up to the abandonment phase of the mining operations. Mining firms should continue to fund their social development and management programs or environmental protection and enhancement programs and sustain the progressive rehabilitation of mined-out areas with or without operations.

Mined-out areas that remain open, without rehabilitation, likewise pose a threat or risk of damage that will affect local livelihood. One area I would like to highlight is the Mining of New Age Minerals and Critical minerals

The shift to clean energy will require more mining and India can be a major player in the decarbonised global economy due to the endowment of natural reserves in critical minerals.

For example, demand for copper, lithium, nickel, graphite, and cobalt is expected to increase by up to six times by 2040. There is a tremendous opportunity to develop new exports and deepen processing capabilities.

Economists have found that revenues rose by 32 per cent among the top 40 miners globally, and net profit soared by 127 per cent on the back of high commodity prices and prudent cost management. Strong ESG credentials will be the foundation for future sustained growth.

The sector's environmental record needs to keep improving as is consultation and coordination with the Tribal peoples. The miners face challenges on several fronts. Prices for critical minerals can be volatile; new projects take time to permit, finance and construct; economic deposits are being depleted;

global geopolitics continue

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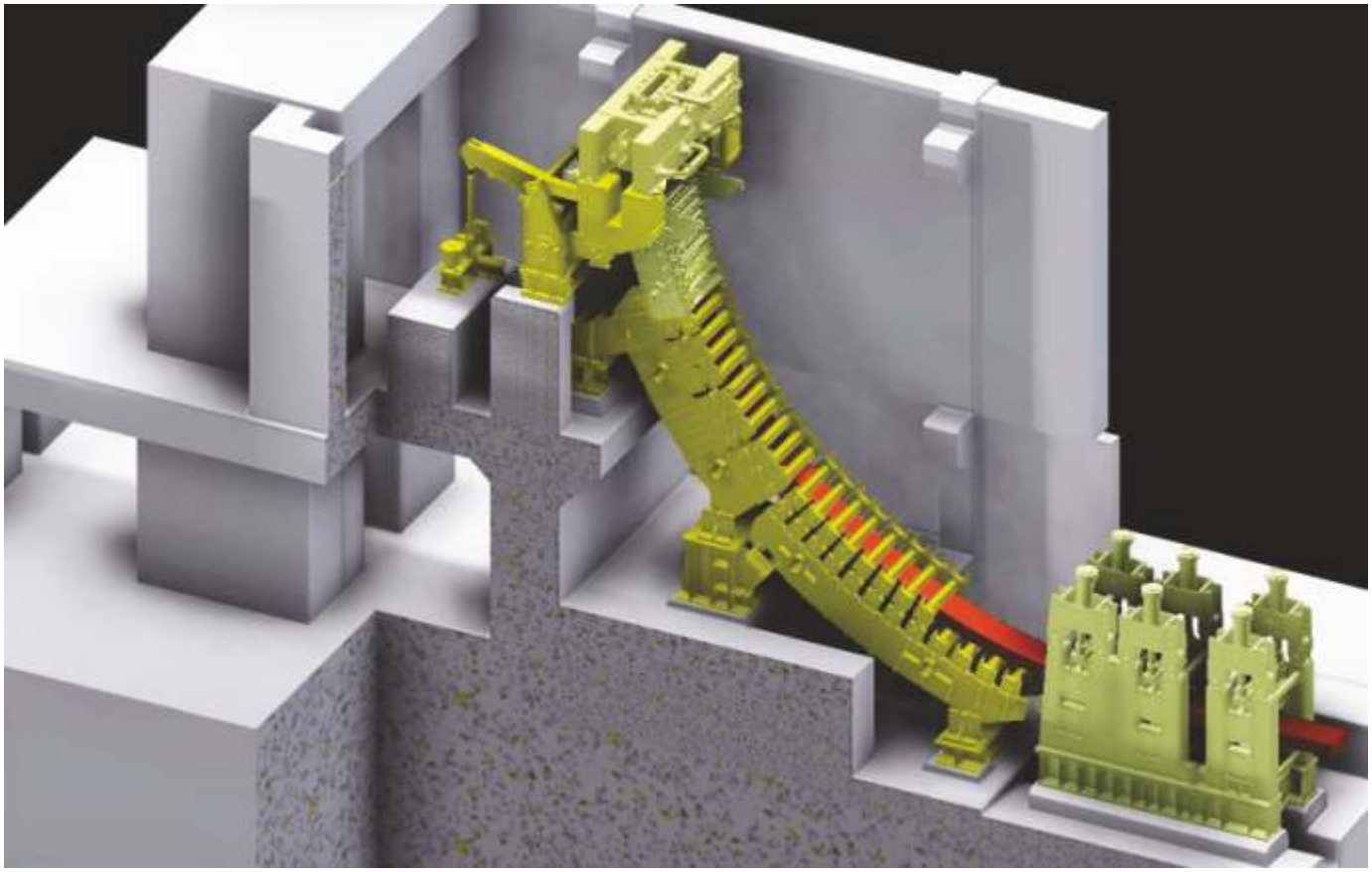

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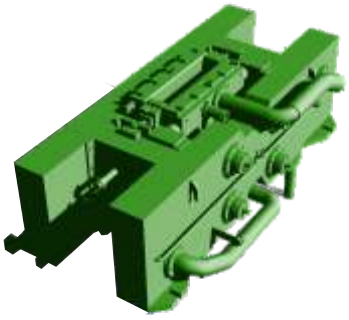

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to present a range of risks.

What it means to be a miner is changing, and the Top Mining Companies must keep up with the pace of that change. There's no single answer to the complex task of transformation. The big miners should be focusing on four key areas:

- Evaluating their exposure to critical minerals and working out where they need to be.
- Revisiting deal strategy and identifying opportunities to own more of the supply chain or to partner with end users and original equipment manufacturers (OEMs).
- Deploying capital and cash flow strategically and at sufficient pace to meet the needs of the transition to net zero.
- Building trust with stakeholders and strengthening mining's social licence to operate by increasing the focus on ESG.
- The miners that can successfully address these challenges will be best positioned not only to navigate the changing market dynamics but also to create value and to benefit from the rapidly increasing demand for critical minerals and the energy transition.

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Effect of Government levies on performance of Steel Industry

In an attempt to curb the inflation, the government of India levied a 15% export duty on steel which was effective from 22nd May 2022. It also levied a steep duty on the export of iron ore while cutting the import duty on key raw materials such as coal to reduce the cost of steel production.

This new export duty levied on steel by the Centre has put steelmakers in a dilemma of choosing between margins and relationship with customers as they ponder whether to continue exports even at a loss.

But, if one looks at the long term, and does not supply to customers, there is a risk of losing them and relationships can be badly affected.

Brief attempt is made in this article to understand the pros and cons of export duty, relaxation of import duties on steel raw materials, effect of Russia – Ukraine war and other factors on the Iron and Steel sector of India..

(A) Reasons for levying export duty: The Indian government levied this export duty on steel on 21st May in a bid to increase supply for domestic consumer industries and to tame inflation. Steep export duty was also levied on iron ore while import duties were cut on inputs like coal to reduce the cost of production for steelmakers. A 45% duty was also levied on the export of iron ore pellets and the duty on high-concentration iron ore was increased to 50% from 30% to increase supplies in the domestic market to reduce the input costs for steelmakers.

Dhiraj K Chauhan
(Director- METCON)

He offers metallurgical consultancy services in the areas of Heat treatment and quality as well as process controls in cold rolling mills. He is B.Tech (Hons) and M.Tech. in Metallurgical Engg. form IIT Mumbai.

These steps taken by the government will have varied effects on the exports of steel, availability of steel in the domestic market, prices and future plans of steel plants like expansion, loss of revenue for the government etc.

In the past, a similar export duty levied in 2008 by New Delhi, which was revoked partially within a month and completely revoked within five months. The government has not indicated any timeline for

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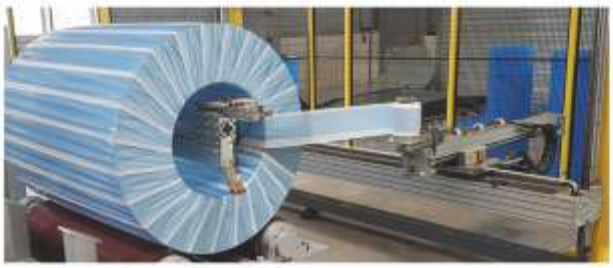

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revoking the current export duty on steel.

Steel ministry has also backed the industry's demand for export duty waiver on earlier orders.

Even within the domestic market, steel companies are laden with inventory that was manufactured at high input costs. However, customers will expect lower prices now following the changes in the duty structure. All this will put a pressure on margins.

(B) Effect of Russia –Ukraine war on the steel prices (apart from government levies): Effect of war will be complex on the steel prices due to multiple factors listed here.

(1) Russia and Ukraine have pushed the steel products in the markets at low prices. (2) Steel prices have gone up due to disruption in the supply. (3) EU imports of steel from Russia and Ukraine are cut off. (4) The steel from Russia will find a way out to world markets. (5) Europe is not ready to buy steel from Russia due to the sanctions problem. (6) Opening up of black Sea will help Russia to supply cheap steel. (7) Due to war, Steel prices in GCC region (Gulf Region) have gone up and range from 600 to 900 USD/MT. (8) In Europe, steel price surge has taken place. In Asia the steel prices surged and are now stabilised. (9) China has stopped importing steel from Russia in the last few months and there is a COVID surge in China again. Due to rising crude prices too there will be an effect on the steel market.

Thus, India is affected due to war since it is the second largest steel producer in the world and it is closer to Russia. Threat to the steel sector is imminent.

(C) Effect of Government levies on future plans of Steel plants: JSW Steel will continue with its planned brownfield expansions, the company will review its investments in greenfield capacity expansion in light of the new export duty. For the ongoing Capital expenditure today, there is no possibility of reviewing that since, these are all at an advanced stage. JSW Steel has earmarked Rs 20,000 crore capital expenditure in the current fiscal and hoped that headwinds such as export duty on steel and high coking coal prices are likely to be short-lived, a top company official said. The leading

Steelmakers in the country do not expect any "substantial easing" of price of the metal in the domestic market from the current levels, unless the prices of coking coal, a key raw material for the steel manufacturing, moderate in the international market, he said. .

(D) Overall effect on Steel prices: As per the news report of Jun 4, 2022, Prices of domestic benchmark hot-rolled steel coil (HRC) at the traders' end have slipped by about 8% or Rs.5,500 to about Rs.63,800 per ton since May 18, according to SteelMint, a market intelligence agency.

In fact, since the beginning of the ongoing fiscal year on April 1, domestic steel prices have come down by 17%, and are now below their year-ago levels. However, raw material prices remain elevated, which would weigh on the performance of steelmakers such as Tata Steel, JSW Steel, Jindal Steel and SAIL.

The government is expecting a revenue loss of Rs 10,000 -15,000 Crore as a result of the recent customs tax recalculation on iron and steel and plastic. With effect from May' 2022, it abolished customs duties on the import of some raw materials needed by the steel industry, thus lowering the costs for the domestic industry.

(E) PLI scheme: To give a boost to steel production, March 29 was the last date for manufacturers to apply for the benefits under the PLI (Production-Linked Incentive) scheme for speciality steel. It was later extended till April 30 and again to May 31, 2022. So far, 10 applications have been received by the government under the PLI scheme.

(F) The steel manufacturers in India like JSW Steel Ltd have decided to continue to supply products to its buyers in Europe without passing on any increase in costs despite New Delhi's decision to impose an export tax and

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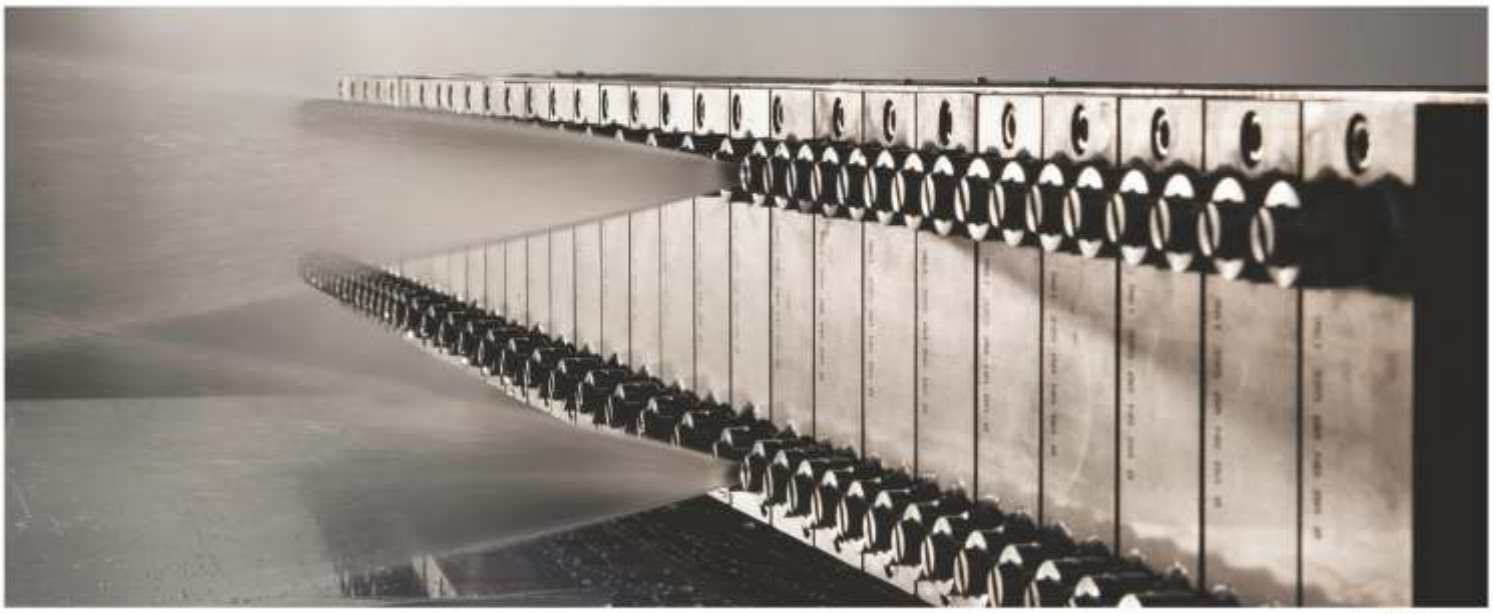

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government scrapped import duty on coking coal, a key steelmaking raw material.

The steel industry is in dialogue with the government to review its "draconian" levy, said Mr Oommen, President of the Indian Steel Association (An association representing steelmakers) in an interview with ET's Satish John. Mr Oommen is also the CEO of ArcelorMittal / Nippon Steel. The duty could have been levied after a consultative process, He felt, if this duty continues, it will be India's loss and China's gain.

levy. When the country was facing issues with Covid, Prime Minister Modi himself had a session with the steel industry and it went out of the way to help by supplying oxygen. Also, when Covid hit us, the domestic demand was totally destroyed. The entire steel industry would have been in tatters had it not been for the export market. If you look at last year, the steel industry exported 13.5 million of finished steel. Where will you find a home for this steel? It has to be exported said Mr. Oommen.

Reacting to the

engineering goods manufacturers and exporters would benefit from the move and become more competitive in the global markets. Steel prices are likely to fall by up to 15% in the domestic market. ■

Steel prices in India have already corrected 10% in line with global trends when the government surprised the industry with a 15% export

government's move to levy export duty on some steel items, EEPC India Chairman Mahesh Desai said

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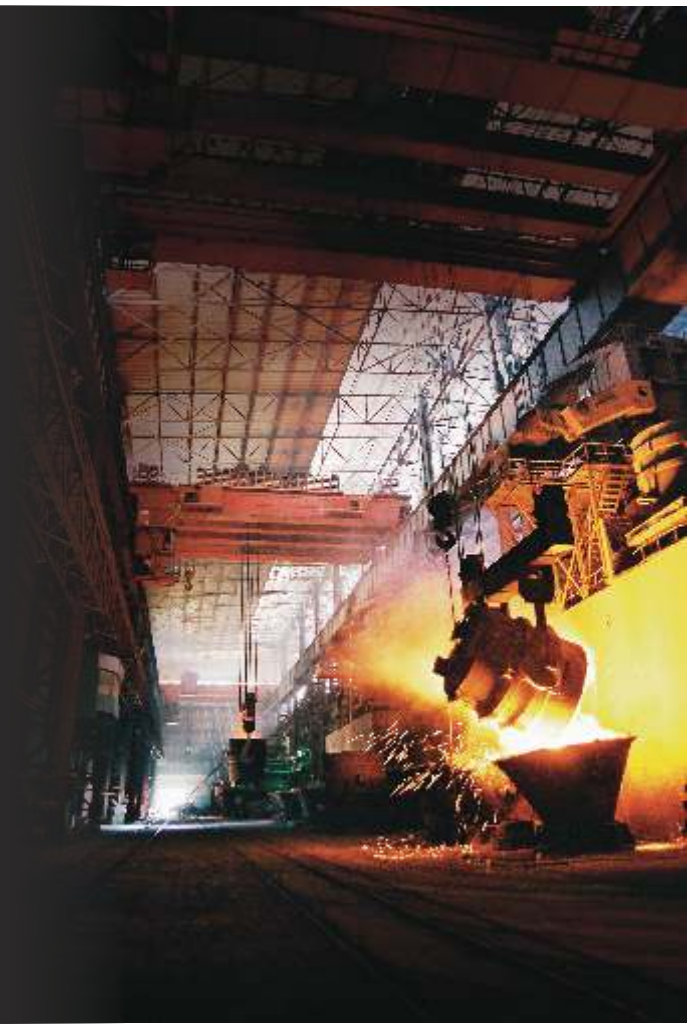

The Indian steel industry has been a frontrunner in the country's industrialization journey.

Today, India is the world's second-largest crude steel producer with production in the country increasing by 18% to reach 120 million tonnes in FY22, courtesy of growing industrial and consumer demand. Simultaneously, in line with changes across the globe, this massive industry is also adapting to newer trends of digitalization, artificial intelligence, and machine learning (AI/ML) and Industry 4.0. Duly, there is an added focus on upgrading systems, introducing sophisticated equipment, and opting for best-in-class service to ensure efficient, productive, and profitable operations.

The steel industry demands the use of heavy-duty machinery that is often exposed to difficult conditions. To cater to weather extremities and the bulk of raw materials processed, the machinery in this sector demands durability and endurance. For this, in turn, high-grade industrial lubricants are today playing a vital role in influencing the success of everyday operations. A driving force leading the innovation of superior lubrication technology for over 150 years, Mobil™ Lubricants have been at the forefront of developing the most advanced solutions that ease core industrial operations. By focusing on specialized industrial lubricants, Mobil is ensuring efficiency, reliability, and productivity with excellent protection against wear and tear.

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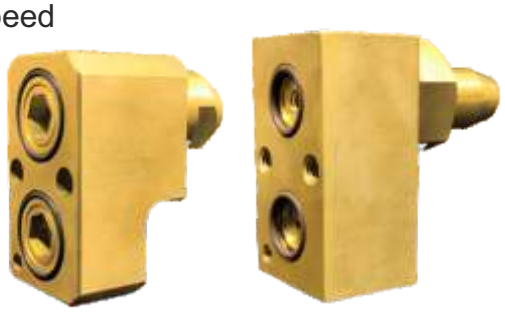

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productivity. For instance, the Mobil SHC™600 Series lubricants are exceptional performance gear and bearing oils designed to provide outstanding service in terms of equipment protection, oil life, and problem-free operations for increased customer productivity. These scientifically engineered oils are formulated using the latest proprietary technology to provide outstanding and balanced performance in demanding applications at high and low temperatures.

These superior lubricants feature excellent low-temperature properties, as well as improved air release performance in the lower viscosity grades. Additionally, the Mobil SHC 600 Series products have demonstrated up to 3.6%improvement in energy efficiency in controlled laboratory testing* due to lower operating temperatures and improved gear efficiency – translating into reduced power consumption.

Similarly, the Mobil SHC™ Gear Series line of exceptional performance, synthetic industrial gear oils have been designed to provide outstanding protection to gears and bearings, extend oil life even under extreme conditions, enable problem-free operations of equipment, and increase customer productivity. These scientifically engineered synthetic lubricants are formulated from synthetic base fluids that have exceptional oxidation and thermal properties and excellent low-temperature fluidity.

The high viscosity index of these premium lubricants delivers less change in viscosity with changes in temperature, enabling a wider operating temperature range and improved low-temperature start-up.

Beyond the Mobil SHC™ Series, Mobil has introduced the Mobil Vacuoline™ 500 Series which provides a versatile lubricant source for a wide range of industrial equipment and is especially suited for the steel industry. These lubricants are formulated from high-quality base stocks and a proprietary additive system to provide superior wettability, extra oil retention, and thin film protection against rust and corrosion that gives excellent resistance to oxidation and thermal degradation, and a high level of protection against wear. The oils are recommended for use in hydraulic systems which specify higher viscosity levels and are particularly resistant to the effects of prolonged high-temperature exposure. They also perform well in circulating systems with short oil residence times.

Mobil has also been working extensively towards revolutionizing industrial greases. For instance, the Mobilgrease XHP™ 460 Series greases are extended service lithium complex greases that have been formulated for a wide variety of heavy-duty applications and operating conditions. These greases have been designed to outperform conventional products by applying high-performance proprietary lithium complex manufacturing technology. They also provide excellent high-temperature performance with quality adhesion, structural stability, and resistance to water contamination.

These greases have a high level of chemical stability and offer excellent protection against rust and corrosion. Under this series, Mobilgrease XHP™ 462 Moly is fortified with 3% molybdenum disulfide and is particularly recommended for applications such as

bucket pins and fifth wheels, where molybdenum disulphide provides an extra level of protection, and where sliding friction and oscillating motion can lead to rupturing of the oil film, resulting in metal-to-metal contact.

Servicing for long-life

Along with opting for premium lubricants, developing servicing solutions that tap into the most recent innovations in digitalization and AI/ML has been significant in influencing the quality of industrial performance.

These innovations are today revolutionizing business by optimizing equipment performance and guiding the industry towards reducing man-machine interaction, reduced negative fallouts and significantly enhancing productivity and profitability. Here, services under the Mobil Serv℠ Lubricant Analysis (MSLA) are helping steel businesses save time and money.

While boosting equipment reliability and productivity. It uses one of the most sophisticated interpretation logic algorithms and the most extensive used-oil analysis limits database which allows users can choose the analysis that best fits their reliability program.

The MSLA program eliminates the conventional process of collecting and labelling samples by delivering pre-labelled sample bottles with QR codes and a unique number identifier, improving sample process efficiency and significantly reducing human interference. With MSLA, oil sampling has become 66% faster**. Moreover, to combat temperature-related challenges in steel plants, engineers at Mobil inspect and document the temperature and condition of critical plant equipment and processes.

Thereafter, they use inspection and temperature data to locate and eliminate potential problems.

Through thermographic inspections, experienced engineers collect operating

temperature data and identify potential equipment and lubricant issues to help avoid costly downtime and enhance operating conditions.

By bringing a rich combination of superior lubrication solutions and a quality service portfolio, Mobil has been aiding the performance of the industrial sector by ensuring smooth production and enhancing energy efficiency.

Due to its dependence on heavy machinery functioning in harsh temperatures, the steel industry relies on quality lubricants to achieve its full potential. Duly, Mobil has been innovating for the sector to aid the journey towards maximum productivity and profitability with assured efficiency in everyday operations.

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*Energy efficiency relates solely to the performance of Mobil SHC 600 when compared to conventional (mineral)reference oils of the same viscosity grade in circulating and gear applications. The technology used allows up to 3.6%efficiency compared to the reference when tested in a worm gearbox under controlled conditions. Efficiency improvements will vary based on operating conditions and application.

**This performance is based on the experience of a single customer. Actual results may vary.

For more information, visit www.mobil.in/business

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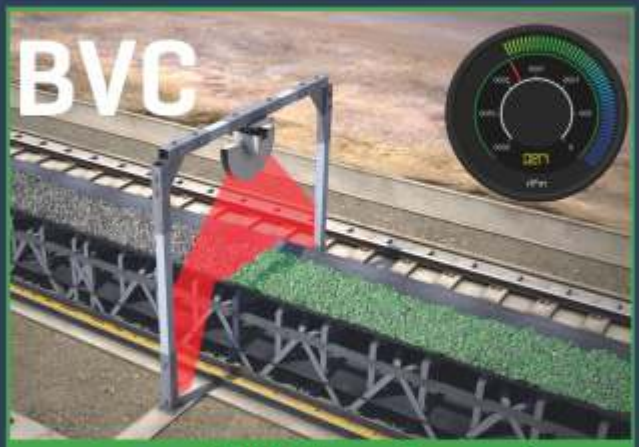

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View Point

Overview of Green Iron and Steelmaking

VISHVA BANDHU
Sr Dy Director
(Indl Services)
NISST

The average annual temperature of the earth is rising since the industrial revolution. This is mainly due to the burning of the fossil fuels which increase the emissions of carbon di-oxide (CO_2) in the atmosphere. Prior to the industrial revolution, 280 ppm (0.028 %) of CO_2 was present in the atmospheric air. This has increased to around 413 ppm (0.0413 %) in the year early 2019. Fig 1 shows global rise in the annual temperature and the concentration of CO_2 on the earth during last 800,000 years. The data of atmospheric CO_2 is provided by the U.S. National Oceanic Atmospheric Administration (NOAA).

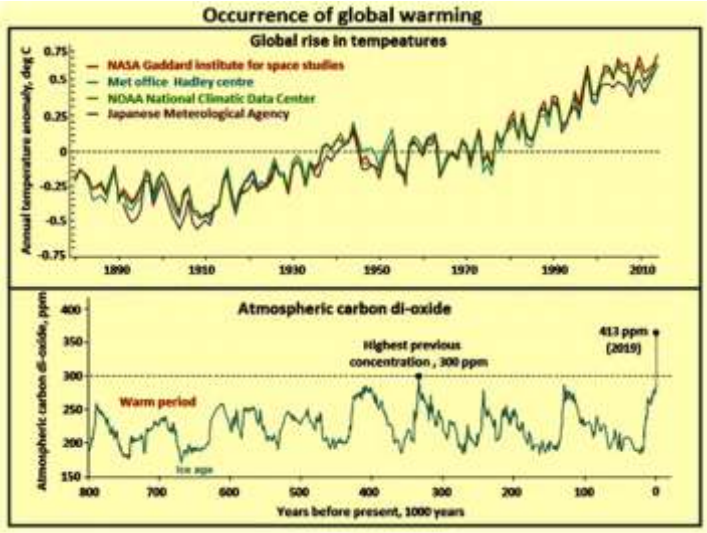

Fig 1 Occurrence of global warming

Increase of 1 deg C temperature, although, does not seem to be high, it is believed that any further increase can have serious consequences such as disappearing of the sea ice, receding of the glaciers resulting into a rise in sea levels, which is presently measured at 3.3 millimetres per year on an average. For the avoidance of the ill effects of the climate change, the global warming is required to be kept at the present level or even below that.

Iron and steel industry is the single largest sector in terms of total global fossil and industrial emissions, making up around 7 % to 9 % of greenhouse gas (GHG) emissions. It is the largest industrial emitter and at present responsible for around 8 % of global final energy demand. Hence, it is a prime focus for the governments. On the other hand, steel is vital to modern economies and so the global demand for steel is expected to grow to meet rising social and economic welfare needs. It is also a critical input for the clean energy transition and key input material for wind turbines, transmission and distribution infrastructure, hydro-power and nuclear power plants, among other critical energy sector assets.

Direct CO_2 emissions from the sector are around 2.6 giga tons of carbon dioxide (Gt CO_2) per year, or around a quarter of industrial CO_2 emissions, owing to its large dependence on coal and coke as fuels and reducing agents. A further 1.1 Gt CO_2 of emissions is attributable to the use of its off-gases, along with other fuels, to generate the electricity and imported heat it consumes.

It is, therefore, iron and steel producers have a major responsibility to reduce energy consumption and greenhouse gas emissions, develop more sustainable products and enhance their competitiveness through innovation, low-carbon technology deployment, and resource efficiency.

The iron and steel industry has recognized that long term solutions are needed to tackle the CO_2 emissions produced during the production of steel. As a result, the steel industry has been highly proactive in

improving energy consumption and reducing the CO2 emissions. Improvements in energy efficiency have led to reductions of around 50 % in energy needed to produce a ton of crude steel since 1975 in most of the top steel producing countries. Further improvements in energy efficiency are being done by making the maximum possible use of the state-of-the-art technologies.

Green steelmaking consists of the use of those processes which result into reduction in CO2 emissions. Development work for the green steelmaking processes is being done in European Union, USA, Canada, Brazil, Japan, South Korea, Australia, and China. In European Union the breakthrough technologies are being developed under the ULCOS (Ultra-Low CO2 Steelmaking) programme. In USA, the development work is being carried out with 'public private partnership' between American Iron and Steel Institute (AISI) and the US Department of Energy (DOE), and Office of Industrial Technology. In Japan the development work is carried out under COURSE50 programme involving six steel and engineering organizations, the Japan Iron and Steel Federation, and New Energy and Industrial Technology Development Organization. In South Korea the development work is carried out involving POSCO, RIST, POSLAB, and POSTECH.

Emerging technologies for the reduction or elimination of the carbon emissions from the steelmaking process can be divided into two distinct categories namely (i) carbon capture, use, and / or storage (CCUS), and (ii) alternative reduction of iron ore. CCUS employs different methods to capture CO2 emissions. It either stores them (for example, in geological formations such as exhausted undersea gas reservoirs) or processes the emissions for onward utilization.

The second type of potential technologies involves replacement of coke or natural gas with alternative reducing agents for the iron ore. These include hydrogen and direct electric current. The advantage of these technologies is that theoretically they can make steel production fully green.

The most promising of the new CCUS and alternative reduction technologies as well as the technology of hydrogen based direct reduction are discussed below.

Technologies with CCUS

In these technologies, CO2 which is emitted during process of operation is separated from other gases and is captured. The captured CO2 is then either transported through a pipeline or shipped to an onshore or offshore storage location or used. Processes for CCUS include post / pre-combustion capture, compression, transport, and store / use. Fig 2 shows CCUS scheme for the simplified blast furnace – basic oxygen furnace (BF-BOF) steelmaking route.

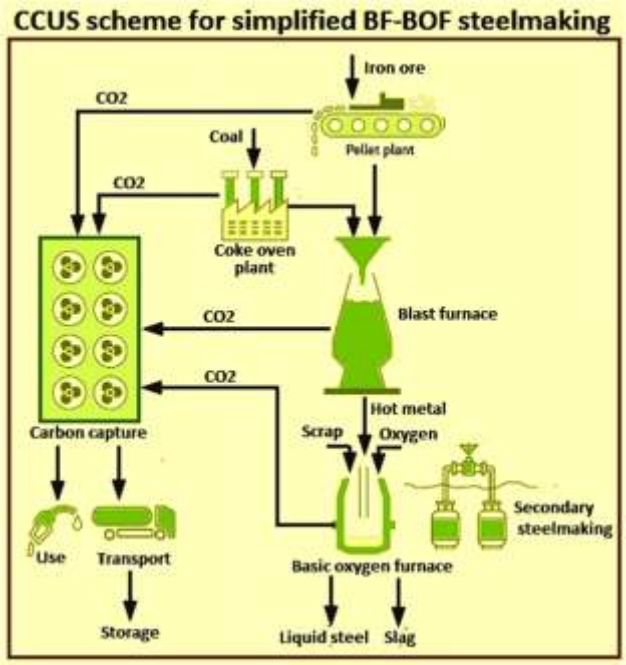

Fig 2 CCUS scheme for simplified BF-BOF route

The main advantage is that CCUS systems can be quite easily integrated into existing conventional brown field plants. The main disadvantage is that CCUS is not fully carbon neutral, as the carbon capture process alone captures only around 90 % of CO2. Also, there are some other challenges.

There are some pilot projects which have been taken up for the processing of emissions such as CO2 to make synthetic fuel. But this is at present not carbon neutral as CO2 is emitted at a later stage.

Hydrogen based shaft furnace for direct reduced iron

In the process, instead of a carbon reducing agent such as reformed natural gas, hydrogen is used for

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reducing iron ore pellets to 'direct reduced iron' (DRI or sponge iron). The reaction takes place in a shaft furnace. The produced DRI is then fed into an electric arc furnace and it is turned into steel by further processing. The most common process technologies are the Midrex and Energiron processes.

In hydrogen based reduction, the iron ore is reduced through a gas-solid reaction, similar to the DRI route of production. The only differentiating factor is that the reducing agent is pure hydrogen instead of natural gas or syngas. Iron ore reduction with hydrogen releases harmless water vapours (H2O) instead of the greenhouse gas CO2.

The stoichiometric consumption of H2 for reducing hematite ore (Fe2O3) is 54 kg per ton of iron. Hence, a 1 million ton per year steel plant needs a hydrogen plant which has a capacity as much as 70,000 Nm3 / hour of hydrogen.

The process makes the whole primary steelmaking route carbon neutral and fossil fuel-free in case green electricity is completely used for the process. Other advantage for the process is the high production flexibility. The process is easy to start and stop, and the ability of the technology to use smaller units enables greater scalability. However, the process still needs iron ore pellets, and producing them can cause significant emissions depending on the heat source of the pellet plant. Fig 3 shows hydrogen based shaft furnace for direct reduced iron.

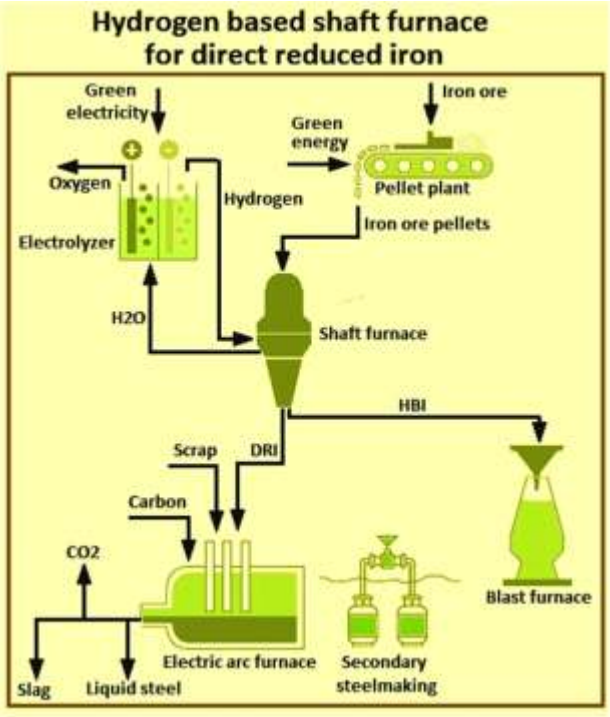

Fig 3 Hydrogen based shaft furnace for direct reduced iron

HYBRIT process uses hydrogen based shaft furnace for the DRI production. HYBRIT is short for 'HydrogenBreakthrough Ironmaking Technology'. On 4 April 2016, the three Swedish companies—SSAB, LKAB, and Vattenfall AB launched a project aimed at investigating the feasibility of a H2 based DRI production process, with CO2 emission-free electricity as the primary energy source. A pre-feasibility study on H2 based direct reduction was carried out in 2017. The study concluded that the proposed process route is technically feasible and, in view of future trends on costs for CO2 emissions and electricity, it is also economically attractive for conditions in northern Sweden / Finland.

HYBRIT process replaces coal with hydrogen for the direct reduction of iron, combined with an electric arc furnace. The process is almost completely fossil-fuel free, and result into substantial reduction in its greenhouse gas emissions. The process is among several initiatives which use a hydrogen-direct reduction / electric arc furnace setup, combining the direct reduction of iron ore by use of hydrogen with an electric arc furnace for further processing into steel. The product from the hydrogen-direct reduction process is DRI or sponge iron, which is fed into an electric arc furnace, blended with suitable shares of scrap, and further processed into steel. The principle flowsheet of the HYBRIT production process is shown in Fig 4.

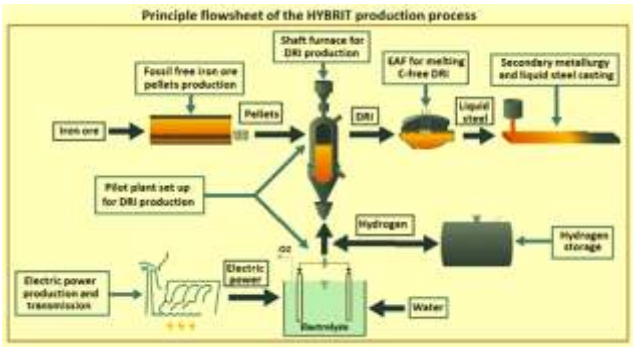

Fig 4 Principle flowsheet of the HYBRIT production process

Hydrogen based fluidized bed process for direct reduced iron

As with the shaft furnace version, this technology uses hydrogen to reduce iron ore and produce DRI to feed into an electric arc furnace. The differences are that

reduction occurs in a fluidized bed rather than a furnace, and finely processed iron ore fines / concentrates are used instead of pellets. Fluidized beds are reactor chambers which can continuously mix solid feed stocks with a gas to produce a solid. The similar processes are FINEX and Circored.

The use of fines over iron pellets has the advantage of removing the need to pelletize and thus cutting of costs and the high CO2 emissions involved in the process. In addition, fluidized bed reactors have fewer internal sticking problems than shaft furnaces, achieving higher metallization (around 90 % to 95 %).

The process shares the same issues regarding the hydrogen supply, electrolyzer and operating cost as the shaft furnace method. The electricity supply is also to be 100 % green to achieve carbon neutrality. In addition, the use of fluidized bed reactors in steelmaking is less developed than shaft furnaces, and hence needs higher investment. Fig 5 shows the hydrogen based fluidized bed process for direct reduced iron.

Hydrogen based Fine-Ore Reduction (or HYFOR for short) is the world's first direct-reduction process for iron-ore concentrates from ore beneficiation which does not need any pre-processing of the material like sintering or pelletizing. This reduces CAPEX and OPEX costs. The process is capable of processing a wide variety of ores, e.g. hematite and magnetite.

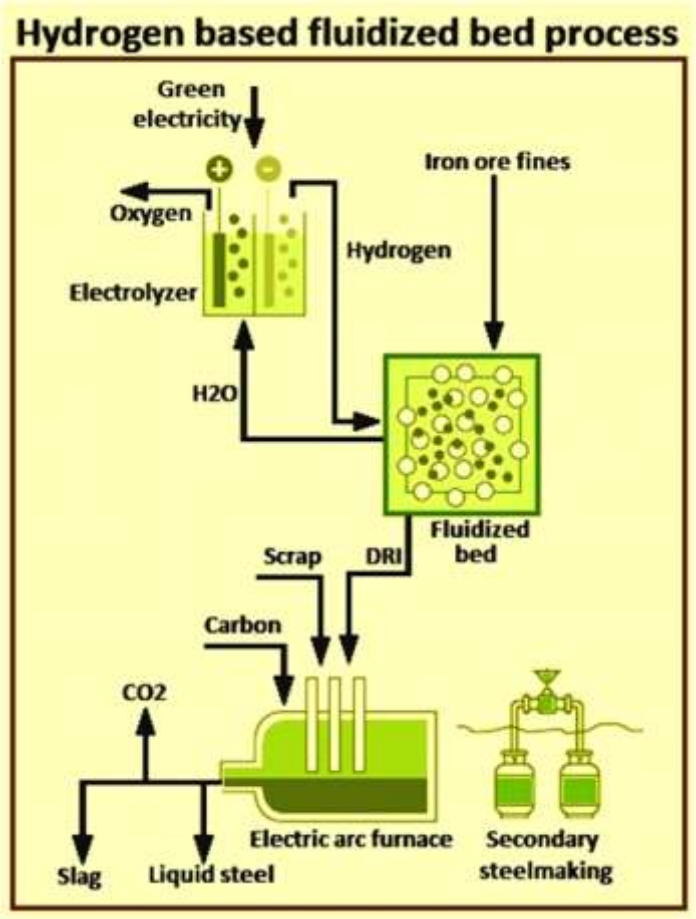

Fig 5 Hydrogen based fluidized bed process for direct reduced iron

HYFOR process has been developed by Primetals Technologies. The new technology can be applied to all types of beneficiated ore. It works with particle sizes of less than 0.15 mm for 100 % of the feedstock, while allowing a maximum grain size of 0.5 mm. Because of the large particle surface, the process achieves high reduction rates at low temperatures and pressures.

As a primary reducing agent, the new process uses hydrogen. Hydrogen can be from renewable energy or alternatively hydrogen rich gases from other gas sources like natural gas pyrolysis or conventional steam reformers. As yet another alternative, HYFOR can run on hydrogen rich waste gases. Depending on the source of the hydrogen, this leads to a low or even zero CO2 emission for the resulting DRI.

A pilot plant for testing purposes has been commissioned in April 2021 Voestalpine Stahl Donawitz, Austria. The plant features a modular design with a rated capacity of 250,000 tons per module per year, making it suitable for all sizes of steel plants. The purpose of the pilot plant is to provide practical evidence for this

breakthrough process and to serve as a testing facility, collecting enough data to set up an industrial-scale plant at a later stage. First tests have been successfully executed in April 2021 and May 2021. The scale of one test run is in the range of processing of 800 kg iron ore. The HYFOR pilot plant is going to be operated for at least 2 years in multiple campaigns to test various ore types and to evaluate the optimal process parameters for the next scale up step. Smooth operation assumed, a hot briquetting unit is going to be added to verify the hot briquetting step as well as the HBI quality to be expected from the HYFOR technology.

In India, crude steel production is about 118 million tonnes and expected to be about 255 million tonnes by 2030 as per NSP-2017 and about 600 million tonnes is expected by year 2050. Certain technologies like coal moisture control, coke dry quenching, different energy-efficient measures like energy-efficient drives, waste heat recovery systems in all processes of iron and steel making including Sinter, stoves of Blast furnace, EAF, BOF etc. should be considered for implementation up to year 2030 and for 2050 technologies like green hydrogen, hydrogen injection, etc. needsto be implemented. By 2070, breakthrough technologies like carbon capture units needs to beimplemented to achieve net-zero. This is of course a challenging task and needs government support. India has already started the journey to achieve the goal and ministry of steel is actively considering all options to achieve net zero carbon emission by 2070.

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View Point

The Blue Blast Furnace : an holistic approach reduction CO_2 emissions

Keywords: blast furnace; Blue blast furnace; syngas; shaft injection; Co2 Reduction; Green Steel

INTRODUCTION

Green House Gases (GHG) emission reduction in the integrated steel making requires an evolution of present technologies.

A key technology for significant CO2 emission reduction of the blast furnace is the production and injection of reducing gases into the blast furnace as a replacement for solid carbon. Injecting syngas through a second bustle pipe at shaft level enables high injection rates of coke oven gas, natural gas or hydrogen at tuyere level.

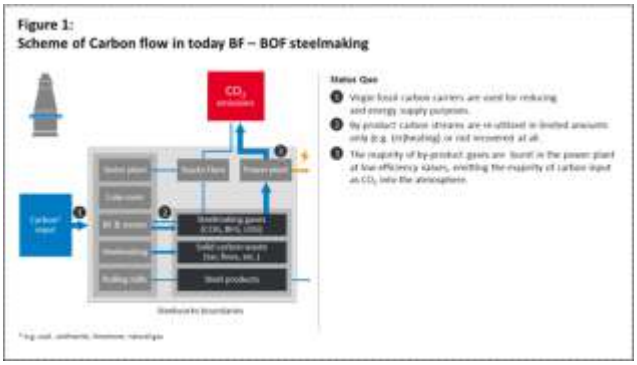
Additional benefits of Enhanced Blast Furnace Technology are Opex reduction, wherever plants are located in countries with competitive natural gas prices such as North America, as well as synergies with cost efficient pre-combustion CO2 capture. Post treatments of lean gas (blast furnace gas) in pre-combustion carbon capture systems shows an increased efficiency of capture itself thanks to the higher LHV of the BF gas generated in an Blue Blast Furnace. Such features further increase the reduction of achievable carbon footprint of the plant.

This paper will describe interaction and advantages of both technologies, focusing on the key economic aspects as well as environmental benefits in terms of CO2 emission reduction.

The Carbon flow in integrated steelmaking

The world crude steel production is largely based on the blast furnace (BF) - basic oxygen furnace (BOF) route . For this reason, focusing technological improvements on BF-BOF route to abate steel CO2 footprint an important role to achieve the reduction targets of Green House Gases (GHG) set by major economies.

Figure 1 schematically outlines the carbon flow in BF BOF steelmaking, resuming the main feature of the today carbon use: typically, once through ending in combustion processes to generate heat or electrical power with limited efficiency.



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In the past years, the availability of electrical power with lower CO2 footprint has increased through the introduction of the solar and wind based renewable energy production and thanks to the significant increase of the efficiency of gas based power plants. Moreover, the cost of the renewable green power has constantly decreased now being competitive in many geographical areas with the one generated by the traditional coal or gas based power plants. This tendency will further intensify in the next years, especially in countries blessed by high solar power and or wind densities or having CO2 emissions taxation schemes.

The integrated steelworks will find, therefore, more

convenient to buy electrical power from the external grids in which increasing amount of low cost green energy will flow: this will automatically push for a different distribution of the carbon flow as depicted in Figure 1. This will trigger the opportunity to decrease the scope 1 CO2 emissions through an increase metallurgical use of the steelworks gases as explained in ***Figure 2.***

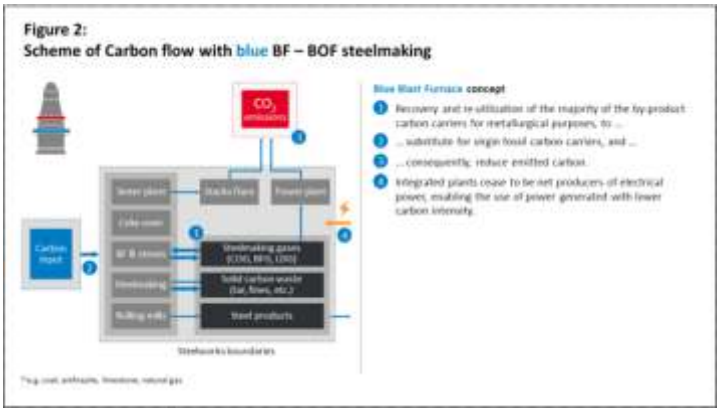

Figure 2:
Scheme of Carbon flow with blue BF – BOF steelmaking

The blue Blast Furnace: the key tool for smart Carbon utilization in BF based Iron making

The key tool to apply this concept, also as a retrofit application in existing plant, is the Blue Blast Furnace, which allows recycling and valorizing the Carbon containing streams, today used inefficiently, as reducing agents for iron ore to replace the costly coke and coal inputs.

Blue Blast Furnace Technology, as schematically shown in Figure 3, mainly consists in the injection of hot syngas (a gas composed mainly by CO and H2) at a second level of the furnace in the lower shaft, above the Blast Furnace cohesive zone.

Various syngas generation technologies are available based on different feedstock, process and syngas characteristics. Paul Wurth has developed syngas generation technologies suited to the concept shown in Figure 2 where the carbon bearing gases available in integrated steelworks, today being sent to power plant and heat users, can be recycled and upgraded to hot syngas for replacing the input carbon streams.

Figure 3
Blue Blast Furnace for low CO2 Ironmaking

The main benefits of this technology on BF operation and process are the following:

Reduction of carbon reducing agent ratio (typically lower coke rate): injection of syngas at BF shaft allows a reduction of fossil fuel based reducing agents, due to the Syngas effect on BF process. Syngas enhances indirect reduction in the middle-upper part of the BF, resulting in a higher reduction degree of the material at cohesive zone and a corresponding lower share of direct reduction. The amount of carbon reducing agent reduction greatly depends on syngas quality (Ratio of H2; CO+H2/CO2+H2O; Temperature at injection; etc.) and is therefore a function of syngas generation technology and relevant feedstock;

Higher injection rate at tuyeres/ charging of HBI: As side effect of shaft injection, top gas temperature typically increases. This effect allows increasing injection rates of oxygen and reducing agents at tuyere and/or allows an increased amount of HBI charging at furnace top. This is a main advantage for specific countries where low top gas temperature is one of the key factors limiting BF operation and productivity.

Higher productivity: Blast furnace productivity can improve, mainly resulting from two factors:

- Since most of the BFs reaches the limit of productivity for the effect of counter current movement of gas and liquids in the cohesive zone (flooding phenomena), shifting part of the reducing gas above such area allows an increased furnace productivity.
- The effect of top gas temperature mentioned

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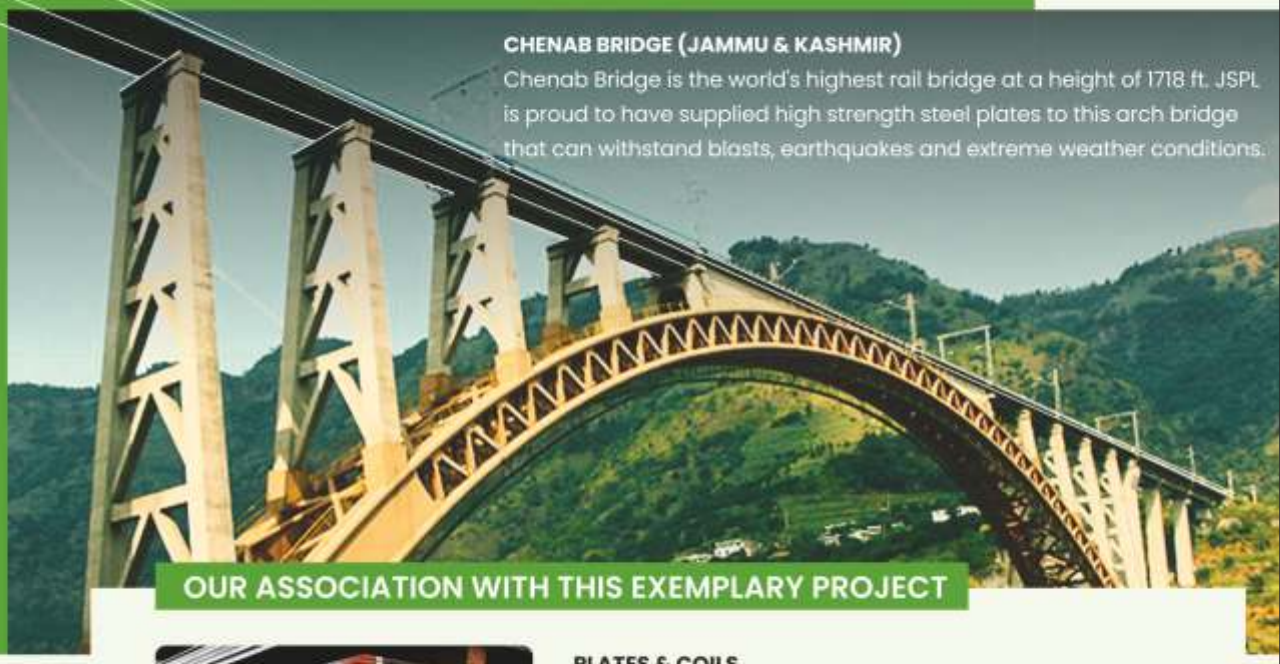

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above and correspondingly an increase rate of oxygen and reducing agents at tuyere level.

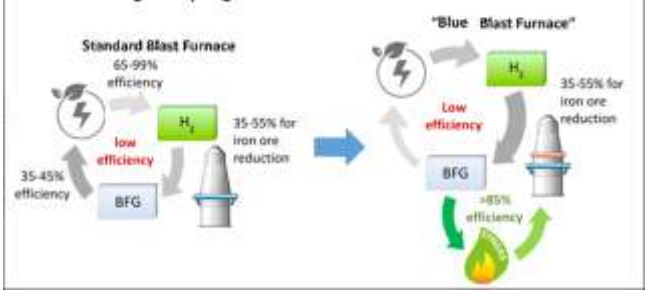
Reduction of CO2 footprint of blast furnace process: due to lower demand in terms of total carbon input, CO2 footprint improves.

Blue Blast Furnace an enabler for efficient utilization of Green Hydrogen in integrated steelmaking

A potential further step to reduce specific CO2 foresees the injection of green hydrogen, produced from renewable energy sources, in the Blue Blast Furnace concept. This step will become a viable option as soon as Green hydrogen will be available at a competitive price.

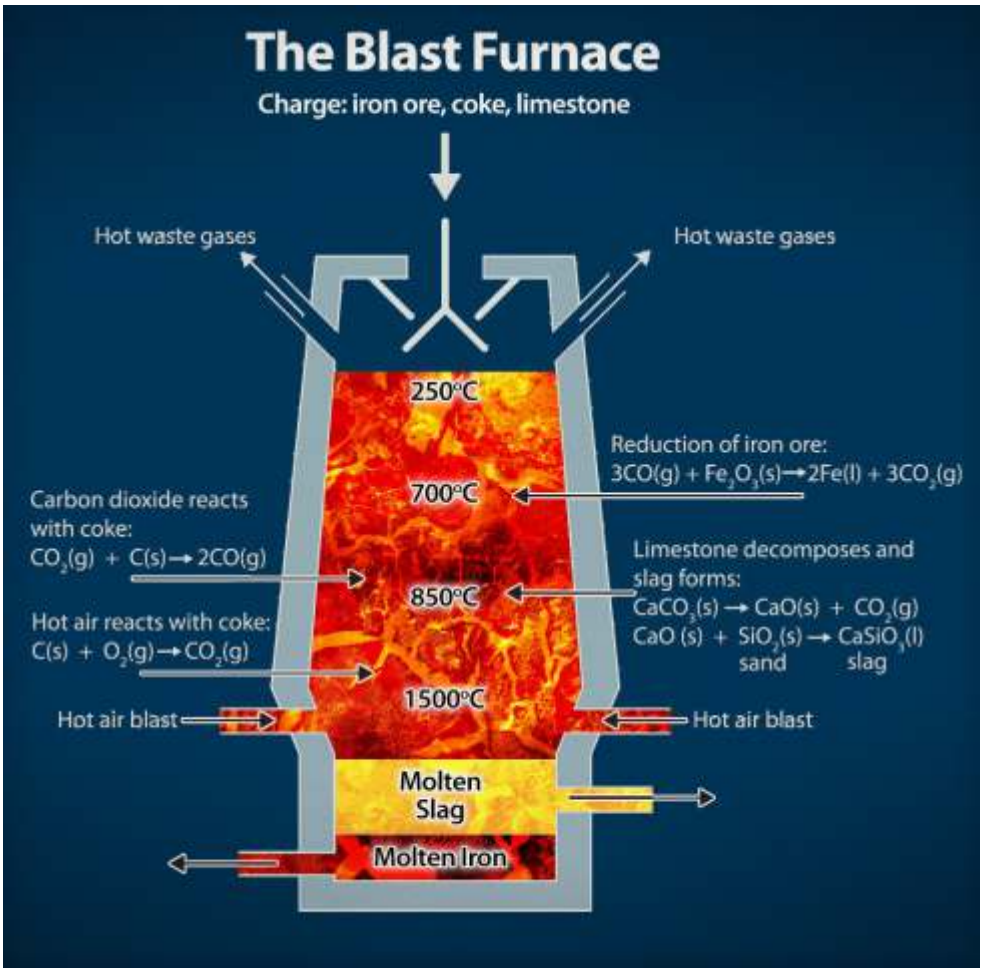
The standard Blast Furnace process, with once through passage of reducing gas, implies that a significant share of the H2 eventually injected into the BF does not participating in the iron ore reduction. In this way, it leaves the BF via the top-gas. TheBlue Blast Furnace, making use of a share of BFG for syngas production recirculated back into the shaft, can provide a significant advantage in terms of Hydrogen utilization compared to a typical steel plant configuration where available BF top gas is burned in captive power plants to produce electricity at low yield, Refer to **Figure 4.**

Figure 4
Efficient use of green hydrogen in Blue Blast Furnace



Conclusions

Rolling out too many steel plants all over the world, the described approach of Blue blast furnace helps for getting quickly important worldwide CO2emission reductions, still maintaining the existing infrastructure of integrated steel plants. It is evident that the enhanced blast furnace is only one, but important step towards green steel production. In addition to reduced CO2 emissions, investing in a Blue blast furnace can offer significant flexibility in selection of energy sources and raw materials. The savings realized from these factors can contribute to further investments in the field of green steel technologies.



Sustainable steel to meet the crucial demand coming from Wind Power

With sustainable steel increasingly crucial to meeting the world's climate targets, manufacturers are turning to wind power to decarbonise production.

Renewable energy technologies are slated to play a key role in the planet's ongoing efforts to limit the impacts of climate change. However, whether it's tidal, solar, geothermal or wind, all these renewable energy sources require significant amounts of steel in their manufacture.

Steel is crucial to the transition to a more sustainable economic model, but, as a traditionally carbon-intensive industry, the race is on to lower the environmental impacts of this vital material.

Wind turbine manufacturers and wind farm operators are looking for ways to decarbonise their procurement and help create 'cleaner' wind power. Low emission steel offers a way to significantly reduce the carbon footprint of a project, and steel manufacturers are increasingly integrating renewables into their energy mix.

With wind power helping lower the amount of fossil fuels used and the CO2 generated per tonne of steel at suitable sites, there is the possibility of a 'virtuous circle' of wind power-produced steel being used to further the transition to renewable energy.

With the transition to renewables dependent on steel, reducing the sector's carbon footprint is vital

A wind-powered future for steel?

When it comes to wind-powered steel, location is everything. In South America, Tenaris is looking to invest $190m for the construction of a windfarm in the Buenos Aires province of Argentina. The site in Adolfo Gonzales Chaves is a high wind zone that will power 24 turbines, generating a total of 509GWh electricity production per year.

Expected to become operational in the second half of 2023, the windfarm is planned to supply nearly half of Tenaris's electricity requirements for its Siderca mill near Buenos Aires. This will reduce CO2 emissions related to steel production there by 152,000 tonnes annually, contributing to Tenaris' plan of reducing 30% of CO2 emitted per tonne of steel by 2030.

Nearly 9,000km to the north, on the windswept fields of the American mid-west, sits Nucor's Sedalia micromill which is set to be the first steel plant in the US to run on wind energy.

The steel producer has signed a 10-year contract with Evergy that will mean

55MW of energy from a new $250m windfarm in Kansas being allocated to Nucor's mill in the adjacent state of Missouri. High wind areas such as this offer an opportunity for any energy-intensive industry that wants to meet ambitious sustainability goals.

In India, steel manufacturer ArcelorMittal is planning a 'giga-scale' wind-solar mix that will provide energy 24 hours a day. Backed by a pumped hydro storage project that will help mitigate against the variable power generation of wind, the $600m project will provide continuous power for steel production.

The site is planned for construction in Andhra Pradesh and will provide power to the plant run by 'ArcelorMittals Indian joint venture company with Japanese manufacturer Nippon Steel. More than 20% of the Hazira, Gujarat, steel mill's electricity will be provided 'around the clock', lowering costs and reducing emissions.

As the need for wind power increases, the steel industry is using that very power to lower the carbon footprint of the steel required to meet that need. With the whole lifecycle thinking increasingly driving sustainability ambitions, steel production is only set to get less carbon intensive, cheaper, and more efficient.

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Decarbonizing steel : end-to-end solutions

Steelmaking may be hard to abate, but there's new mettle within the industry to rethink the entire value chain and quash carbon emissions for good.

According to the head of the World Steel Association (worldsteel), Edwin Basson, three things recently happened on the way to the steel mill that have accelerated the industry's ability to decarbonize. It may yet take 20-30 years of investment in innovative new processes, along with universally available green hydrogen, and a chunk of carbon capture and storage to get to net zero, but the iron gates have been flung wide to new possibilities by a confluence of events.

First, in 2020 China's president Xi Xinping pledged that the world's biggest steel producer with 57% of global output (that year China was the first to reach more than one billion tons of output) would achieve carbon neutrality by 2060, and also see no increase in CO2 emissions by 2030. Basson says many of the world's steel makers had been waiting for China to make a move — the decisive stride in its policy signaled the start of a race to rethink.

Edwin Basson
Director General
World Steel Association

Alongside China's starting gun, the US regime switch two years ago to a more globally engaged leadership with a strong focus on decarbonization, "gave rise to an almost 180-degree turn", Basson says, in the resolve of the steel-making industry to go beyond production efficiencies and tackle the hard-to-abate ore-refining process, its energy sources, and importantly, how steel is used, reused and recycled.

A new wave of progressive CEOs in the industry is the third element Basson cites as having contributed to a change in

steely attitudes which have previously focused on wringing every energy and material saving out of the 300-year-old steel-making process — to benefit the balance sheet and reduce carbon emissions on the side. worldsteel says that efficiency measures in the industry have reduced energy consumption by around 60% since the 1960s, contributing to "a significant reduction in CO2 intensity".

The revised approach?

Basson says, it is driven "by the realization that as a global society, we cannot continue to emit the amount of CO2 that we are still emitting". And that tweaking existing blast furnace technology can no longer deliver the quantum leap in carbon reductions required to save the planet.

A hotbed of opportunity

The steel industry contributes around 8% of the world's carbon emissions and is largely (73%) reliant on blast furnace and basic oxygen furnace (BOF) technologies to separate oxygen from the iron oxides that make up iron ore and produce the strong, permanent material known as steel.

Making steel involves several applications of extreme heat. Among them, the heating of coal at around 1000 degrees Celsius in the absence of oxygen to drive off impurities resulting in a much stronger product 'coke'. The cooled coke, which contains 90-93% carbon, is fed into a blast furnace process, along with iron ore and limestone; air, heated to 1000-1200 degrees Celsius, is blasted into the furnace, initiating a series of chemical reactions that ultimately produce pig iron and CO2.

Pig iron still retains about 4% carbon, which renders it too brittle for most applications, and the BOF is used to further reduce this concentration and other impurities to produce steel with carbon content in a range of about ~ 0.02-2.1% In the BOF, pig iron, scrap metal (about 15-20%) and burnt lime (known as flux) are heated and pure oxygen is "blown" into the mix via a water-cooled lance, which oxidizes the carbon and silicon in the hot iron and liberates more heat which in turn melts the scrap. The

molten mass of resulting steel is tipped into a ladle and may go on to a further, heated, refinement process, to meet customer specifications.

Little wonder that Basson says the single greatest challenge to decarbonization faced by the industry is, "Where do we get our energy from?" At the moment, he says, coal is not only the main source of heat for the various stages of the process but, ''provides us with the basis of the chemical reaction that extracts iron from its oxidized state in iron ore''— and therein lies the definition of hard to abate. Making steel from iron ore currently relies on carbon to drive the reaction; the by-product of which is CO2.

Today, the production of each ton of steel results on average in the emission of 1.8 tons of CO2. "By worldsteel evaluations," says Basson, "we think the best the industry can get to over coming decades, even using new technologies" that are still under development and subject to upscaling is 0.3 tons, or 300 kilograms of CO2 emitted per ton of steel — hence the role for carbon capture and storage.

Innovation unleashed

Basson, who prior to his almost 11-year tenure as head of worldsteel held executive positions at ArcelorMittal, one of the world's largest miners (iron ore and metallurgical coal) and steel producers, says he's proud to see the industry's fresh "willingness to experiment with new technologies". He says it's almost as if the China/US/CEO factors have "unleashed a new wave of freedom of experimentation within the industry".

A report, Iron and Steel Technology Roadmap produced by the International Energy Agency (IEA) with important contributions from worldsteel released in October 2020, detailed the challenges and possibilities for the industry. It notes that, "Steel companies and regional steel associations accounting for roughly one-third of global steel production have set targets to achieve net zero emissions by 2050 or earlier," and that "Most of these targets were set in the past three years."

The separate tracking report also starkly stamps the steel industry as "Not on track" to meet emissions reductions in line with the Paris Climate Accord to prevent global warming greater than 1.5-2 degrees Celsius compared to pre-industrial levels.

Required: more policy, more pilots!

It calls, therefore, for emissions reductions to be tackled from every angle, with governments setting policies that encourage research and development into new processes. In India, the world's second-largest steel producer with an output of 118 million tons in 2021, for example, the government's Perform, Achieve and Trade (PAT) scheme incentivizes industry to pursue energy efficiency, and therefore emissions reductions.

In Europe, government agencies and funds support several specific projects, such as Siderwin which is developing a new ore-refining process in Mazières, France. Since 2017, the European Union's Horizon 2020 program has funded 12 European partners coordinated by ArcelorMittal, to scale up a process first developed in the early 2000s at lab scale, which immerses iron ore in an electrolytic bath — no coking coal, no carbon emissions, just electricity from a future renewables-powered grid — that draws oxygen from the raw material to produce iron metal. Adding carbon to adjust the grade of metal will in this case be carried out during the melting of iron produced by the process, to form steel to customer specifications.

Design to reuse, not recycle

Further down the supply chain, demand can also be moderated, with initiatives to improve recovery of recyclable materials. Basson says that the world must begin to use steel differently in major industries such that it can be reused without incurring the energy load of melting down, remolding and machining.

Worldsteel aims to produce high-quality research that will result in

the decarbonization of steel throughout the value chain, and one of its strategies is to collaborate with industries that use large amounts of steel on how to reduce future demand for the material. The current transition by the automotive industry to produce electric vehicles (EVs) provides an opportunity, says Basson. "We are in the middle of a significant redesign of how steel is used in the new automotive environment because the weight distribution of the EV is very different to that of internal combustion engine vehicles, which makes the requirements of steel very different." It's the right moment to design new kinds of steel components that can be *reused* in the automotive industry.

Basson believes that in large steel-consuming industries such as oil and gas there must also be "opportunities for reusing steel in its existing shape or form for future installations, without having to remelt and rework it". Companies could also apply their engineering expertise to designing steel infrastructure or components of products for easy recovery and reapplication.

At the same time, Basson says, the industry needs to look at how it labels today's steel with its specifications, so that when it is recovered, say from construction sites, it can be redirected and reused with confidence.

There are limits to the electric arc

Where direct reuse is impossible, steel *can* be endlessly recycled. An alternative to the BF-BOF method of steel production from iron ore is electric arc furnace (EAF) technology already used to produce some 30% of the world's steel. EAF uses high-power electric arcs between a cathode and anodes, to melt scrap metals and iron along with purifying additives to produce as-new steel.

Greater use of EAF will play an important role in decarbonizing the steel industry, but, says Basson, it currently has two limitations. First, it requires a high, consistent supply of electricity[1] — and because most of the global electricity supply is still coal or gas generated, those carbon emissions from fossil fuel energy generation must be calculated into the steel production. Renewable sources of energy will have to become more prominent and reliable — backed by storage in the form of batteries or hydrogen — in the grid to make electrification of high-energy industrial processes, including steelmaking, cleaner.

In addition, supplies of scrap steel may only be enough to produce 40-45% of future demand. Basson explains: "Scrap generation in China right now comes from steel used in the 1980s. In 1980, China used in the order of 500 million tons of steel annually, now it uses close to a billion tons, and our best estimation is that the gap between demand and supply of scrap is expected to persist until at least 2070."

On the way to hydrogen–assisted ore reduction

Another promising avenue for lowering the emissions of steel making in the short term is to increase the production of gas-based direct reduced iron (DRI), which currently accounts for only 5% of steel production. The direct reduction process removes oxygen from iron ore in the solid state — using carbon monoxide and hydrogen from reformed natural gas or syngas to bind with the oxygen in iron ore — without melting in a blast furnace. Even though natural gas and syngas are currently fossil-fuel based, emissions from gas-based processes are lower than from the coal-based processes. And systems that are configured now to use gas will more easily be able to transition to using green hydrogen as that zero-emissions gas becomes more readily available. And they can be retrofitted with CCS as carbon capture technologies become better supported with pipeline and storage infrastructure at scale.

"We're sure hydrogen is part of the solution to reducing CO2 emissions from steel making," says Basson. "It can replace coal reduction of iron and basically produces only water vapor as a byproduct". He adds that many ways of

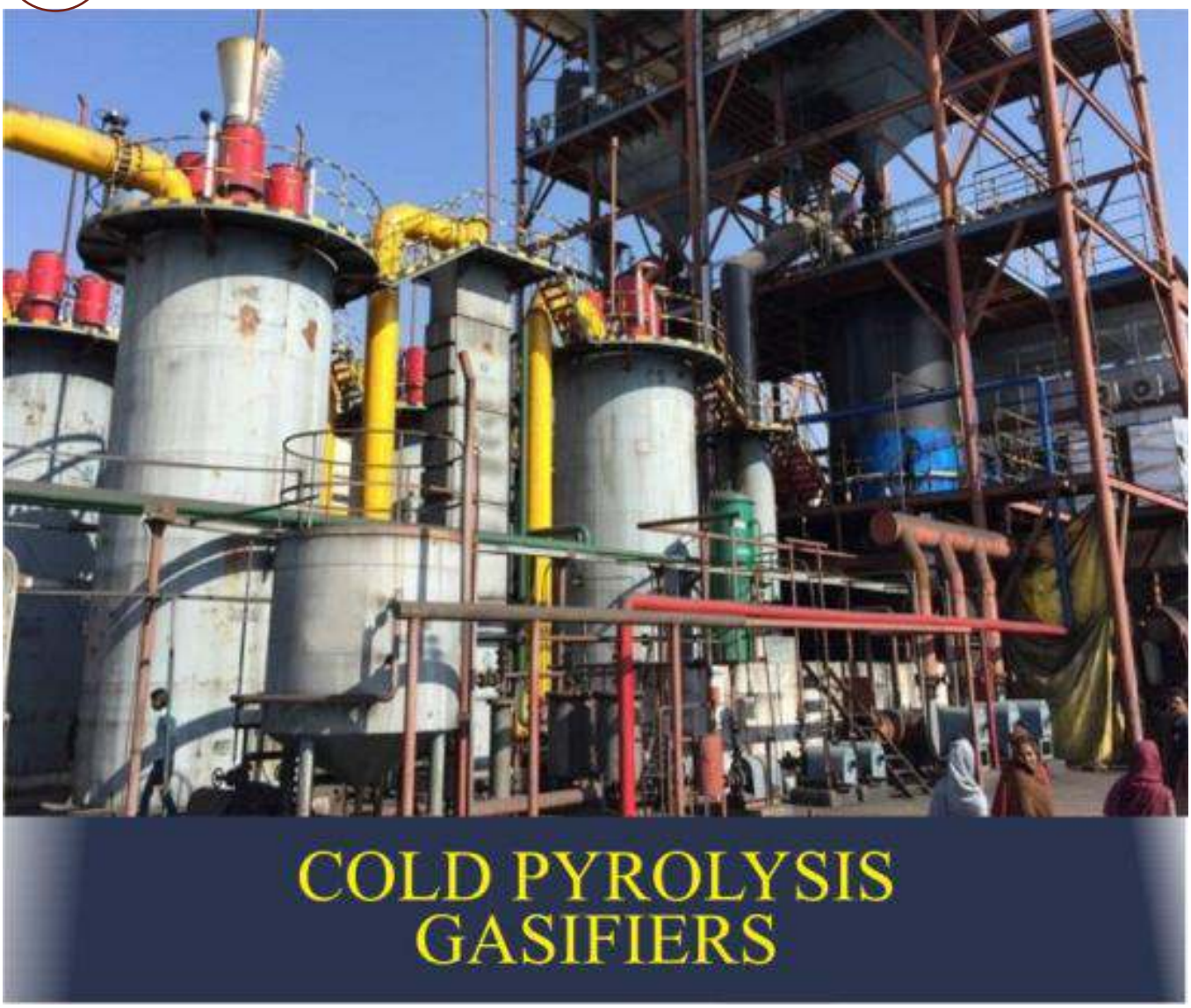
cost-effectively delivering green hydrogen to the industry are being evaluated. One supply chain avenue, for example, is to produce hydrogen using solar energy in consistently sunny countries such as Australia, and process it into ammonia, which is more easily and safely shipped to its user destination than hydrogen. Another possibility could be for the DRI to be produced at the source or the mine instead, thereby avoiding the transport of hydrogen.

A much-referenced example of a government-supported private-enterprise project that integrates hydrogen into the steel making process is HYBRIT. This partnership between iron ore miner LKAB, global steel manufacturer SSAB, and energy provider Vattenfall, supported by the Swedish Energy Agency, and this year also by the EU Innovation Fund, seeks to demonstrate the world's first completely fossil fuel-free value chain for iron and steel production. HYBRIT produced its first fossil-free steel by direct reduction using green hydrogen in August 2021.

That initial gas supply was drawn from a pilot-sized green-hydrogen storage facility, but the consortium has now almost completed preparation of a lined rock cavern that can store around 100 gigawatt hours of renewable hydrogen (enough to supply a full-sized steel mill for three to four days) produced by electrolysis powered primarily with excess generation from wind farms in the region. This will ensure a ready supply of clean hydrogen without overburdening local electricity grids.

One of the priorities of worldsteel research, dissemination of information, and support of its members is to ensure that any new steelmaking infrastructure is built according to the latest known best practice and has the lowest possible carbon footprint. Says Basson, "The key is to make sure that new capacity is focused on CO2 reduction."

Ultimately, he concludes, new integrated solutions will come from concerted global efforts because, "No single country has a full understanding of the technologies or of the supply chain. Therefore, we will have to continue for the next number of years to share experiences and information in a way that does not breach antitrust considerations." worldsteel holds an annual open forum dedicated to this purpose. It brings industry participants together in an effort to share what aspects they can about what they know, and perhaps more importantly "what the industry still needs to learn in order to plug the gaps" in bringing clean steel to market and helping customers to judiciously apply it.



Coal Gasification

an Indigenous and sustainable solution for India's industrial energy demands

India is a developing country and one of the lifelines of development is available energyat economical and sustainable rates.

India's energy demands are ever increasing and is largely dependent on its crude oilimports, the rates of which are controlled by world dynamics. This unfortunately is not incontrol of India.

As of late, the industry in India has been under lot of stress because of constant increasein the fuel rates. Fuel comprising of Furnace oil, Propane, LDO, HFO, Natural gas etc.There is an urgent need of indigenous energy source which is clean, economical andsustainable.

One of the sustainable, long-time solution to the above problem is Coal Gasification.Coal gasification is not new to India. Gasifiers are widely used in our country for the last15 years for thermal applications. In the past there were few makes which were not inline with the Indian pollution control norms and had to closedown specially in state ofGujrat.

Roger Kumar
Managing Director,
CASE GROUPINDIA

Fortunately, there are few

technologies which are very much in the market which are inline with Pollution control agencies and are advance enough to substitute all the type of present fuels economically. These gasifiers are capable to use Indian high ash coal which is readily available. Not to forget that this replacement also saves Indian government huge amount of foreign exchange apart from the effect on inflation and balance of payments.

Coal Gasifier basically is a machine which burns coal (gasifies) in controlled oxygen environment. This process converts Carbon and volatile matter in coal into CO, CH4 and H2. The mixture of these gases is called Coal gas or Synthetic gas or producer gas. This gas burns in the furnace to give thermal energy. Because the calorific value of coal gas is on the lower side, the flame temperature is comparatively low resulting in low NOx formation. Because the Sulphur in Indian coal is below 1% for most type of coal, the Soxgenerated is also low as compared to Furnace oil. Further desulphurization equipment can be easily installed in the downstream of gasifiers if the user is looking for very low Sulphur in process or flue. This works on the principle of capturing H2S and is much economical than installing Desulphurization equipment installed to capture SO2 after the combustion.

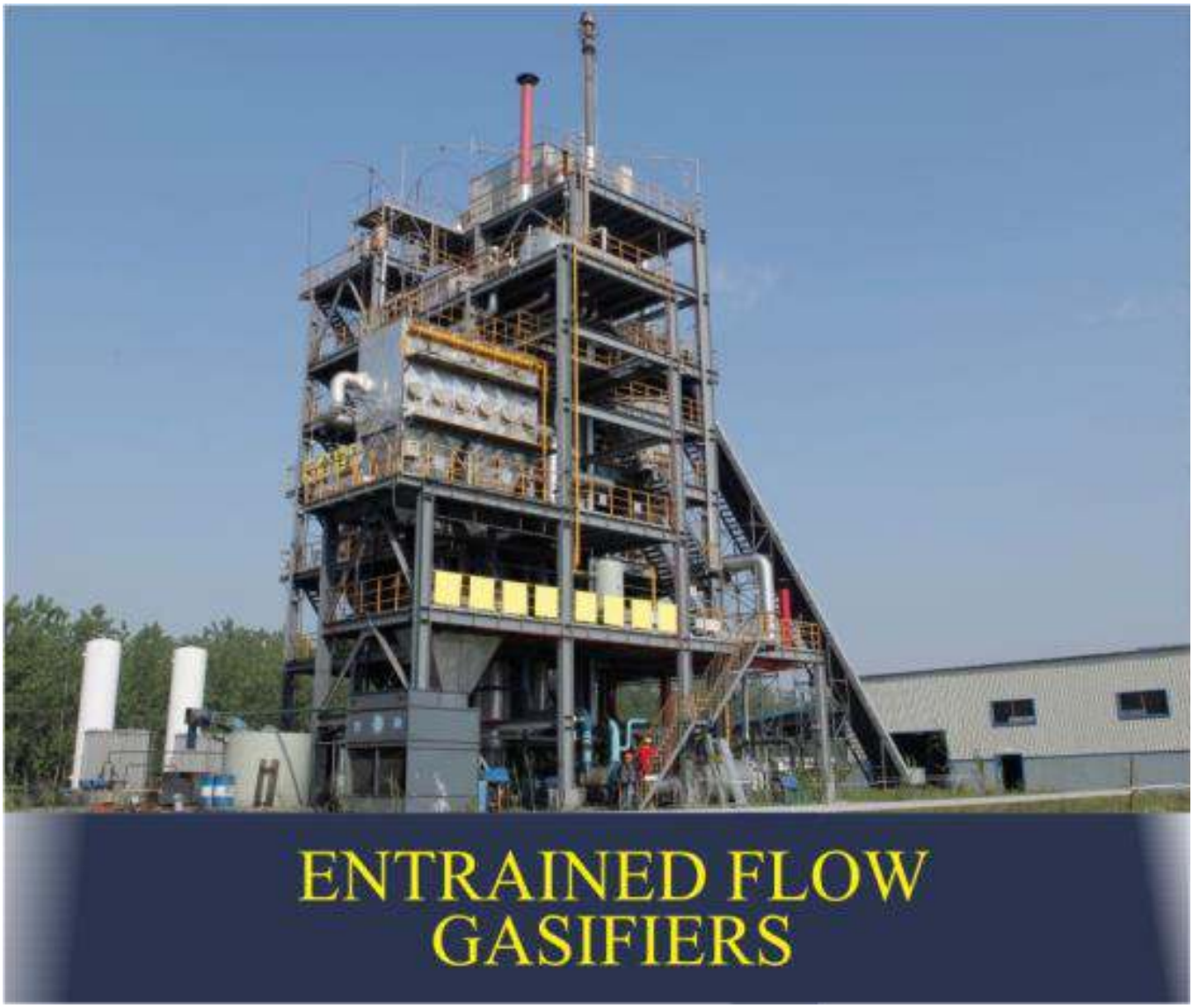
Today more than 1000 Coal gasifiers are in operation in India which are serving industry in the field of Steel Reheating Furnaces, Pellet Plants, Ceramic Furnaces, Glass Plants, Heat treatment Furnaces, Galvanizing plants, Aluminium Industry to name a few. Thetechnology today is advanced with different variants of gasifiers for just about the type ofapplications, size, and coal quality available.

The technology is available in both fixed bed and fluidized bed. There is flexibility to use lump coal as well as coal fines with different heat values and ash contents. The modules are available today up to 100 million Kcal/hr per reactor. Further the technologies are available which are zero liquid discharge (ZLD) resulting in no adverse effect on the environment. All type of pollution whether it is air pollution, water pollution, soil pollution or noise pollution, Coal Gasifier gets a heads up.

It is pertinent to mention here that the technologies available today comes with totally automatic process controlled by PLC. Human intervention has become minimum. The safety norms in the gasifiers are today world class with zero accident rate.

So, in the nutshell, today, coal gasification in India is an advance technology and is all set to rescue the energy demands of our country indigenously and economically.

Furthermore, these coal



Gasifiers are made in India and falling under Honourable Prime Minister's "Make in India" larger plan.

Our Honourable Prime minister has given a special push to gasification in India. And why not. Coal used in Coal Gasifiers is readily available in India and is in abundance. Roughly 300 billion tons of coal is available. With Hydrogen and EV in line to make an impact, it is prudent to utilize our fossil reserves in a professional and clean manner as soon as possible. And in the process if it can also save foreign exchange, improve balance of payments, the incentive to promote coal gasification only become bigger.

Honourable Prime minister has made an ambitious statement roughly two years back togasify 100 million tons of coal by 2030. We need to work hard in this direction to make itpossible.

Coal Gasifiers apart from heating can also be used to make urea, Ammonia, fertilizers andeven Hydrogen called brown hydrogen. Talcher ammonia and Urea plant already has a gofrom the present government. Brown hydrogen in combination with carbon capture canbe a boon for the industry and can play in line with Honourable prime ministers'commitment in COP26 at Glasgow for India to go net-zero carbon emissions by 2070!!

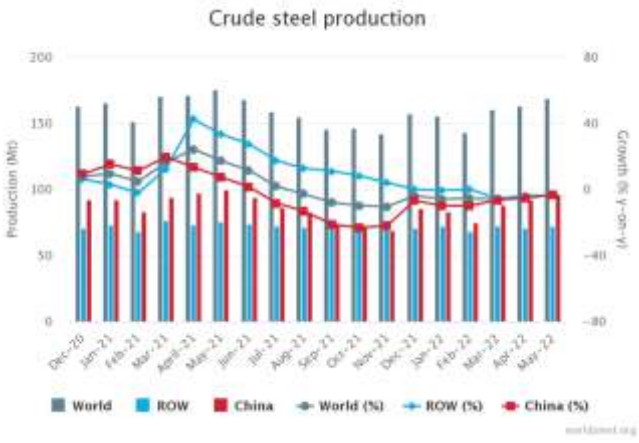
Global steel production dropped for the 11th successive month in May2022: WSA

As per the World crude steel production data for May 2022, dropped for the eleventh successive month in May this year with nine of the top 10 producers led by China reporting reduced output. India was the lone exception with its production increasing by 17.3 per cent to 10.6 million tonnes (mt), World Steel Association (worldsteel) data showed. Steel production among the 64 countries that report to the association dropped by 3.5 per cent to 169.5 mt compared with May 2021. The production was, however, higher month-on-month. In April, global output was 162.7 mt.

World steel production has been dropping since July last year as output in China, which contributes over 50 per cent, has been falling since the last quarter of 2021. The last time steel output increased was in June 2021, up by 11 per cent.

For the first five months of 2022, global steel output dropped by 6.3 per cent year-on-year to 791.8 mt. This is slightly better than the situation in the first four months, when it had dropped by 7.1 per cent.

The drop in China's production yet again mirrored the global decline. It slid to 96.6 mt against 99.5 mt in the year-ago period. For the January-May period, its production was 435 mt compared with 473.1 mt, down by 8.7 per cent.



However, China's production is the highest for the year. It produced 92.8 mt in April, 88.3 mt in March, 83 mt in February and 81.7 mt in January. Production in the Communist nation has been hit this year due to the fourth wave of Covid and the ensuing lockdowns.

There could be further improvement in Chinese production this month with Beijing having lifted lockdowns in important cities such as Shanghai from June 1.

Uable 1. Crude steel production by region

!	N bz!3133!)N u*	& !di bohf!N bz! 22/21	Kbo-May 2022 (Mt)	& !di bohf!Kbo-May 22/21
Bgsjdb	2/2	.18.9	7/2	.7.0
Btjb!boe!Pdfbojb	237/9	.1.7	693/1	.6.5
F V!)38*	23/:	.6.8	73/4	.4.3
Fvspqf-Other	5/2	.1.7	31/3	.3.5
N jeenf!Fbtu	4/6	.10.0	28/1	.6.1
Opsui !Bn fsjdb	: /:	.4.0	58/6	.2.3
Svttjb!' !pui fs! CIS + Ukraine	8/5	.19.1	49/5	.13.1
Tpvui !Bn fsjdb	4/9	.2.8	29/2	.2.4
Upubm!75!dpvousjft	**27: /6**	**.3.5**	**8: 2/9**	**.6.3**

A

The 64 countries included in this table accounted for approximately 98% of total world crude steel production in 2021. Regions and countries covered by the table:

- Africa: Egypt, Libya, South Africa
- Asia and Oceania: Australia, China, India, Japan, New Zealand, Pakistan, South Korea, Taiwan (China), Vietnam
- European Union (27)
- Europe, Other: Bosnia-Herzegovina, Macedonia, Norway, Serbia, Turkey, United Kingdom
- Middle East: Iran, Qatar, Saudi Arabia, United Arab Emirates
- North America: Canada, Cuba, El Salvador, Guatemala, Mexico, United States
- Russia & other CIS + Ukraine: Belarus, Kazakhstan, Moldova, Russia, Ukraine, Uzbekistan
- South America: Argentina, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, Venezuela

Africa produced 1.1 Mt in May 2022, down 18.9% on May 2021. Asia and Oceania produced 126.8 Mt, down 1.7%. The EU (27) produced 12.9 Mt, down 6.8%. Europe, Other produced 4.1 Mt, down 1.7%. The Middle East produced 3.5 Mt, down 10.0%. North America produced 9.9 Mt, down 4.0%. Russia & other CIS + Ukraine produced 7.4 Mt, down 19.1%. South America produced 3.8 Mt, down 2.8%.

Top 10 steel-producing countries

China produced 96.6 Mt in May 2022, down 3.5% on May 2021. India produced 10.6 Mt, up 17.3%. Japan produced 8.1 Mt, down 4.2%. The United States produced 7.2 Mt, down 2.6%. Russia is estimated to have produced 6.4 Mt, down 1.4%. South Korea

produced 5.8 Mt, down 1.4%. Germany produced 3.2 Mt, down 11.5%. Turkey produced 3.2 Mt, down 1.4%. Brazil produced 3.0 Mt, down 4.9%. Iran is estimated to have produced 2.3 Mt, down 17.6%.

Uable 2. Top 10 steel-producing countries

!	N bz!3133! (Mt)		& !di bohf ! May 22/21	Kbo-May 2022 (Mt)	& !di bohf ! Jan-May 22/21
Di job	: 7/7	!	.3.5	546/1	.8.7
Joejb	21/7	!	28/4	64/3	7/6
Kbqbo	9/2	!	.4.2	49/6	.3.5
Vojufe!Tubuft	8/3	!	.2.6	45/4	.1.6
S vt tjb	7/5 f		.1.4	42/1	.2.3
Tpvui !L psfb	6/9	!	.1.4	39/3	.3.4
Hfsn boz	4/3	!	.11.5	27/5	.4.8
Uvsl fz	4/3	!	.1.4	27/1	.2.8
Csb {jm	4/1	!	.4.9	25/6	.2.2
Jsbo	3/4 f		.17.6	22/5	.10.8

A
e – estimated. Ranking of top 10 producing countries is based on year-to-date aggregate

Programmes associated with the sustainability criteria

The worldsteel programmes associated with the Sustainability Charter are listed below:

Sustainability Indicators data collection

Data is collected from our members and reported annually for 8 Sustainability Indicators, systematically measuring and reporting key aspects of the steel industry's economic, environmental and social performance. This programme provides member companies with benchmarking opportunities and scope for improvement.

The 8 indicators are:

- CO_2 emissions intensity
- Energy intensity
- Material efficiency
- Environmental management systems
- Lost Time Injury Frequency Rate
- Employee training
- Investment in new processes and products
- Economic Value Distributed

Life cycle inventory data collection

A life cycle assessment (LCA) of a steel product looks at resources, energy and emissions, from the steel production stage to its end-of-life stage, including recycling. worldsteel collects data for the production of 17 steel products and generates product specific life cycle inventories available to all stakeholders worldwide.

Steel Safety Day

28 April is Steel Safety Day. The initiative aims to reinforce awareness and ensure the presence of controls for high-risk activities in the steel industry. Every year worldsteel launches a global campaign centred on a theme which involves one of the main causes of fatalities in the industry.

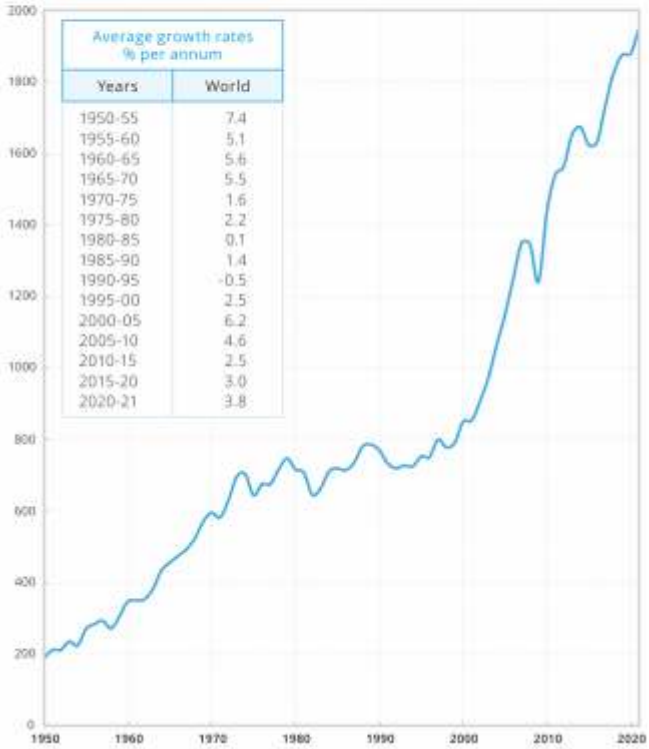
For more information on the worldsteel Sustainability Programme and the organisations that signed the Sustainability Charter, visit the sustainability section of worldsteel.org.

World crude steel production 1950 to 2021

million tonnes, crude steel production

Years	World	Years	World	Years	World
1950	189	2000	850	2011	1 540
1955	270	2001	852	2012	1 562
1960	347	2002	905	2013	1 652
1965	456	2003	971	2014	1 674
1970	595	2004	1 063	2015	1 623
1975	644	2005	1 148	2016	1 632
1980	717	2006	1 250	2017	1 735
1985	719	2007	1 350	2018	1 827
1990	770	2008	1 345	2019	1 875
1995	753	2009	1 241	2020	1 879
		2010	1 435	2021	1 951

million tonnes, crude steel production



Top steel-producing companies 2021

million tonnes, crude steel production

Rank	Company	Tonnage	Rank	Company	Tonnage
1	China Baowu Group [1]	119.95	26	China Steel Corporation	15.95
2	ArcelorMittal [2]	79.26	27	Jingye Group	15.38
3	Ansteel Group [3]	55.65	28	Techint Group	14.91
4	Nippon Steel Corporation [4]	49.46	29	Sinogiant Group	14.34
5	Shagang Group	44.23	30	Gerdau S.A.	14.20
6	POSCO	42.96	31	CITIC Pacific	13.97
7	HBIS Group	41.64	32	MMK	13.59
8	Jianlong Group	36.71	33	Rizhao Steel	13.57
9	Shougang Group	35.43	34	EVRAZ	13.57
10	Tata Steel Group	30.59	35	Zenith Steel	12.76
11	Shandong Steel Group	28.25	36	Shaanxi Steel	12.39
12	Delong Steel Group	27.82	37	Tsingshan Holding	12.37
13	JFE Steel Corporation	26.85	38	Shenglong Metallurgical	12.16
14	Valin Group	26.21	39	thyssenkrupp	12.00 [e]
15	Nucor Corporation	25.65	40	Severstal	11.65
16	Fangda Steel	19.98	41	Nanjing Steel	11.58
17	Hyundai Steel	19.64	42	Metinvest Holding LLC	11.48
18	Liuzhou Steel	18.83	43	Sanming Steel	11.40
19	JSW Steel Limited	18.59	44	Donghai Special Steel	10.42
20	SAIL	17.33	45	Xinyu Steel	10.14
21	NLMK	17.29	46	Steel Dynamics, Inc.	9.84
22	IMIDRO [5]	16.70 [e]	47	Anyang Steel	9.50
23	Baotou Steel	16.45	48	Erdemir Group	9.02
24	U. S. Steel Corporation [6]	16.30	49	Jiuquan Steel	8.75
25	Cleveland-Cliffs [7]	16.30 [e]	50	SSAB	8.18

[e] = estimate

[1] Includes tonnage of Taiyuan Steel and Kunming Steel
[2] Includes 60% AM/NS India (former Essar Steel)
[3] Includes tonnage of Benxi Steel
[4] Includes Nippon Steel Stainless Steel Corporation, Sanyo Special Steel, Ovako, 40% AM/NS India and 31,4% USIMINAS
[5] Estimated combined tonnage of Mobarrakeh Steel, Esfahan Steel, Khuzestan Steel and NISCO
[6] Includes Big River Steel
[7] Include AK Steel and former ArcelorMittal USA operations.

Notes on company ownership and tonnage calculations:
For worldsteel members, the data was sourced from their official tonnage declarations. For Chinese companies, the official CISA tonnage publication was used, unless especially noted. In case of more than 50% ownership, 100% of the subsidiary's tonnage is included, unless specified otherwise. In cases of 30%-50% ownership, pro-rata tonnage is included. Unless otherwise specified in the declaration, less than 30% ownership is considered a minority and therefore, not included. Figures represent ownership ending 31 December 2021.
For an extended company listing, go to worldsteel.org/steel-by-topic/statistics/top-producers.

Major steel-producing countries 2021 and 2020

million tonnes, crude steel production

Country	2021		2020	
	Rank	Tonnage	Rank	Tonnage
China	1	1 032.8	1	1 064.7
India	2	118.2	2	100.3
Japan	3	96.3	3	83.2
United States	4	85.8	4	72.7
Russia	5	75.6	5	71.6
South Korea	6	70.4	6	67.1
Turkey	7	40.4	7	35.8
Germany	8	40.1	8	35.7
Brazil	9	36.2	9	31.4
Iran [e]	10	28.5	10	29.0
Italy	11	24.4	13	20.4
Taiwan, China	12	23.2	11	21.0
Vietnam	13	23.0	14	19.9
Ukraine	14	21.4	12	20.6
Mexico	15	18.5	15	16.8
Indonesia	16	14.3	16	12.9
Spain	17	14.2	18	11.0
France	18	13.9	17	11.6
Canada	19	13.0	19	11.0
Egypt	20	10.3	20	8.2
Saudi Arabia	21	8.7	22	7.8
Poland	22	8.5	21	7.9
Austria	23	7.9	24	6.8
United Kingdom	24	7.2	23	7.1
Belgium	25	6.9	26	6.1
Malaysia [e]	26	6.9	25	6.6
Netherlands	27	6.6	27	6.1
Australia	28	5.8	29	5.5
Bangladesh [e]	29	5.5	28	5.5
Thailand	30	5.5	30	4.5
Pakistan	31	5.3	35	3.8
South Africa [e]	32	5.0	34	3.9
Argentina	33	4.9	36	3.7
Slovakia	34	4.9	38	3.4
Czechia	35	4.8	31	4.5
Sweden	36	4.7	32	4.4
Kazakhstan [e]	37	4.4	33	3.9
Finland	38	4.3	37	3.5
Algeria	39	3.5	39	3.0
Romania	40	3.4	40	2.8
United Arab Emirates	41	3.0	41	2.7
Belarus [e]	42	2.4	42	2.5
Luxembourg	43	2.1	45	1.9
Oman [e]	44	2.0	44	2.0
Portugal	45	2.0	43	2.2
Serbia	46	1.7	47	1.5
Greece	47	1.5	48	1.4
Colombia	48	1.3	54	1.1
Chile	49	1.3	53	1.2
Kuwait [e]	50	1.3	49	1.3
Others		17.7		16.2
World		1 951.2		1 879.4

[e] = estimate

Crude steel production by process, 2021

	Million tonnes	Oxygen %	Electric %	Open hearth %	Other %	Total %
Austria	7.9	91.3	8.7	-	-	100.0
Belgium	6.9	69.7	30.3	-	-	100.0
Bulgaria	0.5	-	100.0	-	-	100.0
Croatia	0.2	-	100.0	-	-	100.0
Czechia	4.8	96.1	3.9	-	-	100.0
Finland	4.3	60.3	39.7	-	-	100.0
France	13.9	66.8	33.2	-	-	100.0
Germany	40.1	69.8	30.2	-	-	100.0
Greece	1.5	-	100.0	-	-	100.0
Hungary	1.1	68.6	31.4	-	-	100.0
Italy (e)	24.4	16.0	84.0	-	-	100.0
Luxembourg	2.1	-	100.0	-	-	100.0
Netherlands	6.6	100.0	-	-	-	100.0
Poland	8.5	48.1	51.9	-	-	100.0
Portugal	2.0	-	100.0	-	-	100.0
Romania (e)	3.4	68.2	31.8	-	-	100.0
Slovakia (e)	4.9	80.2	19.8	-	-	100.0
Slovenia	0.7	-	100.0	-	-	100.0
Spain	14.2	31.7	68.3	-	-	100.0
Sweden	4.7	64.5	35.5	-	-	100.0
European Union (27)	152.6	56.1	43.9	-	-	100.0
Turkey	40.4	28.4	71.6	-	-	100.0
United Kingdom	7.2	81.7	18.3	-	-	100.0
Others (e)	4.7	47.1	52.9	-	-	100.0
Other Europe	52.3	37.4	62.6	-	-	100.0
Russia	75.6	59.0	39.0	2.0	-	100.0
Ukraine	21.4	76.0	5.8	18.2	-	100.0
Other CIS (e)	8.4	51.3	48.7	-	-	100.0
Russia & Other CIS + Ukraine	105.4	61.8	33.0	5.1	-	100.0
Canada (e)	13.0	54.7	45.3	-	-	100.0
Mexico	18.5	15.9	84.1	-	-	100.0
United States	85.8	30.8	69.2	-	-	100.0
USMCA	117.2	31.1	68.9	-	-	100.0
Argentina	4.9	54.8	45.2	-	-	100.0
Brazil	36.2	75.2	23.6	-	1.2	100.0
Chile	1.3	63.2	36.8	-	-	100.0
Venezuela	0.0	-	100.0	-	-	100.0
Other Central & South America (e)	3.9	6.6	93.4	-	-	100.0
Central & South America	46.3	66.8	32.2	-	1.0	100.0
Egypt	10.3	-	100.0	-	-	100.0
South Africa (e)	5.0	57.7	42.3	-	-	100.0
Other Africa (e)	5.1	8.6	91.3	-	0.1	100.0
Africa	20.4	16.1	83.9	-	0.0	100.0
Iran (e)	28.5	9.7	90.3	-	-	100.0
Saudi Arabia	8.7	-	100.0	-	-	100.0
Other Middle East (e)	8.7	-	100.0	-	-	100.0
Middle East	45.8	6.0	94.0	-	-	100.0
China (e)	1 032.8	89.4	10.6	-	-	100.0
India	118.2	44.8	55.2	-	-	100.0
Japan	96.3	74.7	25.3	-	-	100.0
South Korea	70.4	68.2	31.8	-	-	100.0
Taiwan, China	23.2	60.5	39.5	-	-	100.0
Other Asia (e)	62.4	35.6	64.4	-	-	100.0
Asia	1 403.4	80.7	19.3	-	-	100.0
Australia	5.8	73.6	26.4	-	-	100.0
New Zealand	0.6	100.0	-	-	-	100.0
Total of above countries	1 949.9	70.8	28.9	0.3	0.0	100.0

The countries in this table accounted for approximately 99.9% of world crude steel production in 2021.
(e) = estimate

Continuously-cast steel output 2019 to 2021

	Million tonnes			% Crude steel output		
	2019	2020	2021	2019	2020	2021
Austria	7.1	6.5	7.6	96.1	96.1	96.4
Belgium	7.8	6.1	6.9	100.0	100.0	100.0
Bulgaria	0.6	0.5	0.5	100.0	100.0	100.0
Croatia	0.1	0.0	0.2	100.0	100.0	100.0
Czechia	4.3	4.3	4.7	96.6	96.5	96.5
Finland	3.5	3.5	4.3	99.5	99.5	99.6
France	14.0	11.3	13.6	97.2	97.5	97.5
Germany (e)	37.8	34.3	38.5	95.3	96.1	96.1
Greece	1.4	1.4	1.5	100.0	100.0	100.0
Hungary	1.8	1.5	1.1	100.0	100.0	100.0
Italy (e)	22.0	19.3	23.1	94.9	94.7	94.7
Luxembourg	2.1	1.9	2.1	100.0	100.0	100.0
Netherlands	6.7	6.1	6.6	100.0	100.0	100.0
Poland	8.8	7.7	8.3	98.1	98.4	98.4
Portugal	2.0	2.2	2.0	100.0	100.0	100.0
Romania (e)	3.4	2.7	3.3	97.7	97.7	97.8
Slovakia	3.9	3.4	4.9	100.0	100.0	100.0
Slovenia	0.5	0.5	0.5	80.2	80.4	81.6
Spain	13.4	10.9	14.0	98.3	99.3	98.9
Sweden (e)	3.9	3.7	3.9	83.0	83.0	82.9
European Union (27)	144.9	127.9	147.6	96.5	96.7	96.7
Turkey	33.7	35.8	40.4	100.0	100.0	100.0
United Kingdom	7.1	7.0	7.2	98.5	99.1	99.5
Others (e)	5.0	4.2	4.7	100.0	100.0	100.0
Other Europe	45.8	47.0	52.3	99.8	99.9	99.9
Russia (e)	59.2	59.1	62.4	82.5	82.5	82.6
Ukraine	11.6	13.6	14.1	55.7	66.2	66.2
Other CIS (e)	8.0	7.9	8.4	99.3	98.6	99.3
Russia & Other CIS + Ukraine	78.8	80.6	84.9	78.3	80.4	80.6
Canada (e)	10.1	8.6	10.1	78.2	78.1	78.1
Mexico	18.4	16.8	18.5	100.0	100.0	100.0
United States	87.5	72.6	85.6	99.7	99.8	99.8
USMCA	116.0	97.9	114.2	97.4	97.4	97.4
Argentina	4.6	3.6	4.9	99.7	99.6	99.7
Brazil	31.9	30.8	35.3	98.0	98.1	97.5
Chile	1.1	1.2	1.3	100.0	100.0	100.0
Venezuela	0.1	0.0	0.0	100.0	100.0	100.0
Other Central & South America (e)	3.9	2.9	3.9	100.0	100.0	100.0
Central & South America	41.6	38.6	45.4	98.4	98.4	98.0
Egypt	7.3	8.2	10.3	100.0	100.0	100.0
South Africa	6.1	3.9	5.0	98.8	100.0	100.0
Other Africa (e)	4.0	5.3	5.8	99.9	123.1	113.7
Africa	17.3	17.4	21.1	99.5	106.1	103.4
Iran (e)	25.6	29.0	28.5	100.0	100.0	100.0
Saudi Arabia	8.2	7.8	8.7	100.0	100.0	100.0
Other Middle East (e)	10.5	8.6	8.6	100.0	99.9	99.9
Middle East	44.3	45.4	45.8	100.0	100.0	100.0
China (e)	980.4	1 049.4	1 018.2	98.5	98.6	98.6
India (e)	97.0	87.2	103.0	87.1	87.0	87.1
Japan (e)	97.7	81.9	94.8	98.4	98.4	98.4
South Korea	70.4	66.2	69.4	98.6	98.7	98.6
Taiwan, China	21.9	21.0	23.1	99.5	100.0	99.6
Other Asia (e)	48.7	54.9	62.4	100.0	100.0	100.0
Asia	1 316.1	1 360.5	1 371.0	97.6	97.8	97.7
Australia	5.5	5.5	5.8	100.0	100.0	100.0
New Zealand	0.7	0.6	0.6	100.0	100.0	100.0
Total of above countries	1 811.0	1 821.4	1 888.8	96.6	97.0	96.9

The countries in this table accounted for approximately 99.9% of world crude steel production in 2021
(e) = estimate

Apparent steel use 2017 to 2021

million tonnes, finished steel products

	2017	2018	2019	2020	2021
Austria	4.1	4.2	4.0	3.6	4.5
Belgium-Luxembourg	3.5	4.5	3.4	3.0	4.9
Czechia	7.2	7.6	7.2	6.7	8.2
France	14.8	14.9	14.6	12.2	13.9
Germany	41.0	39.6	35.1	31.2	35.2
Italy	24.8	25.3	25.0	20.4	25.9
Netherlands	4.0	4.8	4.6	4.1	4.6
Poland	13.6	14.9	13.6	12.9	15.1
Romania	4.2	4.6	4.5	4.1	4.3
Spain	13.3	13.8	13.2	11.6	13.1
Sweden	4.1	4.1	3.8	3.1	3.6
Other EU	17.7	19.1	19.0	18.0	19.4
European Union (27)	152.3	157.4	148.1	131.0	152.8
Turkey	36.1	30.7	26.1	29.5	33.4
United Kingdom	11.0	10.8	10.2	9.0	10.8
Others [e]	6.5	6.8	6.8	6.5	6.9
Other Europe	53.7	48.3	43.2	44.9	51.0
Russia	40.7	41.3	43.5	42.3	43.9
Ukraine	4.6	4.7	4.7	4.6	4.8
Other CIS [e]	9.0	9.5	10.1	10.7	9.7
Russia & Other CIS + Ukraine	54.2	55.5	58.3	57.6	58.5
Canada	14.0	14.1	13.0	12.2	14.6
Mexico	25.8	25.3	24.3	21.4	25.3
United States	97.7	99.8	97.6	80.0	97.1
USMCA	137.6	139.2	134.9	113.6	136.9
Argentina	4.9	4.8	3.9	3.6	5.0
Brazil	19.5	21.2	21.0	21.4	26.4
Venezuela	0.5	0.2	0.1	0.1	0.1
Other Central & South America [e]	17.2	16.5	16.8	13.7	19.2
Central & South America	42.2	42.7	41.8	38.8	50.7
Egypt	10.2	11.1	10.4	9.7	10.2
South Africa	5.2	5.1	4.8	3.8	5.0
Other Africa [e]	19.8	20.7	24.3	21.7	22.2
Africa	35.2	36.9	39.5	35.2	37.4
Iran	20.0	19.6	18.5	17.2	18.2
Other Middle East [e]	33.2	32.0	31.4	29.7	30.1
Middle East	53.2	51.5	49.9	47.0	48.3
China	773.8	836.1	911.9	1 006.3	952.0
India	88.7	96.7	102.6	89.3	106.1
Japan	64.4	65.4	63.2	52.6	57.5
South Korea	56.3	53.7	53.2	49.0	55.6
Taiwan, China	17.7	17.8	17.6	18.8	21.1
Other Asia [e]	100.4	103.8	106.0	94.6	98.4
Asia	1 101.2	1 173.5	1 254.6	1 310.7	1 290.8
Oceania	6.6	6.6	6.6	6.1	7.3
World	1 636.0	1 711.6	1 776.9	1 784.9	1 833.7

[e] = estimate

Apparent steel use per capita 2017 to 2021

kilograms, finished steel products

	2017	2018	2019	2020	2021
Austria	464.3	470.7	444.4	405.2	516.9
Belgium-Luxembourg	288.4	371.9	280.3	242.8	397.2
Czechia	676.6	712.6	674.8	624.3	775.5
France	227.6	228.5	223.5	187.1	211.0
Germany	496.0	477.0	420.8	371.9	426.1
Italy	409.5	417.7	412.7	337.6	439.4
Netherlands	233.9	283.3	269.9	241.7	264.4
Poland	358.4	392.8	359.8	341.1	399.7
Romania	213.2	234.4	234.4	214.5	220.6
Spain	284.2	296.4	283.3	249.0	282.2
Sweden	416.6	407.5	378.6	310.3	355.8
Other EU	242.0	261.0	259.9	246.7	263.8
European Union (27)	342.8	353.9	332.7	294.2	344.2
Turkey	445.3	372.3	312.6	349.6	394.9
United Kingdom	164.9	161.2	151.8	132.1	159.0
Others	192.6	212.3	212.7	200.5	210.6
Other Europe	295.2	266.0	235.7	243.5	276.0
Russia	279.6	283.5	298.3	290.0	305.8
Ukraine	102.5	105.8	105.8	105.2	110.3
Other CIS	88.7	92.7	97.5	101.5	92.7
Russia & Other CIS + Ukraine	186.2	189.8	198.5	195.4	200.1
Canada	382.2	380.6	347.0	323.1	384.5
Mexico	206.8	200.5	190.7	165.9	186.6
United States	300.6	305.0	296.6	241.8	290.9
USMCA	282.7	283.8	273.1	228.3	270.0
Argentina	112.0	108.8	87.5	79.5	109.7
Brazil	93.9	101.2	99.4	100.9	122.7
Venezuela	17.4	5.9	4.2	3.0	2.5
Other Central & South America	74.7	70.5	71.2	57.2	79.7
Central & South America	82.4	82.7	80.4	73.9	94.7
Egypt	105.5	112.4	103.1	94.7	97.4
South Africa	90.9	87.7	81.2	63.3	83.8
Other Africa	18.2	18.5	21.2	18.4	18.2
Africa	28.3	28.9	30.2	26.2	27.0
Iran	247.4	239.1	223.0	204.9	216.3
Other Middle East	230.5	216.9	208.5	195.4	191.5
Middle East	214.1	204.2	194.5	179.9	180.7
China	544.6	585.6	636.0	699.2	666.5
India	66.2	71.5	75.1	64.7	76.0
Japan	504.9	514.2	498.3	416.1	456.2
South Korea	1102.1	1049.6	1039.1	955.0	1075.6
Taiwan, China	745.7	749.7	740.9	789.0	885.6
Other Asia	88.1	90.0	90.8	80.1	82.8
Asia	268.5	283.7	300.9	311.8	306.2
Oceania	159.9	158.8	156.6	143.9	170.0
World	216.7	224.3	230.4	229.0	232.8

Pig iron 2020 and 2021

million tonnes

	Production 2020	Production 2021	- Exports 2021	+ Imports 2021	Apparent= Consumption 2021
Austria	5.3	6.1	0.0	0.0	6.2
Belgium-Luxembourg	3.6	4.2 (e)	0.1	0.1	4.2
Czechia	3.5	3.9	0.1	0.1	3.8
Finland	1.9	2.5	0.0	0.0	2.5
France	7.7	9.5	0.1	0.1	9.5
Germany	22.5	25.7	0.2	0.3	25.7
Hungary	1.0	0.6	0.0	0.0	0.6
Italy	3.4	3.9	0.0	1.4	5.3
Netherlands	5.4	5.9	0.3	0.5	6.0
Poland	3.5	3.6	0.1	0.2	3.7
Romania	1.8	2.1	0.0	0.1	2.1
Spain	2.9	4.0	0.0	0.2	4.3
Sweden	2.9	3.0	0.0	0.0	3.0
Other EU	2.8	4.0	0.0	0.1	4.1
European Union (27)	70.9	83.0	1.0	3.1	85.1
Turkey	10.0	10.4	0.0	1.2	11.6
United Kingdom	5.2	5.8	0.0	0.0	5.8
Others	1.9	2.1 (e)	0.1	0.0	2.0
Other Europe	17.1	18.4	0.1	1.2	19.5
Kazakhstan	2.8	3.1 (e)	0.0	0.0	3.1
Russia	51.9	53.6 (e)	4.0	0.0	49.6
Ukraine	20.4	21.2	3.2	0.0	17.9
Other CIS	0.0	0.0	0.0 (e)	0.1	0.1
Russia & Other CIS + Ukraine	75.1	77.9	7.2	0.1	70.8
Canada	5.2	6.2	0.1	0.1	6.2
Mexico	2.4	2.7	0.0	0.3	2.9
United States	18.3	22.2	0.0	6.0	28.2
USMCA	26.0	31.1	0.1	6.3	37.4
Argentina	1.9	2.1	0.0	0.1	2.2
Brazil	24.6	28.5	3.3	0.0	25.3
Chile	0.7	0.7	0.0	0.0	0.7
Other Central & South America	0.2	0.3 (e)	0.0	0.1	0.3
Central & South America	27.4	31.6	3.3	0.3	28.6
South Africa	2.1	2.9	0.5	0.0	2.4
Other Africa	0.4	0.3 (e)	0.0	0.0	0.3
Africa	2.5	3.2	0.5	0.0	2.7
Iran	2.5	2.7 (e)	0.1	0.0	2.6
Other Middle East	0.0	0.0 (e)	0.2	0.3	0.0
Middle East	2.5	2.7	0.3	0.3	2.6
China	907.6	868.6	0.1	2.0	870.5
India	67.8	77.6	0.9	0.0	76.7
Japan	61.6	70.3	0.0	0.1	70.4
South Korea	45.4	46.4	0.1	0.2	46.5
Taiwan, China	13.4	15.2	0.0	0.4	15.6
Other Asia	20.0	23.1 (e)	0.1	0.3	23.2
Asia	1 115.8	1 101.3	1.2	3.0	1 103.0
Australia	3.7	3.8	0.0	0.0	3.8
New Zealand	0.6	0.7	0.0	0.0	0.7
Other Oceania	0.0	0.0 (e)	0.0	0.1	0.1
Oceania	4.3	4.4	0.0	0.1	4.5
World	1 341.7	1 353.6	13.7	14.4	1 354.3

(e) = estimate

Direct reduced iron production 2017 to 2021

million tonnes

	2017	2018	2019	2020	2021
Germany	0.6	0.6	0.5	0.5	0.5 (e)
Sweden	0.1	0.1	0.1	0.1	0.1 (e)
European Union (27)	0.7	0.7	0.6	0.6	0.6
Russia	7.2	7.9	8.0	7.8	7.8
Canada	1.6	1.7	1.4	1.2	1.6
Mexico	6.0	6.0	6.0	5.2	5.8
United States	3.0	3.4	3.2	3.4	3.5 (e)
USMCA	10.6	11.0	10.7	9.7	11.0
Argentina	1.2	1.6	1.1	0.5	1.4
Trinidad and Tobago	1.6	-	-	-	-
Venezuela	0.5	0.4	0.4	0.3	0.3
Central & South America	3.3	2.0	1.5	0.8	1.7
Algeria	-	0.1	1.5	2.2	3.1
Egypt	4.7	5.8	4.4	4.8	5.4
Libya	0.6	0.6	0.9	0.8	0.9
South Africa	0.9	0.8	0.7	0.2	0.2
Africa	6.2	7.3	7.5	8.0	9.5
Bahrain	1.3	1.6	1.5	1.4	1.4 (e)
Iran	19.4	25.7	28.5	30.8 (e)	29.8
Oman	1.5	1.5	1.8	1.8	1.7
Qatar	2.5	2.5	2.4	0.8	0.8
Saudi Arabia	5.7	6.0	5.8	5.2	6.1
United Arab Emirates	3.6	3.8	3.7	3.0	3.7
Middle East	34.1	41.2	43.6	42.9	43.5
India	29.5	34.2	36.8	33.6	39.0
Indonesia	0.0	0.2	0.1	0.0	0.1 (e)
Malaysia	0.6	0.7	0.6	0.7 (e)	0.7 (e)
Asia	30.1	35.2	37.5	34.4 (e)	39.8
World	92.2	105.3	109.4	104.3	113.85

(e) = estimate

Iron ore 2020

million tonnes, actual weight

	Production	- Exports	+ Imports	= Apparent consumption
Austria	3.0	0.0	3.2	6.2
Belgium-Luxembourg	-	-	-	0.0
Czechia	-	0.0	4.9	4.9
France	-	0.1	11.2	11.1
Germany	1.2	0.9	33.4	33.8
Italy	-	0.0	5.4	5.3
Netherlands	-	16.9	24.4	7.5
Poland	-	-	5.2	5.2
Romania	-	-	2.2	2.2
Slovakia	-	0.1	4.4	4.3
Spain	-	0.1	3.6	3.5
Sweden	29.2	27.1	0.0	2.2
Other EU	-	0.5	4.0	3.5
European Union (27)	33.4	45.6	101.9	89.6
Bosnia-Herzegovina	1.4	0.0	0.0	1.4
Norway	1.6	1.8	0.0	-0.2
Turkey	7.9	2.2	9.9	15.6
United Kingdom	-	0.0	7.1	7.1
Other Europe	-	0.0	1.4	1.4
Europe	44.2	49.7	120.3	114.9
Russia & Other CIS + Ukraine	203.1	86.1	8.2	125.2
Canada	58.8	55.1	7.1	10.7
Mexico	11.4	1.9	1.5	11.0
United States	38.6	10.4	5.2	33.3
USMCA	108.7	67.5	13.7	55.0
Brazil	391.0	342.6	0.2	48.6
Chile	15.0	17.0	0.2	-1.8
Peru	8.9	11.6	0.0	-2.8
Venezuela	1.5	0.8	-	0.7
Other Central & South America	0.3	0.6	5.1	4.8
Central & South America	416.6	372.6	5.5	49.5
Liberia	5.1	5.1	-	0.0
Mauritania	13.5	14.1	-	-0.6
South Africa	69.0	65.5	0.0	3.5
Other Africa	5.7	0.5	23.2	28.4
Africa	93.3	85.1	23.2	31.4
Middle East	53.6	10.4	25.1	68.3
China[(1)]	270.5	15.6	1 170.4	1 425.2
India	203.8	52.0	0.7	152.5
Japan	-	0.0	99.4	99.4
South Korea	0.3	0.3	70.4	70.5
Other Asia	17.9	40.9	78.9	55.9
Asia	492.6	108.8	1 419.8	1 803.6
Australia	922.5	873.0	0.9	50.4
New Zealand & Other Oceania	3.8	2.9	0.0	0.9
World	2 338.4	1 656.1	1 616.8	2 299.1

(1) Production adjusted so that Fe content is similar to world average. Source: RMG.

World trade in iron ore by area, 2021

million tonnes

Destination \ Exporting region	European Union (27)	Other Europe	Russia & Other CIS + Ukraine	USMCA	Other America	Africa & Middle East	Asia	Oceania	Total imports	of which: extra-regional imports
European Union (27)	32.2	2.2	30.0	22.8	23.3	20.4	0.4	0.2	131.6	99.4
Other Europe	3.8	0.7	4.4	2.6	6.8	2.1	-	0.0	20.5	19.7
Russia & Other CIS + Ukraine	0.0	0.0	2.0	-	-	0.0	0.0	-	2.0	0.0
USMCA	0.9	0.1	0.4	10.9	4.7	0.4	0.2	0.0	17.7	6.7
Other America	0.0	-	0.0	1.1	5.8	0.1	0.4	-	7.5	1.7
Africa & Middle East	7.1	0.5	1.3	2.3	26.1	16.0	1.0	0.0	54.3	38.3
China	1.5	1.6	30.6	19.2	271.1	54.6	50.5	696.6	1125.6	1075.1
Japan	-	-	1.4	8.5	31.0	4.6	1.0	66.6	113.1	112.1
Other Asia	0.4	0.4	5.4	3.7	18.2	2.5	43.7	116.0	190.2	146.5
Oceania	0.0	0.0	-	0.0	0.0	0.9	0.0	-	0.9	0.9
Total exports	45.9	5.5	75.5	71.2	387.2	101.7	97.1	879.3	1663.4	1500.5
of which: extra-regional exports*	13.6	4.7	73.5	60.3	381.3	85.7	2.0	879.3	1500.5	
Net exports (exports-imports)	-85.8	-15.0	73.5	53.5	379.7	47.4	-1331.8	878.5		

* Excluding intra-regional trade marked

Trade in ferrous scrap 2020 and 2021

million tonnes

	Exports		Imports	
	2020	2021	2020	2021
Austria	1.2	1.4	1.2	1.3
Belgium	4.0	4.2	4.6	5.3
Bulgaria	0.4	0.6	0.2	0.1
Czechia	2.2	2.4	0.4	0.5
Finland	0.7	0.7	0.0	0.0
France	6.1	7.1	1.5	1.6
Germany	7.7	7.8	3.8	4.8
Greece	0.1	0.1	0.8	0.9
Italy	0.7	0.6	5.2	6.5
Netherlands	6.3	7.6	3.6	3.9
Poland	2.2	2.7	0.7	0.6
Slovakia	0.8	0.8	0.3	0.4
Spain	0.6	0.9	3.3	4.1
Sweden	1.4	1.4	0.2	0.2
Other EU	7.7	9.5	5.4	5.9
European Union (27)	42.1	47.9	31.1	36.2
Turkey	0.2	0.2	22.5	25.0
United Kingdom	6.9	8.3	0.4	0.4
Others	2.3	2.4	1.1	1.2
Other Europe	9.3	10.9	24.0	26.6
Kazakhstan	0.5	0.9	0.0	0.0
Russia	4.7	4.1	0.5	0.9
Ukraine	0.0	0.6	0.0	0.0
Other CIS	0.1	0.3	1.5	1.5
Russia & Other CIS + Ukraine	5.3	5.9	2.0	2.4
Canada	4.5	4.9	1.0	0.8
Mexico	0.7	0.7	2.1	2.7
United States	16.9	17.9	4.5	5.3
USMCA	22.1	23.4	7.7	8.7
Brazil	0.7	0.5	0.1	0.2
Other Central & South America	1.6	3.3	0.5	1.1
Central & South America	2.3	3.8	0.6	1.4
South Africa	0.3	0.2	0.1	0.1
Other Africa	0.8	1.4	0.6	1.8
Africa	1.2	1.6	0.7	1.9
Middle East	3.0	3.9	0.9	0.8
China	0.0	0.0	0.0	0.6
Japan	9.4	7.3	0.0	0.1
South Korea	0.3	0.4	4.4	4.8
Taiwan, China	0.1	0.2	3.6	3.1
Other Asia	2.6	2.7	23.6	22.8
Asia	12.3	10.5	31.7	31.3
Australia & New Zealand	2.7	2.8	0.1	0.1
World	100.3	110.7	98.8	109.5

World trade in ferrous scrap by area, 2021

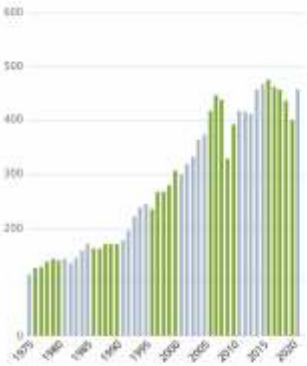
million tonnes

Exporting region / Destination	European Union (27)	Other Europe	Russia & Other CIS + Ukraine	USMCA	Other America	Africa & Middle East	China	Japan	Other Asia	Oceania	Total imports	of which: extra-regional imports
European Union (27)	28.6	3.3	0.6	0.7	0.5	0.3	-	0.0	0.0	0.0	34.0	5.5
Other Europe	14.3	2.6	2.5	3.8	0.9	1.4	-	0.0	0.0	0.0	25.6	23.0
Russia & Other CIS + Ukraine	0.4	0.0	1.1	0.0	0.0	0.0	0.0	-	0.0	0.0	1.5	0.4
USMCA	0.6	0.3	0.0	8.4	0.0	0.0	0.0	0.0	0.0	0.0	9.3	0.9
Other America	0.0	0.0	-	0.8	0.3	0.0	-	-	0.0	0.0	1.1	0.9
Africa	2.2	1.6	0.1	0.5	0.0	0.2	-	-	0.0	0.0	4.5	4.3
Middle East	0.1	0.2	0.0	0.2	0.0	0.2	-	0.0	0.0	0.0	0.8	0.6
China	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.1	0.0	0.6	0.6
Japan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.1	0.0	0.1	0.1
Other Asia	1.8	2.7	0.9	8.8	2.0	3.5	0.0	6.9	2.9	2.7	32.1	29.2
Oceania	0.0	0.0	-	0.0	0.0	-	-	-	0.0	0.1	0.2	0.1
Total exports	47.9	10.9	5.1	23.3	3.8	5.5	0.0	7.3	3.2	2.8	109.8	65.4
of which: extra-regional exports*	19.3	8.2	4.1	14.9	3.5	5.2	0.0	7.3	0.3	2.7	65.4	
Net exports (exports-imports)	13.9	-14.7	3.7	14.0	2.6	0.2	-0.6	7.2	-28.9	2.6		

* Excluding intra-regional trade marked

World steel trade in products 1975 to 2021

million tonnes

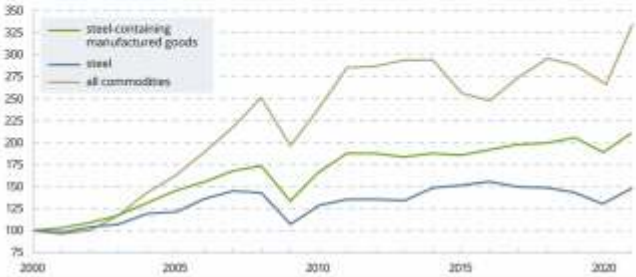


Exports are of finished and semi-finished steel products. Production of finished steel, where not available from national sources, is calculated from crude steel production, taking into account the continuous casting ratio.

Year	Exports	Production	Exports share %
1975	114.7	506.9	22.6
1980	140.6	578.7	24.3
1985	171.0	599.0	28.5
1990	171.0	654.0	26.2
1991	177.1	660.0	26.8
1992	196.1	658.0	29.8
1993	222.5	664.9	33.5
1994	238.6	656.2	36.4
1995	246.6	685.6	36.0
1996	236.4	687.1	34.4
1997	267.9	730.1	36.7
1998	268.7	713.4	37.7
1999	280.8	725.8	38.7
2000	307.5	783.6	39.2
2001	300.5	785.9	38.2
2002	318.0	837.1	38.0
2003	333.6	899.1	37.1
2004	368.3	985.6	37.4
2005	373.3	1 065.5	35.0
2006	418.5	1 161.3	36.0
2007	446.8	1 255.4	35.6
2008	438.5	1 250.4	35.1
2009	330.1	1 155.9	28.6
2010	392.7	1 337.6	29.4
2011	418.7	1 435.4	29.2
2012	416.0	1 458.2	28.5
2013	412.6	1 542.4	26.8
2014	457.4	1 562.6	29.3
2015	467.4	1 514.6	30.9
2016	476.8	1 522.1	31.3
2017	462.9	1 619.0	28.6
2018	457.2	1 702.2	26.9
2019	438.8	1 738.3	25.2
2020	405.6	1 753.4	23.1
2021	458.9	1 820.0	25.2

World volume of trade 2000 to 2021

Quantum indices 2000 = 100



World steel exports by product 2017 to 2021

million tonnes

	2017	2018	2019	2020	2021
Ingots and semi-finished material	60.2	61.8	56.1	55.7	61.2
Railway track material	2.7	2.6	4.9	2.6	2.8
Angles, shapes and sections	22.1	22.7	21.5	19.6	20.3
Concrete re-inforcing bars	18.3	18.8	19.1	19.2	22.1
Bars and rods, hot-rolled	21.2	18.7	15.2	12.8	15.3
Wire rod	27.0	27.6	26.8	25.2	28.9
Drawn wire	8.9	9.0	8.8	8.7	9.6
Other bars and rods	5.9	6.4	5.6	4.5	6.1
Hot-rolled strip	3.9	3.8	3.2	2.8	3.5
Cold-rolled strip	4.5	4.5	4.0	3.7	4.8
Hot-rolled sheets and coils	85.0	78.9	78.4	74.6	79.2
Plates	33.2	33.3	32.8	29.4	30.9
Cold-rolled sheets and coils	37.4	35.7	32.5	19.0	36.7
Electrical sheet and strip	4.5	4.6	4.1	3.9	5.1
Tinmill products	7.0	6.8	6.9	7.0	6.8
Galvanised sheet	46.2	44.7	43.0	37.0	45.3
Other coated sheet	18.0	17.9	18.2	18.1	20.2
Steel tubes and fittings	41.9	41.2	40.9	32.3	34.3
Wheels (forged and rolled) and axles	0.8	0.9	0.8	0.7	0.9
Castings	1.2	1.3	1.3	1.1	1.4
Forgings	1.0	1.1	1.0	0.9	1.0
Total	450.7	442.2	425.2	378.8	436.3

Exports include intra-EU trade, trade between countries of the CIS, and trade between USMCA countries. The figures are based on a broad definition of the steel industry and its products, including ingots, semi-finished products, hot-rolled and cold-finished products, tubes, wire, and unworked castings and forgings. The above table comprises the exports of 62 countries, which represents approximately 94.8 per cent of total world trade in 2021.

Passenger Vehicle dispatches increase by 19 pc in June as Chip supply improves

As per the latest month data released from SIAM for the month of June 2022, indicate that the industry seems to have bounced back in the first quarter of the financial year 2022-23 as Covid restrictions wane and supply chains get better with an improved chip supply.

The month of June 2022 also saw the total passenger vehicle dispatches to dealers rising 19% year-on-year to 20,81,148 units, data released by the industry body SIAM (Society of Indian Automobile Manufacturers) shows.

Commenting on Q1 performance, Mr Rajesh Menon, Director General, SIAM said, "In Quarter-1 this year, sales in the Passenger vehicle segment stood at 9.1 lakh units, in Two-wheeler segment 37.25 lakh units, in Three-wheeler segment 76 thousand units and in Commercial vehicle segment 2.25 lakh units.

Recently the government has taken significant measures to ease the inflationary pressure and help the common man by reducing central excise duty on petrol & diesel and changing the duty structure to moderate prices of steel & plastic.

Indian Automobile Industry appreciates and thanks the government for these efforts. Industry also keenly looks forward to similar support on CNG prices which has seen exponential increase in the last 7 months. Support on CNG prices would help the common man, facilitate public transport and will enable a cleaner environment." Society of Indian Automobile Manufacturers.

Total commercial vehicle wholesales also rose to 2,24,512 units against 1,05,800 units a year ago. Two-wheeler dispatches jumped to 37,24,533 units as against 24,13,608 units in the year-ago period.

Similarly, three-wheeler dispatches grew to 76,293 units in the first quarter from 24,522 units in the year-ago period.

Total sales across categories rose to 49,35,870 units in the April-June quarter compared to 31,90,202 units in the first quarter of last fiscal.

SIAM Director General Rajesh Menon said that in the first quarter, PV sales stood at 9.1 lakh units while two-wheeler dispatches were at 37.25 lakh units. Similarly, commercial vehicle sales stood at 2.25 lakh units.

"Recently, the government has taken significant measures to ease the inflationary pressure and help the common man by reducing central excise duty on petrol and diesel and changing the duty structure to moderate prices of steel and plastic. Indian automobile industry appreciates and thanks the government for these efforts," Menon said.

The industry also keenly looks forward to similar support on CNG prices, which have seen an exponential increase in the last seven months, he said.

"Support on CNG prices would help the common man, facilitate public transport and will enable a cleaner environment," Menon added.

SIAM

Segment wise Comparative Production, Domestic Sales & Exports data for the month of June 2022

(Number of Vehicles)

Category	Production		Domestic Sales		Exports	
Segment/Subsegment	June		June		June	
	2021	2022	2021	2022	2021	2022
Passenger Vehicles (PVs)*						
Passenger Cars	167,932	159,121	121,378	132,342	34,837	37,071
Utility Vehicles (UVs)	117,913	154,492	100,760	133,076	17,677	19,437
Vans	10,145	10,398	9,495	10,370	397	97
Total Passenger Vehicles (PVs)	**295,990**	**324,011**	**231,633**	**275,788**	**52,911**	**56,605**
Three Wheelers						
Passenger Carrier	49,047	53,078	5,615	17,934	45,278	33,674
Goods Carrier	2,720	7,551	3,559	7,050	1,406	287
E-Rickshaw	41	1,282	196	1,464	-	-
E-Cart	22	240	34	253	-	-
Total Three Wheelers	**51,830**	**62,151**	**9,404**	**26,701**	**46,684**	**33,961**
Two Wheelers						
Scooter/ Scooterettee	252,558	449,905	247,499	421,362	23,995	33,535
Motorcycle/Step-Throughs	1,077,419	1,210,557	777,169	849,928	322,314	361,585
Mopeds	19,653	34,326	35,897	37,474	726	288
Total Two Wheelers	**1,349,630**	**1,694,788**	**1,060,565**	**1,308,764**	**347,035**	**395,408**
Quadricycle	746	198	-	47	665	234
Grand Total	**1,698,196**	**2,081,148**	**1,301,602**	**1,611,300**	**447,295**	**486,208**

* BMW, Mercedes, Tata Motors and Volvo Auto data is not available

Society of Indian Automobile Manufacturers (13/07/2022)

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