Met-Info

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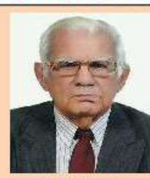
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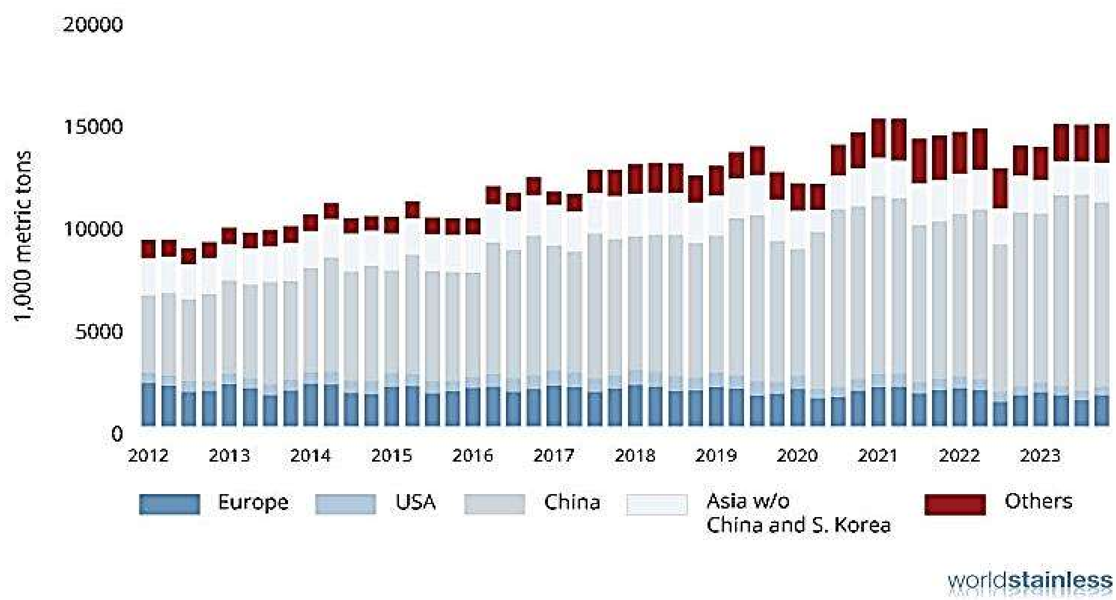
Tata Steel: Sustainability Champion for the 7th Consecutive Year

Tata Steel has been recognised as a Steel Sustainability Champion 2024 by worldsteel for the seventh consecutive year for its commitment and action to sustainable development and adherence to world-class standards. Tata Steel has been a champion every year since the programme's launch in 2018. The award acknowledges Tata Steel's efforts to maintain its leadership as a world-class steel producer that is fully dedicated to the principles of sustainability.

Tata Steel is among 11 steel-producing companies that have been named 2024 Steel Sustainability Champions at worldsteel's April Special General Meeting (SGM) of the Board of Members.

Stainless Steel Melt Shop Production 2023



Stainless steel melt shop production increased by 4.6% year–on–year to 58.4 million metric tons in 2023.

[000 metric tons]

Region	Quarter				Total	+/- %
	1/2023	2/2023	3/2023	4/2023	2023	y-o-y
Europe	1,636	1,495	1,270	1,502	**5,902**	-6.2%
USA	478	465	442	440	**1,824**	-9.6%
China	8,418r	9,291r	9,970r	8,997	**36,676**	12.6%
Asia w/o China and S. Korea	1,631	1,687	1,619r	1,943	**6,880**	-7.2%
Others	1,665	1,809	1,798	1,891	**7,163**	-5.2%
Total	**13,828r**	**14,745r**	**15,099r**	**14,773**	**58,444**	**4.6%**
Region	Quarter				Total	
	1/2022	2/2022	3/2022	4/2022	2022	
Europe	1,860	1,761	1,169	1,503	**6,294**	
USA	569	520	500	429	**2,017**	
China	8,097r	8,454r	7,357r	8,668r	**32,575r**	
Asia w/o China and S. Korea	1,956	1,930	1,752	1,773	**7,411**	
Others	2,053	2,030	1,991	1,483	**7,557**	
Total	**14,535r**	**14,695r**	**12,768r**	**13,856r**	**55,855r**	

Others: Brazil, Russia, S. Africa, S. Korea, Indonesia, r=revised

Source: World Stainless Association Media Release

Global Molybdenum Production and Use Rises in 2023

Global production of molybdenum was at 627.4 million pounds (mlbs) in 2023, a rise of 9% from 577.8 mlbs in 2022, {figures released by the International Molybdenum Association (IMOA)}. Global usage rose 1% to 630 mlbs from 625.1 mlbs the previous year.

China remained the largest producer of molybdenum at 281.8 mlbs, up 13% from 248.6 mlbs in 2022. South America remained the second largest producer at 168.5 mlbs, a rise of 1% from 166.7 mlbs the previous year. North America saw a 1% rise in production to 113 mlbs from 112.1 mlbs the previous year. While Other regions saw the largest percentage increase in production, 27%, to 64.1 mlbs from 50.4 mlbs in 2022.

China remained the largest user of molybdenum at 278.5 mlbs in 2023 a 4% rise from 268.9 mlbs in 2022. Europe remained the second largest user at 124.8 mlbs, a rise of 1% from 124.2 mlbs when compared to 2022. Other regions saw a 6% fall in usage to 93.3 mlbs from 99.3 mlbs the previous year. The USA saw the largest percentage rise in use, 5%, to 64.4 mlbs from 61.3 mlbs in 2022. Japan, however, saw the largest percentage fall in usage, 7%, to 47.5 mlbs from 50.9 mlbs the previous year. Use in CIS rose 4% to 21.4 mlbs from 20.5 mlbs the previous year.

Molybdenum is added to alloy steels to improve strength, toughness, hardenability and weldability for numerous applications in the automotive, shipbuilding, construction, mining, chemical, oil & gas and energy generation industries. In stainless steels and superalloys, it improves corrosion resistance and high-temperature performance and finds uses in many industrial applications. It is also used in a variety of products from catalysts and lubricants to pigments and paint.

Source: IMOA News. April 2024

Stainless Steel Microwave-safe Food Containers

Stainless steel microwave-safe food containers can help here reducing food waste and the waste streams of single-use food containers.

When you have leftovers, are meal-prepping, or taking a lunch to work or school, … a new revolution can now help you: stainless steel microwave-safe food containers. You only need one box to store, freeze, and reheat your food. After use, you just clean and reuse. No more food waste and no more single-use packaging waste.

Traditionally, metal food containers have been prohibited from being used in microwave ovens due to electrical arcing inside the ovens. Today it is easy to find microwave-safe stainless steel food containers. Most stainless steel food containers are made of 304 grade (18/8 stainless), and new microwave-safe containers have had their corners specially designed so they do not cause problems when used in a microwave oven.

The main advantages of stainless steel microwave-safe food containers are:

Eco-friendly
A resilient, reusable and recyclable product that does not harm our environment, nor humans.

Food safe
A completely safe material that meets all global food hygiene standards.

Versatile
Innovative product that can be used in every appliance in your kitchen including microwave ovens.

Convenient
Lightweight, portable and easy to use - just clean and reuse ... over and over again.

Economical
Damage resistant and extremely long lasting, meaning no need to re-purchase.

Source: Worldstainless.org

Energy Transition Minerals and Clean Energy Age

Since thousands of years, fossil fuels have played a central part in the story of humanity. But as the world transitions away from these planet-warming energy sources, demand is shifting towards a subset of minerals such as lithium, nickel and cobalt.

These energy transition minerals are essential components in many of today's clean energy technologies, from wind turbines to electric vehicles. However, the mining and processing of transition minerals can ravage landscapes, decimate biodiversity and spew greenhouse gases. There are also concerns competition for these resources could worsen geopolitical tensions.

Energy transition minerals can help usher in the clean energy age and opportunities for development. But the urgency and scale of demand could also lead to environmental destruction.

What exactly are energy transition minerals?

Transition minerals are naturally occurring substances, often found in rocks, that are ideal for use in renewable technology. Lithium, nickel and cobalt are core components of batteries, like those that power electric vehicles. Rare earth elements are part of the magnets that turn wind turbines and electric motors. Copper and aluminium are used in massive amounts in power transmission lines.

Where are energy transition minerals found?

All over the world. But a handful of countries, and companies control their extraction. China mines most rare earth materials. Indonesia extracts the most nickel. Democratic Republic of the Congo produces most of the cobalt. Many energy transition minerals are also found in a group of land-locked developing countries, some of which are among the world's least developed countries.

Is the market for energy transition minerals growing?

Yes. Between 2017 and 2022, demand for lithium tripled, demand for nickel rose by 40 per cent, and demand for cobalt jumped by 70 per cent, according to the International Energy Agency. If the world is to fully embrace renewable energy and reach net zero greenhouse gas emissions, the use of energy transition minerals will need to increase six-fold by 2040.

What are the environmental concerns with the extraction of energy transition minerals?

Mining can devastate the environment if done unsustainably, leading to deforestation, water pollution and what is known as dewatering. Just to take one example, it takes 2 million litres of water to extract a single tonne of lithium. But some 50 per cent of global copper and lithium production are concentrated in areas with water scarcity.

How can the energy transition minerals industry be made more sustainable?

First and foremost, the world needs to address the demand for minerals while limiting the environmental and social impacts associated with their production. An important strategy is to reduce the mining of virgin minerals. There are two keys to this. Firstly, renewable technology must become more efficient to allow mineral users to do more with less. Secondly, industries must find ways to use minerals longer, a process known as circularity. For example, firms should design products that can be repaired and recycled and from which metals can be recovered. This will lessen the need to mine virgin minerals.

Source : https://www.unep.org/news-and-stories/story/what-are-energy-transition-minerals-and-how-can-they-unlock-clean-energy-age ; 28 March 2024

Molten Oxide Electrolysis May Prove to be a Cheaper Option than Direct Iron Reduction

It has been a long-held view that the only possible way to decarbonise steel production is to use green hydrogen to extract iron from ore, and then use electric arc furnaces to turn the iron into steel.

But Molten Oxide Electrolysis, a long-gestating technology being developed by a well-funded start-up promises to not just compete with green hydrogen, but potentially destroy the business case for H_2 in steel production altogether.

Massachusetts-based Boston Metal has invented the molten oxide electrolysis (MOE) process that blasts a liquid electrolyte containing iron ore pieces with large amounts of clean electricity, heating it to 1,600°C (the melting point of iron) via an electrode able to withstand such high temperatures. At this temperature, the iron oxide in the ore splits into pure molten iron and oxygen; impurities such as silica and manganese rise to the top of the furnace, and the liquid electrolyte remains in situ to continue the process.

Another advantage of the technology is that while hydrogen-direct-iron reduction (DRI) requires scarce high-grade iron ore — causing Swedish developer H_2 Green Steel to import ore from Canada and Brazil — MOE can work with low-grade iron ore. cheaper resource.

Boston Metal already operates a pilot plant at its headquarters in Woburn, Massachusetts, and is opening a commercial-scale factory in Brazil producing low-carbon iron alloys, which the company believes can bring in $400m of revenue by 2026 — the year it hopes to start making green steel commercially.

Boston Metal has been well-funded — it has been working on MOE technology since its formation in 2013, and the company's potential is so large that it has continued to attract high-profile investors.

Breakthrough Energy Ventures — the tech venture capital firm funded by billionaires such as Bill Gates, Jeff Bezos and Richard Branson — was one of Boston Metals' early financial backers, and continues to support the company.

Another investor was steel giant ArcelorMittal.

Estimates suggest green hydrogen-based steel will be 20-40% more expensive than grey steel made with blast furnace-basic oxygen furnace route.

But Boston Metal claims that its technology would enable the production of green steel to reach cost parity with the highly polluting variety once MOE plants produce between one and two million tonnes a year, with electricity prices of about $30/MWh — a figure already being reached by solar power in the sunniest parts of the world.

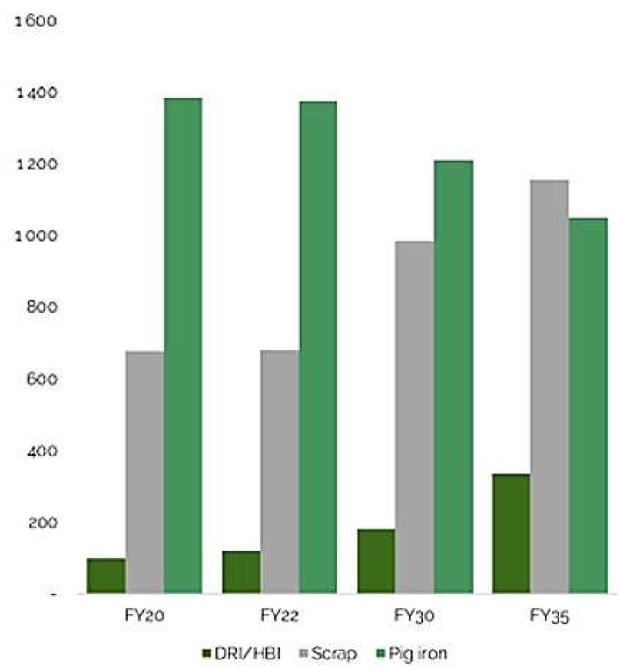
Nevertheless, plenty of off-takers have been willing to pay a premium for hydrogen-derived green steel. For example, H_2 Green Steel has already signed binding offtake agreements with Mercedes-Benz, Porsche, truck maker Scania, US conglomerate Cargill, German auto technology firm ZF, German auto parts supplier Kirchhoff Automotiv, Italian steel maker Marcegaglia, UK-based SPM and Germany's Bilstein Group.

Replacing grey steel made using coal with the more expensive green variety will cost about €300 ($326) per car, according to estimates — an increase that can be fairly easily absorbed by customers already paying five figures for new vehicles.

Boston Metals' MOE technology can also be used to produce low-carbon metals other than iron and steel. In November, the US government awarded funding to allow Boston Metal to build a new facility in West Virginia to manufacture ultra-pure chromium.

Source: Accelerate Hydrogen, Newsletter, Mar 7, 2024

Global Metallic Demand Forecast for Steel Manufacture



Cutting-edge Tech Development to Clean- up Steel Manufacture

A new infusion of US federal funding will support some of the most cutting-edge efforts to decarbonize the steel industry.

U.S. Department of Energy selected 13 projects to receive a total of $28 million through its Advanced Research Projects Agency-Energy (ARPA-E). The initiative aims to spur solutions that can eliminate carbon dioxide emissions from the ironmaking process and sharply reduce emissions across the entire steel supply chain.

Iron and steel production are among the most difficult industrial sectors to decarbonize, which is why ARPA-E is laser focused on accelerating game-changing technological breakthroughs to lower emissions from these critical sectors.

Globally, steel production generates as much as 9 percent of human-caused CO_2 emissions every year — more than any other heavy industry.

About 70 percent of those emissions come from the ironmaking process alone. Existing blast furnaces use "coke" and limestone to turn iron ore into molten iron at extremely high temperatures. A separate facility then turns iron into high-strength steel, which goes on to become car parts, structural beams, kitchen appliances, and much more.

ARPA-E selected 13 companies, universities, and research institutions for award, primarily targeting those blast-furnace emissions.

Electra, a startup based in Boulder, Colorado, is developing electrochemical devices similar to batteries that can turn iron ore into iron at about the same temperature as a fresh cup of coffee. The company, which commissioned its first pilot facility in March, claims it can slash emissions from ironmaking by 80 percent and at half the cost of existing traditional processes.

Another startup, Limelight Steel, is designing a furnace that uses laser technology to produce industrial heat and make molten iron. The Oakland, California–based company says its approach could reduce energy consumption from steelmaking by nearly half and curb emissions by over 80 percent. Limelight and Electra are each set to receive $2.9 million for their projects.

Argonne National Laboratory in Lemont, Illinois is slated for a $3 million award to further develop its zero-emission ironmaking process, which involves using hydrogen plasma in a "microwave-powered rotary kiln" reactor. A team from the University of Minnesota in Minneapolis will get $2.8 million to pursue similar methods.

If these and other emerging technologies can successfully scale, that would enable a reduction of global CO_2 emissions by over 2.9 metric gigatons annually, or 5.5 percent of total global emissions, according to ARPA-E.

The next generations of cleaner steelmaking

Aside from the size of their funding, there are two key differences between ARPA-E awards and the larger Department of Energy initiative.

First, the technologies included in ARPA-E's announcement are in much earlier phases of development, meaning teams are running laboratory tests or pilot projects, not approaching industrial-scale operations. Second, these novel processes don't involve using copious amounts of hydrogen — while many of the more advanced "green steel" initiatives do.

Rather than using hydrogen to produce direct reduced iron, focus is on funding emerging processing pathways with novel themes, including electrochemistry, hydrogen plasma, and advanced thermal approaches. The program is also unique because the projects must also try to "make primary iron with equal or lower cost than the incumbent processes".

It may take decades before the cutting-edge pathways can reach a scale that meaningfully transforms how the world makes iron and steel.

Iron-focused startup Element Zero is one of its 2024 Pioneers. The Australian company uses an electrolysis process that can convert low-quality iron ore into high-quality iron using intermittent renewable power sources, like wind and solar. Boston Metal received the same recognition in 2020. The U.S. company has since raised at least $262 million to develop its "molten oxide electrolysis" process for making iron.

Such technologies could play in helping the global steel industry achieve net-zero emissions by 2050.

Electricity-based methods may represent just 1 percent of total steel production by mid-century, as it will take long to scale. This means that, for now, hydrogen-based ironmaking represents one of the clearest paths to reduce the industry's emissions. Other options include installing systems to capture CO_2 emissions directly from blast furnaces, then storing or repurposing the carbon for industrial uses. Companies can also increase the use of recycled scrap metal to reduce the need for primary iron — the industry's biggest carbon culprit.

All these approaches face key challenges. Carbon capture, for instance, doesn't eliminate the other health-harming pollutants that spew from furnaces or reduce the use of coal. And there's a limit on how much scrap metal in the world can be melted down and remade into steel. Recycled steel, which can contain impurities, also isn't viable for certain uses, such as car parts.

As for hydrogen, the biggest hurdle steelmakers face is getting their hands on low-carbon supplies. The vast majority of hydrogen today is produced using fossil fuels through emissions-intensive processes. Green hydrogen — made using renewable electricity and water — remains expensive and in extremely limited supply. Making more of it will require massive new investments in solar, wind, and other renewable sources, as well as producing more electrolyzers to split water molecules into hydrogen and oxygen.

Source: Canary Media Newsletter, 18 April 2024

Steel & Aluminium: 20% of Emissions Reductions Target Must Come from Recycling

Recycling is needed to achieve 20% of the emissions reductions targets for the steel and aluminium sectors. It's an integral part of the 1.5°C climate-aligned decarbonisation pathways in many metal sectors.

For aluminium products, the share that comes from post-consumer scrap needs to increase from 21% in 2020 to 46% by 2050. Recycling is already a reality, but reporting and transparency of recycling shares is poor and needs to be greatly improved. Only when customers see the numbers can they demand, pay for and thus incentivise better recycling by the producers.

Recycling: 20% of emissions reductions target for Steel and Aluminium

Improved recycling and resource efficiency are an integral part of the 1.5°C climate-aligned decarbonisation pathways in many metal sectors. Material efficiency and recirculation contribute to almost 20 percent of the cumulative greenhouse gas (GHG) emissions reductions necessary between now and 2050 from the steel and aluminium sectors. Consumer-facing companies like Apple, BMW and beverage can manufacturers are setting ambitious targets related to recycled content in their products.

In the metals sector, particularly for steel and aluminium, the use of recycled material (also called scrap) has been a part of the production process for some time. There has been a gradual build-up of scrap-based electric arc furnaces (EAFs) for steel manufacturing and new recycling facilities for aluminium product manufacturing.

While increased scrap availability and economics might have played a role in getting the facilities built, these companies are starting to capitalise on the positive environmental benefits of products with recycled content. Branded products from steel and aluminium offer a case in point. Despite this increasing scrap usage, there is a lack of transparency around what kind of scrap is used in different products.

This is important because from an environmental perspective, the use of scrap generated from manufacturing processes provides less environmental benefits compared to the use of end-of-life scrap.

The role of scrap in the Aluminium industry

Scrap is generated at multiple steps in the lifecycle of an aluminium product — a soda can, for example. Based on where in a product's lifecycle the scrap is generated, it can be **classified as pre-consumer scrap, post-consumer scrap, or internal scrap**:

- **Pre-consumer scrap** includes the waste aluminium materials that come from manufacturing final aluminium products such as beverage cans from semi-fabricated aluminium products (also called semis) such as rolled can sheet.
- On the other hand, **post-consumer scrap (or end-of-life scrap)** is the recycled aluminium from various aluminium products that have reached the end of their useful life in the economy.
- The scrap that is formed when molten aluminium is cast into ingots or when aluminium slabs are converted to rolled sheet doesn't fall into the pre- and post-consumer dichotomy. This waste material, usually referred to as **internal scrap** is mostly fed back into the remelting processes onsite.

From a climate mitigation perspective, the collection, recycling, and reuse of post-consumer scrap should be encouraged as much as possible. It provides emissions benefits by replacing the emissions-intensive production for primary aluminium (16 tons of CO_2e per ton of primary aluminium as global average).

On the other hand, pre-consumer scrap use does not impact the volume of emissions-intensive primary aluminium used (see Exhibit 1). Instead, generation of pre-consumer scrap is primarily an inefficiency (i.e., it consumes additional energy to be reprocessed) in the system to produce the desired output (e.g., beverage cans). As a result, emissions reductions at the global level will be achieved by reducing the generation of pre-consumer as opposed to increasing its recycling rates (which are already high at around 96 percent).

Aluminium cans in Europe

Despite its environmental benefits, not all post-consumer scrap is looped back into aluminium production. Consider the case of aluminium beverage cans in Europe.

In 2019, among Europe's beverage cans that have reached their end-of-life, roughly 45 percent were used again in the production of new cans. Around 27 percent were recycled to other uses. Almost 28 percent of the used beverage cans either ended up in a landfill or were incinerated.

Globally, around 26 percent of the total post-consumer scrap generated from all aluminium products (roughly 7 million tons) ends up in a landfill or incineration facility currently. This number is expected to be around 18 million tons by 2050.

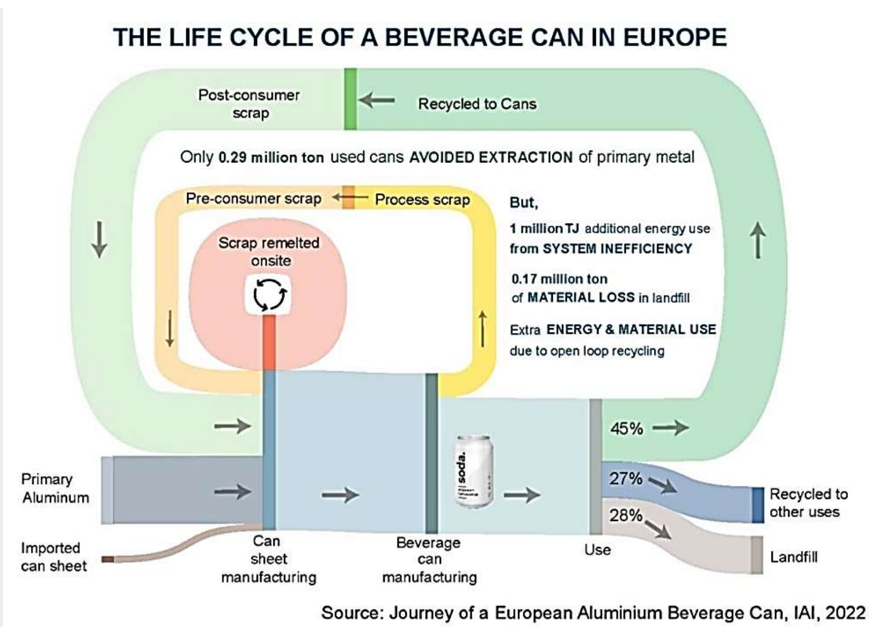


Exhibit 1

For the aluminium industry to stay within 1.5°C aligned greenhouse gas (GHG) trajectory, the share of pre-consumer scrap to the total aluminium production needs to decrease from 13 percent in 2020 to around 9 percent by 2050. This can be achieved through improved production efficiency of aluminium manufacturing processes so that there is less pre-consumer scrap in the first place.

The pre-consumer scrap that is inevitably generated needs to be completely recovered and used back in aluminium production. Simultaneously, the share of post-consumer scrap needs to increase from 21 percent in 2020 to 46 percent in 2050 even as total aluminium production is expected to rise considerably by 2050. In addition to this, there will be about 30 million metric tons of internal aluminium scrap remelted each year until 2050.

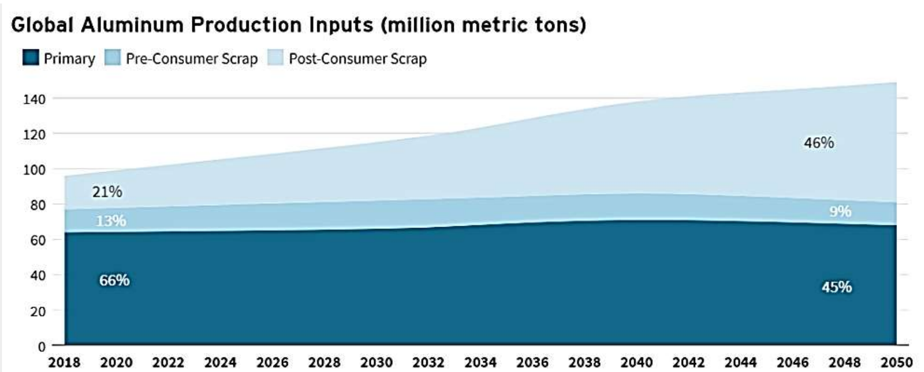


Exhibit 2

Better reporting and transparency needed

To incentivise the use of more post-consumer scrap, it is important to know what percentage of an aluminium product's inputs are from this end-of-life scrap. Currently, most aluminium producers just report the total recycled content in their aluminium products, making it impossible to know whether or how much post-consumer scrap was used. To overcome this challenge, buyers of aluminium products are increasingly requesting more information on the share of post-consumer scrap in their purchased products.

The International Aluminium Institute has also released guidelines on aluminium scrap transparency that highlight the need for aluminium producers to report on the percentage of post-consumer scrap share in their products. Once reporting of post-consumer scrap share becomes common practice, it will be easy for aluminium buyers to make informed purchasing decisions based on that reported data. It can lead to increased demand for products with high post-consumer scrap content. This will provide the right incentives for aluminium producers to increase the use of post-consumer scrap within the aluminium sector. This can lead to broad sectoral decarbonisation. There are already some signs of this increased demand in the market.

Recent projects exploring effective recovery techniques and use of materials from end-of-life products are another sign of growing interest in post-consumer scrap.

Steel Sector: Better disclosures = more recycling

Just like in aluminium, there is a need to differentiate the use of pre- and post-consumer scrap in the steel sector as well. Even though more than 70 percent of the steel generated in the U.S. and 50 percent in the EU is from scrap, at a global level the scrap share of the total steel scrap generated is much lower. Separate disclosure of the different types of scrap inputs into products can eventually lead to improved collection and recycling rates of post-consumer scrap resulting in broad sectoral decarbonisation.

Source: energypost.eu; June 8, 2023

Understanding Full Value-chain Carbon Intensity in Hydrogen Production

Labelling hydrogen by colour is a popular way of differentiating its production process. The hydrogen 'rainbow' includes brown hydrogen, made using coal, and grey hydrogen, produced from natural gas. Blue hydrogen is grey or brown hydrogen produced using carbon capture and storage (CCS) to cut carbon dioxide emissions, while green hydrogen, produced from water through electrolysis fuelled by renewable power, offers the potential for near zero emissions.

As momentum builds around low-carbon hydrogen, the industry is having to look past colour labels. The future of low-carbon hydrogen hinges on governments putting in place regulations, subsidies and other incentives that are increasingly tied to the carbon intensity – rather than the colour – of the hydrogen produced.

Calculating hydrogen's carbon intensity is complex. For green (electrolytic) hydrogen, emissions can range from almost zero to levels beyond those of brown hydrogen. Green hydrogen is, in principle, made using 100% renewable energy. In practice, however, what is described as 'green' can also be produced using power from a grid that relies heavily on fossil fuels.

What's more, hydrogen's carbon intensity isn't limited to its production. With over 40% of announced project capacity targeting exports, it is important to understand its full life-cycle emissions, including processing and transportation. The European Union (EU) is already using full-cycle emissions to assess eligibility for its incentives and regulatory compliance, and other hydrogen markets are likely to follow suit. But different importers may have very different incentives and standards, leading to a two-tiered low-carbon hydrogen market.

The industry, therefore, requires ever more accurate project-level certification of carbon intensity as the market for low-carbon hydrogen evolves. With the sector requiring massive levels of capital investment and subsidies to support growth in supply and demand, it is time to go beyond the rainbow and establish hydrogen's true colours.

Deciphering the carbon intensity of the hydrogen rainbow

The global hydrogen market today is around 90 million tonnes per annum (Mtpa), almost all of it carbon-intensive grey or brown hydrogen. The volume and make up of supply are about to change dramatically. Base-case forecast projects production to triple to 270 Mtpa by 2050, with low-carbon green and blue hydrogen accounting for 200 Mtpa of this. In a world on course for net zero emissions by 2050, that growth would have to be even faster: our Net Zero 2050 scenario requires 500 Mtpa of low-carbon hydrogen by 2050.

The push for better measurement of efforts to cut emissions globally is shining a spotlight on the precise carbon intensity of different sources of hydrogen supply. Because of its potential to deliver almost carbon-free hydrogen, green hydrogen is generating the most industry interest, but it is important to look more closely at the full value chains of blue and green hydrogen.

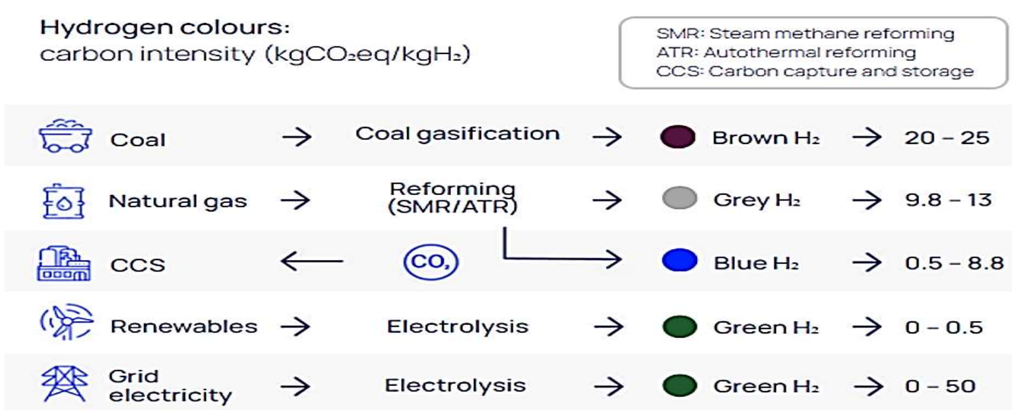


Figure 1: Carbon intensity of the hydrogen rainbow

Assumptions: Values are for 2023. The blue low end (0.5 kgCO_2e/kgH_2) represents the average blue asset in Norway with 95% CO_2 capture. The high end represents the average blue asset in North Dakota (USA) with 60% CO_2 capture. Blue includes methane fugitive emissions, which vary by asset. For green, the low end assumes an electrolyser powered 100% by renewables and the high end assumes a grid-connected electrolyser in India

In the case of blue hydrogen, emissions can come from upstream natural gas production, transportation, reforming and energy use. The bulk of the carbon dioxide emissions are produced in the reformer, which splits hydrogen out of hydrocarbons. In principle, almost all these emissions can be captured and stored. However, capturing more than 60% of the carbon dioxide from hydrogen production is costly and has yet to be proven at scale.

New autothermal reforming (ATR) technology can achieve 95% carbon dioxide capture at a lower cost. Unfortunately, the total emissions of ATR with 95% carbon dioxide capture could still be higher than for a steam methane reformer (SMR) with 95% capture, as it requires an energy-intensive air separation unit. Developers will have to evaluate the cost to emissions reduction potential of all emissions abatement options. Some developers will use renewable power to reduce the emissions from the electricity used in reforming and capture, but this must also be balanced against potentially higher costs.

How green is green hydrogen?

For green hydrogen, nearly all emissions are attributable to the electricity used by the electrolyser. In principle, hydrogen should be called green only if it uses 100% renewable power. However, because of the variability of renewables such as wind and solar, many electrolytic hydrogen projects around the world are planning grid connection to maximise the utilisation of electrolysers and lower hydrogen unit costs. At least 30% of the 565 GWe of announced or operational green hydrogen projects plan to be grid connected.

While projects able to secure all of their power supply from certifiable renewable sources will have negligible production emissions, this will not be the case for projects that require access to grid power. Emissions from electrolytic hydrogen produced from 100% grid power today could be as high as 50 $kgCO_2e/kgH_2$ – worse than brown hydrogen – if the electrolyser is connected to a grid dominated by fossil fuels. As grids decarbonise, carbon intensity levels will fall accordingly, reinforcing the importance of regular certification of emissions from hydrogen production.

Electrolyser demand for clean power could also inadvertently lead to additional fossil-based generation to meet other demand on the grid, increasing overall emissions, especially in markets that lack rules on additionality (adding new renewable capacity alongside hydrogen production) and temporal correlation (matching renewable generation to hydrogen production).

Could a two-tier low-carbon hydrogen market emerge?

Policymakers in many parts of the world are keen to avoid a two-tier low-carbon hydrogen market and have put in place a variety of different rules on additionality, temporal correlation and the geographical location of renewables. Regulation varies significantly by country, however, and this variance risks the emergence of a two-tier market for electrolytic hydrogen.

The EU has led the way, establishing the first set of rules for electricity used to produce electrolytic hydrogen, which allow grid-connected electrolysers only under very specific conditions. The US has similarly announced stringent rules for the use of grid power and renewables in electrolysers to govern eligibility for tax credits based on carbon intensity.

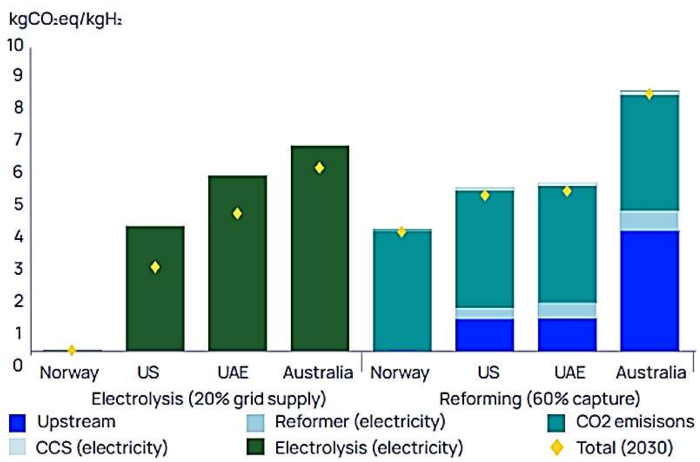


Figure 2: Blue and green hydrogen emissions, 2023

Assumptions:

1) Blue hydrogen: Assuming a retrofitted SMR unit with 60% capture. Reforming emissions will vary by technology (SMR vs ATR) and whether the asset is retrofit or newbuild. For upstream, we assume the average emissions for all gas-producing assets in each country, including methane fugitive emissions. Upstream emissions and methane fugitive emissions vary by asset. Electricity for reforming and CCS is sourced from the grid, assuming an average grid intensity in each country. The grid intensity will vary by region in larger markets such as Australia and the US and will decrease over time.

2) Green hydrogen: assuming the electrolyser is powered by on–site renewables and 20% grid electricity, taking the average grid intensity. Electricity consumption assumed is 55kWh/kgH_2 for the electrolyser system. The electricity consumption will vary by electrolyser technology and can range from 40 kWh/kgH_2 to 60 kWh/kgH_2 for an electrolyser system. Electrolyser efficiency is expected to improve over time.

Source: Wood Mackenzie Lens Hydrogen and Ammonia Service

Other major markets, such as Japan, South Korea, Canada and India, currently have less stringent rules on grid-connected electrolysers, but do require developers to have a green power purchase agreement (PPA) in place. However, the availability and deliverability of a truly green PPA remains challenging, even in the most willing markets.

In some developing economies, such as India, the rapid roll-out of renewables is struggling to keep pace with power demand growth, limiting green PPA availability for electrolytic hydrogen. In addition, markets with grid congestion face hurdles in delivering green power, despite developers having signed a PPA. In these markets, permitting some grid supply can be seen as the pragmatic approach to kickstarting the hydrogen economy.

China will inevitably play a role

Inevitably, China will also impact the outlook for electrolytic hydrogen production. The country already has 0.3 Mtpa of grid-connected electrolysers in operation, largely based on Chinese alkaline technology. Chinese alkaline electrolysers have lower limits of 20% to 50% to operate safely, meaning they require some continual electrical load. PEM technology, more commercialised by western OEMs, can operate at lower limits closer to 0%, allowing developers to mirror hydrogen production to renewable generation. But this comes at a higher cost. China's role will be critical, with the country accounting for 57% of the current 45 GW of global electrolyser manufacturing capacity and an additional 15 GW planned in 2024.

With China's highly competitive electrolyser OEMs seeking to dominate the global market in a similar way to its renewables and battery manufacturers, China's low-cost and efficient alkaline electrolysers could proliferate. This could have consequences for both for technology choices and emissions. A significant expansion of grid-powered hydrogen projects operating on China's alkaline technology across price-sensitive emerging economies could result in a two-tiered hydrogen market.

Emissions from hydrogen transport and processing

If hydrogen is produced close to the final consumer, then focusing on production emissions does a fair job of accounting for most of the emissions in the hydrogen value chain. But any future trade in hydrogen between Australia and Northeast Asia or the Middle East and Europe means significant shipping distances. And once transport is required, production emissions only tell part of the story, as unaccounted, often substantial, emissions occur through the rest of the value chain.

Many countries have already established carbon-intensity thresholds for low-carbon hydrogen. But most, including future importers such as Japan and South Korea, only count production or well-to-gate emissions. For future developers and buyers of blue and green hydrogen, it is critical to consider emissions abatement strategies across each step of the value chain.

At present, only the EU counts full-life-cycle emissions from converting, compressing, transporting and reconverting hydrogen. This creates additional challenges for hydrogen project developers seeking to export hydrogen to the bloc. Developers must manage emissions from ammonia synthesis and transportation to ensure they do not breach the EU's threshold, while also being subject to Carbon Border Adjustment Mechanism (CBAM) rules.

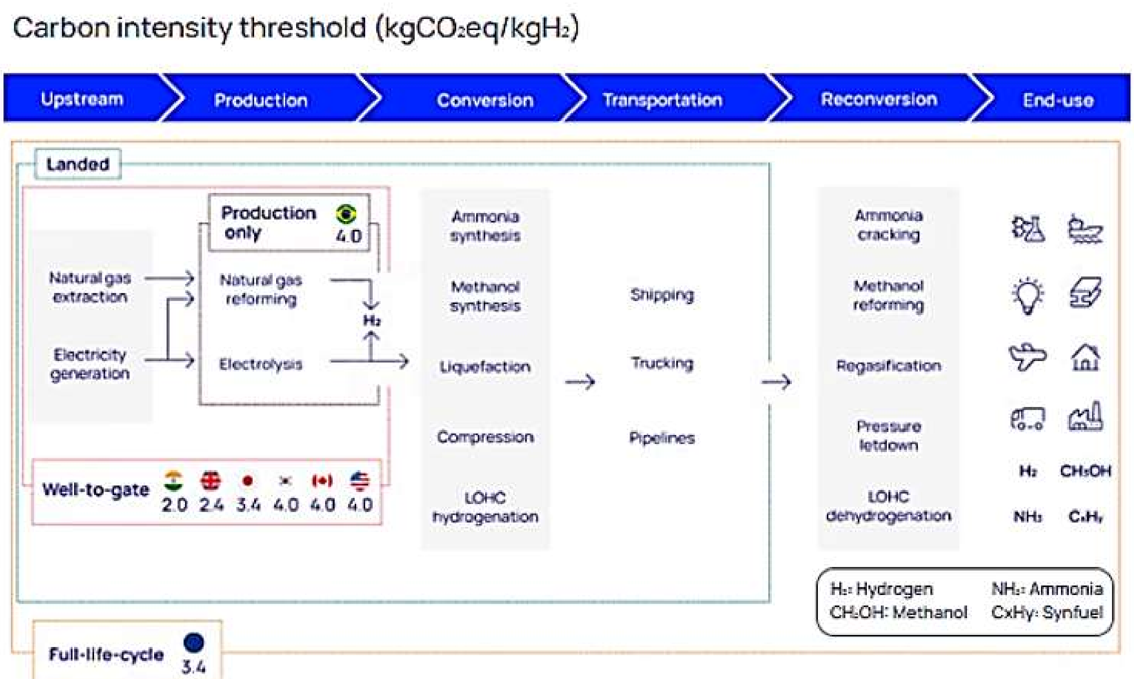


Figure 3: Hydrogen carbon intensity thresholds and emissions scope

Note: Hydrogen and derivatives (ammonia, methanol and synthetic fuels) can be used in end-use sectors. Using a hydrogen derivative directly can have both cost and emissions savings.
Source: Wood Mackenzie

Because of its low density, transporting hydrogen requires compression or liquefaction – both energy- and emissions-intensive processes – or conversion into derivatives. For long distances by sea, only carriers such as ammonia and methanol offer the technological readiness to transport hydrogen at scale this decade.

Ammonia emissions

Most developers of hydrogen export projects aim to use ammonia as the carrier. Hydrogen would be converted into ammonia, shipped to a port close to the final consumer, and then cracked back into hydrogen. Although ammonia is the most promising carrier from a cost and a technology readiness perspective, its total value-chain emissions (ammonia synthesis, transportation and cracking) are significant, and could add 1- 4.5 $kgCO_{2e}/kgH_2$ to the CI of the final product.

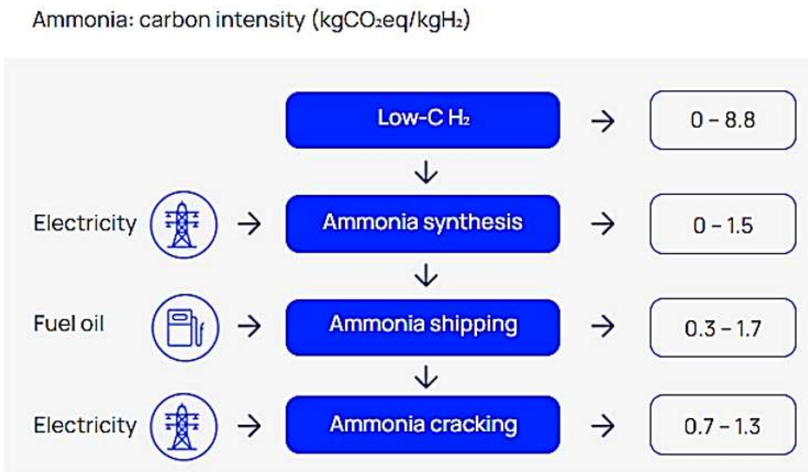


Figure 4: Carbon intensity of ammonia

Ammonia is synthesised via the energy-intensive Haber-Bosch process and transported in vessels that today run almost exclusively on bunker fuel oil. Ammonia shipping emissions will vary depending on the carrier size (25,000–65,000 m3) and distance travelled.

Some sectors, such as power, can use ammonia directly, but others will need to crack ammonia back into hydrogen. Ammonia cracking requires an energy source and, typically, a stream of uncracked ammonia is combusted to provide the necessary heat for the reaction. Alternatives exist, but either way, some energy will be needed in the process, potentially generating additional emissions.

Emissions from transport and processing can make a critical difference to whether hydrogen sources can meet regulatory requirements. Green hydrogen with 20% grid supply and blue hydrogen with 60% capture do not make the cut in the EU. But even US blue hydrogen with 95% capture converted to ammonia and shipped to the EU would have a landed emissions intensity at the very limit of the European carbon intensity threshold. Cracking the ammonia back into hydrogen in the Netherlands, for example, would tip hydrogen over the edge.

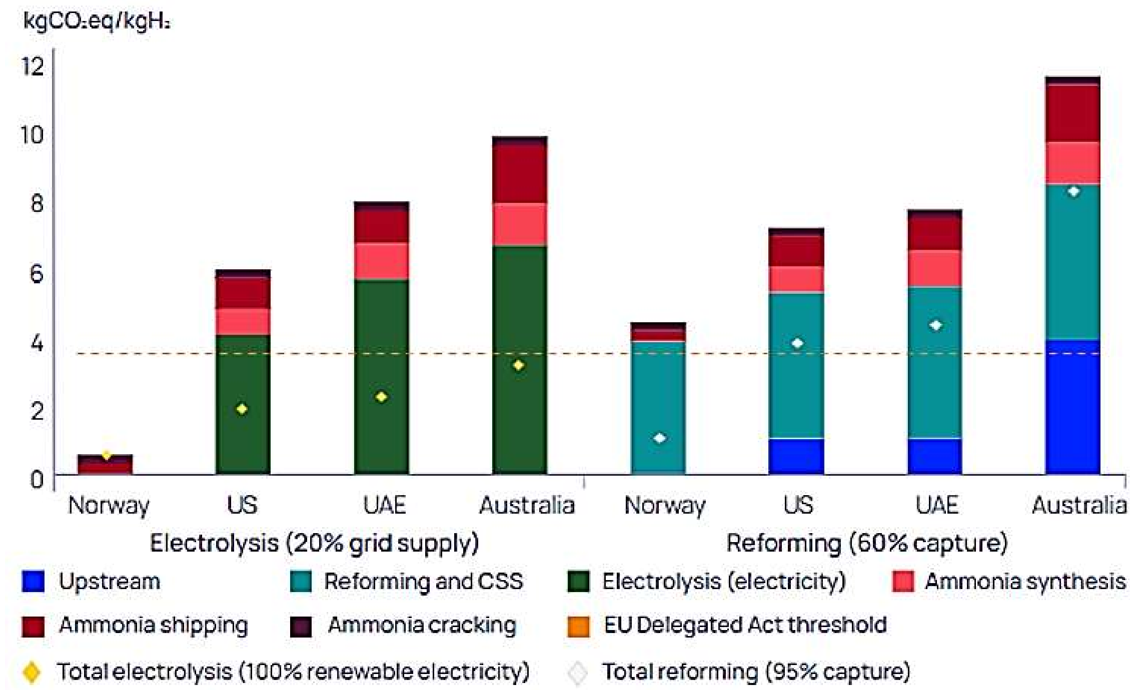


Figure 5: Emissions from ammonia imported into the Netherlands, 2023

Assumptions:

1) Blue hydrogen: assuming a retrofitted SMR unit with 60% capture. Reforming emissions will vary by technology (SMR vs ATR) and whether the asset is retrofit of newbuild. For upstream, we assume the average emissions for all gas-producing assets in each country, including methane fugitive emissions. Electricity for reforming and CCS is sourced from the grid, assuming an average grid intensity in each country.

2) Green hydrogen: assuming the electrolyser is powered by on–site renewables and 20% grid electricity, taking the average grid intensity. Electricity consumption assumed is 55 kWh/kgH_2 for the electrolyser system.

3) Ammonia: assuming power is sourced from the grid, taking the average grid intensity in each market.

4) Ammonia shipping: assuming ammonia is transported in a 25,000 m3 vessel running on bunker fuel oil.

5) Ammonia cracking: assuming power is sourced from the Netherlands grid.

Source: Wood Mackenzie Lens Hydrogen and Ammonia Service

Green hydrogen made using 100% renewable power and converted into green ammonia would have an emissions intensity below the EU threshold, even if shipped from Australia. But if imported hydrogen is produced using even a small amount of grid power, it could struggle to stay below EU threshold limits.

Exporters, therefore, will need to focus on technologies for reducing the emissions from ammonia, transport and processing. Ammonia production and cracking emissions can be reduced by using renewable electricity at the facilities, while shipping emissions can be reduced by operating vessels on a low-carbon fuel, including ammonia itself.

Incentives linked to an array of emissions policies

Subsidies will be vital in order to support low-carbon hydrogen supply and demand for years to come and will make or break project economics. With carbon-intensity thresholds and associated rules forming the basis of incentive frameworks in most markets, a key issue for the industry now is how far these rules will incorporate full-cycle emissions including transport and processing.

Only the EU defines carbon intensity as including emissions across the full life cycle. In the US, guidance issued by the Treasury in December 2023 sets increasingly demanding requirements for projects to be eligible for the maximum US\$3/kgH_2 production tax credit available under the Inflation Reduction Act. However, under the current well-to-gate scope, US green hydrogen project developers need to source renewable electricity only for their production, not for any conversion to ammonia or another derivative.

In Asia, Japan and South Korea have signalled they will gradually expand the emissions scope to 'landed' to include ammonia conversion and transportation emissions, though neither has yet implemented this.

It looks inevitable that project developers will require detailed certification across the value chain to sell their delivered product into an increasing number of markets. This won't come cheap. Several bodies have emerged that are willing to certify entire hydrogen value chains for a hefty fee. And without global agreement on carbon-intensity measurements, emissions scopes, methodology and rules, developers may require multiple certificates to access different markets.

Conclusions

Labelling by colour has played its part in helping to define the various hydrogen production processes but doesn't tell the whole story. Hydrogen carbon intensity varies by project and location – not simply by colour – and may also change over time.Efforts to minimise a project's carbon intensity throughout the value chain will impact both its costs and eligibility for subsidies. Developers will weigh up the benefits of building out the least carbon intense molecule that can capture premium prices against focusing solely on production and targeting lower-value markets.

Buyers, too, must also go beyond production and understand the emissions of the entire hydrogen supply chain. Each project, location and supply chain has unique risks, all of which must be quantified. As demand for low-carbon hydrogen expands, it is only by understanding both projects and value chains and how these will change over time that buyers can really be sure of what they are purchasing.

Source: Wood Mackenzie, Horizons Feb. 14, 2024

Green H_2-DRI Steelmaking: Challenges

Iron and steel manufacturing is one of the most energy and carbon-intensive industries worldwide. The global steel industry emitted over 3.6 billion tons of carbon dioxide (CO_2) in 2019. This accounted for over 7% of global greenhouse gas (GHG) emissions and over 11% of global CO_2 emissions. Decarbonization in the steel industry will be pivotal in reaching global climate targets. A transition from conventional, coal-based steelmaking to utilizing green hydrogen in direct reduced iron production (H_2-DRI) represents a great opportunity for producing low-carbon steel. Several commercial-scale projects in Europe and Asia have begun or announced to use H_2-DRI as an input for steelmaking. Still, there are some technological, economic, and other barriers to cost-effectively scaling up this technology to a level needed to meet a substantial portion of global steel demand as well as climate goals.

There are several different challenges

- Cost, Economic Viability and Market Dynamics of Green H_2-DRI
- Metallurgical Complexities and Technical Challenges in H_2-DRI Steelmaking
- Clean Energy Requirement and Infrastructure for H_2-DRI Processes
- Regulatory Framework and Standardization for H_2-DRI
- Stakeholder Engagement and Skill Development in H_2-DRI Transition

One of the primary hurdles is the technology's cost and economic viability. Major economic barriers are the high cost of hydrogen production and the relative price of renewable electricity compared to fossil fuels in most regions of the world. Solutions include leveraging advancements in production economies, achieving economies of scale, and exploring financial support mechanisms and policies to make H_2-DRI technology more economically attractive.

From a metallurgical perspective, H_2-DRI introduces complexities in steelmaking processes, such as chemical composition and embrittlement variances. Without an inherent carbon source, there are challenges to ensuring the H_2-DRI will behave chemically as is necessary for high-quality steel production with carbon addition, though the carbon footprint is lower. It will be necessary to carefully control the conditions of an H_2-DRI plant to ensure a consistent and high-quality final steel product, particularly with the current global shortage in the supply chain of high-grade iron ore. These issues may necessitate equipment modifications, even in plants that already utilize an electric arc furnace (EAF) in their steelmaking. With these modifications, rigorous quality control measures and the implementation of advanced control systems are needed to ensure product quality and process efficiency.

Green hydrogen production is highly energy-intensive, and hydrogen is not as strong a reducing agent as its fossil fuel predecessors. As a result, the energy demand from switching to green H_2-DRI steelmaking will require large-scale renewable electricity production. However, the intermittent nature of renewables and their need to be sited close to resource-abundant areas pose an infrastructure challenge that varies by region and can drive up the costs of H_2-DRI steelmaking. Proper renewable energy, green hydrogen generation, and distribution planning are needed to address this challenge. This can vary for each country/region.

There is also an absence of clear global regulations and standards for hydrogen production, handling, and storage, which require policy intervention. Additionally, there will need to be training to create a shift in the workforce to accommodate this new technology.

Solution may include implementing carbon pricing mechanisms, providing financial incentives for adopting green H_2-DRI technology and for building more renewable electricity and green H_2 infrastructure, and establishing clear regulations and standards for green hydrogen production and steelmaking processes to ensure quality and safety.

The social perspective, particularly resistance to change among stakeholders and policymakers, and a general lack of awareness about H_2-DRI technology are also identified as challenges. There is a need for more education programs and public-private partnerships to build support for green H_2-DRI technology and facilitate its adoption.

Transitioning to green H_2-DRI steelmaking pathways has major potential for decarbonizing the steel industry, contributing to over 7% of annual global GHG emissions. Though scaling up the technology comes with challenges, there are opportunities to lessen these challenges with technological innovations, regulatory support, and stakeholder collaboration.

Geothermal is the Hottest Thing in Clean Energy

Earth's interior contains an inexhaustible supply of heat, its many layers continuously warmed by the furnace-like core of our planet. For millennia, humans have tapped into this abundance for cooking food and keeping warm. More recently, over the last century, countries have harnessed geothermal energy to produce electricity from volcanoes in Iceland and Indonesia, underground heat pockets in Kenya, and bubbling hot springs in Italy and the United States.

But these efforts have only scratched the surface of geothermal's potential. As the urgency of addressing the climate crisis makes it necessary to find sources of always-on, emissions-free energy, the energy source is experiencing a surge of investment and policy support for new technologies that aim to access more heat in many more places.

Solar, wind power and battery-storage projects are already cleaning up the electrical grid. But these technologies might not be enough on their own to fully buck reliance on fossil-fuel-burning power plants. The grid also needs carbon-free electricity available on demand to guarantee it can provide the sort of 24/7 power needed by cities, data centers and industrial facilities like aluminium smelters or steel mills.

Recent advances in geothermal technologies, demonstrated by a handful of projects, suggest that harnessing the earth's heat could be among the most promising ways to solve this clean-energy conundrum. But that can only happen if it can overcome the sizable challenges that stand in its way.

Where geothermal stands today?

Geothermal resources are available virtually everywhere. Getting to them is a different story. Today's geothermal plants primarily pull hot water or steam from relatively easy-to-reach places like hot springs or geysers to drive turbines and generate electricity. That significantly limits the places where geothermal power plants can go.

In the United States, just 3,700 megawatts (3.7 gigawatts) of geothermal power plants are operating across seven states, amounting to only about 0.4 percent of total U.S. electricity generation in 2023.

In recent years, both the U.S. government and private investors have started spending hundreds of millions of dollars to develop "next-generation" technologies that make it easier and cheaper to access the earth's heat nationwide. If these systems reach commercial scale, they could expand the nation's geothermal capacity by more than twentyfold, adding at least 90 GW of firm and flexible power to America's grid by 2050. That's equal to nearly 10 percent of current U.S. electricity capacity.

Next-generation technologies include several different approaches, all of which rely to some extent on the expertise and deep pockets of another subterranean energy industry: oil and gas. One category in particular, "enhanced geothermal systems," uses the same horizontal drilling and fracking techniques as the shale gas industry.

Dozens of startups are now crowding into the space. So far, only a few have successfully deployed full-scale, real-world projects in North America. Many steps still need to happen before the sector can grow beyond its buzzy beginnings, including reforming governmental permitting, finding corporate buyers for clean energy and mitigating the potential for environmental impacts.

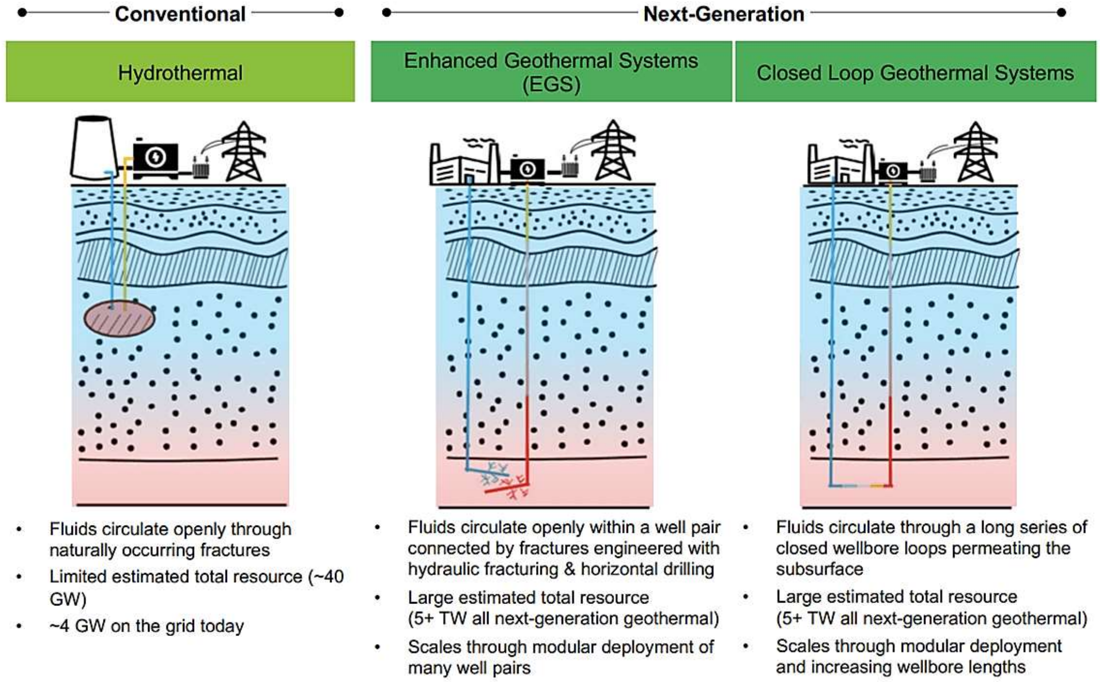
Geothermal developers need the money so they can drill lots of holes — to both refine their technologies and drive down construction costs.

Next-generation geothermal could follow a trajectory similar to that of solar power or batteries — two clean-energy technologies that have risen to the top of the energy system as they've tumbled down the cost curve.

Getting geothermal to stand on its own

To make the leap from intriguing new technology to a commercially viable energy player, next-generation geothermal will have to lean much less on public funding and become self-sufficient.

The enhanced geothermal system uses horizontal drilling techniques and fiber-optic sensing tools to create fractures in hard, impermeable rocks found beneath the surface. Technicians then pump the fractures full of water and working fluids. The hot rocks heat those liquids, eventually producing steam that drives electric turbines.



An illustration shows how conventional (left) systems compare to two types of next-generation systems.

Enhanced systems involve drilling dozens or hundreds of wells to create more artificial reservoirs underground. But another type of next-generation technology, called "advanced geothermal," typically involves drilling just one or several very deep boreholes. A sealed-off, closed-loop system circulates fluids from top to bottom, collecting heat from the hot rocks below and bringing it to the surface — without injecting fluids directly into the ground.

The third, and least-developed, type of next-generation geothermal is called "superhot rock energy." The idea is to inject water to depths where rock temperatures exceed 750 degrees Fahrenheit (400 degrees Celsius) to power generators — potentially as deep as 8 miles down. Existing drilling equipment and well casings aren't designed to withstand such extreme temperatures or pressure.

Capital, customers and permitting: The challenges at the core of geothermal

Yet for all of its momentum, next-generation geothermal isn't guaranteed to achieve commercial scale. The industry could still struggle to advance beyond today's tiny number of bespoke and expensive early-stage projects.

"There are obstacles standing in the way of the massive growth and development of geothermal energy,". The single largest barrier to scaling up next-generation geothermal is convincing banks and other large investors to pony up for these risky, unproven systems. Right now, startups must cobble together investments from a small pool of equity and venture funding, which slows the pace of progress. It is estimated that companies looking to establish new next-generation geothermal projects in places with no previous development will need to raise around $450 million for a system that can yield 30 MW, or what the agency described as "a reasonable amount of power."

For developers, a crucial way to drive that much-needed investment is to guarantee their projects will have customers — particularly ones willing to pay an initially higher price for electricity. To that end, tech giants Google and Microsoft and steelmaker Nucor recently announced a plan to aggregate their gargantuan energy demand to buy electricity from early-stage "clean, firm" projects, including next-generation geothermal, advanced nuclear, clean hydrogen and long-duration energy storage.

Another solution to geothermal's money problem is the oil and gas industry. Fossil-fuel companies may use money from their business to invest in companies looking to harness clean heat from the earth.

Arrangement is needed to help technologies achieve commercial scale and viability. Oil and gas companies can not only provide money — they also bring scientific data and drilling know-how that geothermal startups need to develop their own projects.

Even as we may strive to move at breakneck speeds, we'll need to proceed cautiously enough to limit the potential for environmental impacts, including induced earthquakes that rattle buildings and possible groundwater contamination from chemical compounds used in wells.

There will always be some risks that are associated with novel approaches to energy production, especially in such an abundant scale.

The payoff of overcoming these varied challenges — and properly dealing with the risks — is potentially huge for the efforts to reshape the electricity grid into a system that can power homes, factories and data centers without wrecking the climate.

Canary Media, 25 March 2024

Funding of a New Venture

What Is Series A, B, and C Funding?

Series A, B, and C are funding rounds that generally follow "seed funding" and "angel investing," providing outside investors the opportunity to invest cash in a growing company in exchange for equity or partial ownership. Series A, B, and C funding rounds are each separate fund-raising occurrences.

Many companies must complete several fundraising rounds before the initial public offering (IPO) stage. These fundraising rounds allow investors to invest money into a growing company in exchange for equity/ownership. The initial investment—also known as seed funding—is followed by various rounds, known as Series A, B, and C. A new valuation is done at the time of each funding round. Various factors, including market size, company potential, current revenues, and management determine valuations.

How Series A, B, and C Funding Rounds Work

Before exploring how a round of funding works, it's necessary to identify the different participants. First, there are the individuals hoping to gain funding for a new business. Businesses tend to advance through funding rounds; it's common for a company to begin with a seed round and continue with A, B, and C funding rounds.

On the other side are potential investors. While investors wish for businesses to succeed because they support entrepreneurship and believe in the aims and causes of those businesses, they also hope to gain something back from their investment.

For this reason, nearly all investments made during one or another stage of developmental funding is arranged such that the investor or investing company retains partial ownership of the company they are funding. If the company grows and earns a profit, the investor will be rewarded commensurate with the investment made.

What Is the Funding Valuation?

Before any round of funding begins, analysts undertake a valuation of the company in question. Valuations are derived from many factors, including management, growth expectation, projections, capital structure, market size, and risk.

Investors each have their own method for valuating a business, but many use some of the same factors:

- **Market size**: The size of the market the business is in, in dollar value
- **Market share**: How much of the market the business makes up, like 0.10% of the overall market
- **Revenue**: An estimate of how much the company made and will make. This is market size multiplied by market share.
- **Multiple**: Generally an estimate used by the investor to give them an idea of the business's value, like 10x or 12x the revenue
- **Return**: The increase in value, in percent form of how much is invested, based on estimates of growth in market share, market size, and revenue.

Pre-Seed Funding

The earliest stage of funding a new company comes so early in the process that it is not generally included in the funding rounds. Known as "pre-seed" funding, this stage typically refers to when a company's founders get their operations off the ground. The most common "pre-seed" funders are the founders, close friends, supporters, and family.

In terms of growth, this phase can be considered planting a seed (using funds to start the business).

Depending upon the nature of the company and the initial costs of developing the business idea, this funding stage can happen very quickly or take a long time. It's also likely that investors at this stage are not investing in exchange for equity in the company.

Seed Funding

Seed funding is the first official equity funding stage. It typically represents the first official money a business venture or enterprise raises. Some companies never extend beyond seed funding into Series A rounds or beyond.

This early financial support is akin to watering the seed planted during pre-seeding. Given enough revenue, a successful business strategy, and the perseverance and dedication of investors (enough water and care), the company will hopefully eventually grow into a fruitful "tree."

Seed funding helps a company finance its first steps, including market research and product development. With seed funding, a company has assistance in determining what its final products will be and who its target demographic is. Seed funding is generally used to employ a founding team to complete these tasks.

What Is Series A Funding?

The first round after the seed stage is Series A funding. The term gets its name from the preferred stock sold to investors at this stage. In this round, it's important to have a plan for developing a business model that will generate long-term profit.

Typically, Series A rounds raise between $2 million and $15 million, but this number varies due to many circumstances. From Jan. 1, 2023, to May 29, 2023, the Series A funding average was $22 million.1

In Series A funding, investors are not just looking for great ideas. Rather, they are looking for companies with great ideas and a strong strategy for turning that idea into a successful, money-making business. For this reason, it's common for firms going through Series A funding rounds to be valued (pre-money) at up to $50 million.1

The investors involved in the Series A round come from more traditional venture capital firms. Well-known venture capital firms that participate in Series A funding include Sequoia Capital, IDG Capital, Google Ventures, and Intel Capital.1

How Series A Funding Works

By this stage, it's also common for investors to take part in a somewhat more political process. It's common for a few venture capital firms to lead the pack. In fact, a single investor may serve as an "anchor." Once a company has secured a first investor, it may find it easier to attract additional investors as well. Angel investors also invest at this stage but tend to have much less influence in this funding round than in the seed funding stage.

It is increasingly common for companies to use equity crowdfunding to generate capital as part of a Series A funding round. Part of the reason for this is the reality that many companies, even those that have successfully generated seed funding, tend to fail to develop interest among investors as part of a Series A funding effort. Indeed, fewer than 10% of seed-funded companies will go on to raise Series A funds as well.1

What Is Series B Funding?

Series B rounds are about taking businesses to the next level, past the development stage. Investors help startups get there by expanding market reach. Companies that have gone through seed and Series A funding rounds have already developed substantial user bases and have proven to investors that they are prepared for success on a larger scale. Series B funding is used to grow the company so that it can meet these levels of demand.

Building a winning product and growing a team requires quality talent acquisition. Bulking up on business development, sales, advertising, tech, support, and employees is costly for a firm.

How Series B Funding Works

Companies undergoing a Series B funding round are well-established, and their valuations tend to reflect that; Series B companies had a median valuation of $35 million in 2022 and an average of $51 million.1

Series B appears similar to Series A regarding the processes and key players. Series B is often led by many of the same characters as the earlier round, including a key anchor investor that helps to draw in other investors. The difference with Series B is the addition of a new wave of other venture capital firms specializing in later-stage investing.

What Is Series C Funding?

Businesses that raise Series C funding are already quite successful. These companies look for additional funding to help them develop new products, expand into new markets, or even acquire other companies. In Series C rounds, investors inject capital into successful businesses in an effort to receive more than double that amount back. Series C funding focuses on scaling the company, growing as quickly and successfully as possible.

One possible way to scale a company could be to acquire another company. Imagine a startup focused on creating vegetarian alternatives to meat products. If this company reaches a Series C funding round, it has likely already shown unprecedented success in selling its products in the United States. The business has probably already reached targets coast to coast. Through confidence in market research and business planning, investors reasonably believe the company would do well in Europe.

Perhaps this vegetarian startup has a competitor with a large market share. The competitor also has a competitive advantage from which the startup could benefit. The culture appears to fit well, as investors and founders both believe the merger would be a synergistic partnership. In this case, Series C funding could be used to buy another company. As the operation gets less risky, more investors come to play.

How Series C Funding Works

In Series C, groups such as hedge funds, investment banks, private equity firms, and large secondary market groups accompany the type of investors mentioned above. The reason for this is that the company has already proven itself to have a successful business model; these new investors come to the table expecting to invest significant sums of money into companies that are already thriving as a means of helping to secure their own position as business leaders.

Most commonly, a company will end its external equity funding with Series C. For the most part, companies gaining up to hundreds of millions of dollars in funding through Series C rounds are prepared to continue developing globally.

The rare companies that continue to Series D or beyond (Stripe announced a Series I round for more than $6.5 billion with a valuation of $50 billion in May 2023) funding tend to do so either because they are searching for a final push before an IPO or they have not yet been able to achieve the goals they set out to accomplish during previous series.

Many of these companies utilize Series C funding to help boost valuations in anticipation of an IPO. At this point, companies enjoy higher valuations. Companies engaging in Series C funding should have established strong customer bases, revenue streams, and histories of growth.

How Many Series of Funding Before IPO?

The typical number of seed rounds a company goes through before completing an initial public offering (IPO) is three. However, no set number of rounds must be used to raise funds.

What Happens After Series C Funding?

Many companies will complete an initial public offering (IPO) after their Series C funding round. However, other companies may need to continue using fundraising rounds to expand or grow.

What Does Series D Funding Mean?

Series D funding is the fourth stage of fundraising that a business completes after the seed stage. The initial round of funding after the seed stage is Series A. The second is Series B, and then the third is Series C.

The Bottom Line

Understanding the distinction between these rounds of raising capital will help you decipher startup news and evaluate entrepreneurial prospects. The different funding rounds operate in essentially the same basic manner; investors offer cash in return for an equity stake in the business. Between the rounds, investors make slightly different demands on the startup.

Company profiles differ with each case study but generally possess different risk profiles and maturity levels at each funding stage. Nevertheless, seed and Series A, B, and C investors all help ideas come to fruition. Series funding enables investors to support entrepreneurs with the proper funds to carry out their dreams, perhaps cashing out together down the line in an IPO.

Source: Investopedia, December 22, 2023

Warmest February

We have experienced the warmest February on record, with the average global surface air temperature in Feb.'24 being 13.54°C, nearly 1°C above the 1991–2020 average. This is the ninth month in a row that was the warmest on record.

Why Robotics is Becoming Key to Metalworking

The other day we had the opportunity to watch a robot using an abrasive to thin a piece of metal to the appropriate size. It could even turn the object around to grind on another side.

This was at 3M's recently launched abrasive robotics lab. We were shown a variety of abrasives, each to be used for a different purpose – metal grinding, deburring (removing small imperfections from machined metal products), sanding (smoothing or polishing a surface).

The time it took the robot to finish the job, a human worker would have taken about twice or more the time. And even then, it may not have come out with the consistency the robot could achieve.

Raghavendra Koneri, application engineer for robotics & automation, at 3M India says robots have been used in manufacturing primarily for material handling, and occasionally for welding. But more intricate processes like metal removal or grinding were done manually. Now, abrasive makers like 3M and system integrators have come together to create robotic solutions for such processes too. "While a 3M abrasive used in a manual process performs at a certain level, when integrated with a robot and standardized processes like force or pressure, its performance can escalate by 1.5x to 4x," Koneri says.

Hari Parthasarathi, application engineering leader for India, South-East Asia & ANZ, says customers' eye for quality is also improving, which makes use of robotics very important.

Koneri notes that in the automobile sector, for instance, there are numerous components that require a certain level of aesthetic finish. "Those buying high-end bikes look at everything with a magnifying glass. They want the finish to be consistent across, be it the hand-holder, the silencer. The difference in finish quality between manual and automated processes is significant," he says.

Terry Ceulemans, global application engineering leader, says another big reason why robotics will become necessary for India is the growing exports of manufactured products to Western markets. "In exports, maintaining consistent quality becomes even more crucial. You have to take away the worker-to-worker variability. By programming robots to perform tasks consistently, we can guarantee the same level of quality output every time," he says.

Parthasarathi says their process of determining the robotics solutions to be created involves observing what their customers are doing, documenting it, and identifying clear needs. While 3M develops abrasives that robots can use, robotics & automation players in India like DiFacto, Dolphin, Future, and Nexgen integrate the systems.

Taichi Ando, Asia portfolio leader for robotics & automation, says those involved in system integration excel at using tools for painting, welding and material handling. But for more complex process, he says, even they are still in learning mode.

Industries driving the change towards robotics are primarily transportation related – automobiles, aerospace, metro rail. Industrial equipment manufacturers are also increasingly using it. "Even metro stations and airports are relying on metal fabrication, for ticketing systems, for various amenities. As airports and metros expand, the demand for robotic metal fabrication will rise," says Kunal Vakil, division sales leader.

Source: Times of India, 6th March , 2024

Indian Steel Industry: Yesterday, Today and Tomorrow

Shri S C Suri, Past Chairman, IIM DC

Steel Industry Yesterday

The Steel Industry in India has come a long way since Independence when there were only three steel plants namely TISCO, IISCO and VISL. These plants were producing steel of about 1.2 Mt in 1948.

After Independence Govt. decided to set up steel plants at Rourkela, Bhilai, Durgapur, Bokaro and Vizag in late Fifties and early Sixties. Subsequently Alloy Steels Plant and Salem Steel Plant were also set up.

Post liberalization private sector players also entered the steel sector. Apart from this secondary sector also entered the Steel Industry.

In 2002-03 the steel capacity of India was around 33 Mt.

Steel Sector Today

Today the steel capacity of India is around 179 Mt and per capita consumption of steel is about 90 kg. A number of technological interventions have taken place in Indian Steel Sector. These are helping steel industry to improve on the technoeconomic parameters in terms of improvements in energy efficiency, raw materials utilization, coke making capacity, Blast Furnace productivity, improvements in Steel making, ladle metallurgy, continuous casting, rolling mills, shifting of Process Routes in Steel making, quality of Steel Technological developments in EAF Steel making and application of information technology in steel industry.

Steel Industry Tomorrow

Future Expansion in Steel Sector

Future expansion in steel sector will cater to strategic materials needed in the steel sector to improve economy and productivity in the MSME, energy sector and improved technological knowledge.

Following are some of the key areas on which developmental work is being undertaken:

- The module size for the new steel plants is 6 million tonnes.
- Coal washeries are being established to upgrade the quality of Indian Coal.
- The emphasis on increasing the size of Blast Furnace. Blast Furnaces of 4500 tonne production per day are already operating at NMDC plant, Bellary & Rourkela.
- Bigger furnaces are being set up in Indian Steel Sector.
- There is emphasis on production of light steel material along with corresponding increase of high mechanical strength.
- In alloy steels making alloys additions are being made in the ladle furnace, hence no wastage of alloys in steel making alloys.
- There is no wastage of alloys in the slag since all alloy additions are being made in ladle furnace.
- The nickel resources are very meagre and their concentration is also very limited. Ferritic Stainless Steel is becoming more popular by users.
- Colour coated products are being increasingly used in the Indian Steel Sector.
- The technology of dry quenching of coal has been very well-established resulting in energy saving.
- Stamp charging of coal is also being used in Indian Steel Plants resulting in larger production of coke and use of inferior coal is being used in steel plant blend.
- Steel plants are being established near raw material base.
- Energy efficiency in production of steel is the need of the hour.
- Use of renewable energy instead of fossil fuel needs to be attended.
- Use of hydrogen is being attempted in the blast furnaces in a limited way. This technology has to be perfected.
- The alumina silica ratio in Indian Iron Ore is adverse. Washing of Indian Ore results in removal of silica instead of alumina.

- It is anticipated that production capacity of steel will be grow to about 305 million tonnes in next 8 years.
- These New Technologies are being perfected to increase the productivity of Indian Steel Plants.
- Technology of making CRGO steel should be thought of
- There is a need for development of strategic steel products for Defence Sector as Defence Sector is growing rapidly and also for automobiles.
- Steel Sector is attempting to avail of PLI scheme for developing steel items which were hitherto being imported.
- Thrust needs to be given to development of composites which make the steel lighter with properties of high load bearing capacity. It is expected that Indian Steel Sector will play a pivotal role in the growth of India economy and will promote strong base for the growth of India.
- Focus needs to be given to extraction of lithium and its application in batteries.

Visit of Shri M P Sharma to Oman for Consultancy in the area of Aluminium

It is a matter of pride for our Delhi Chapter that one of our EC members, Shri M P Sharma was invited by AI-SIFA Trading Company located in Oman to render technical advice in the use of aluminium metal scrap in metal processing. He visited Oman for three days in April 2024 and interacted with Mr. Kiran Madhv Director of this Company. He helped this Company in many areas of aluminium value added processing. He also visited some other metal companies of large scale in Oman and interacted with senior staff of these companies. His technical inputs were appreciated by the management.

National Conference on Recent Developments in Galvanizing & Zinc Spraying - Technology, Environment & Markets

India Lead Zinc Development Association (ILZDA) / Indian Galvanizers Association (IGA) organized a **National Conference on Recent Developments in Galvanizing & Zinc Spraying - Technology, Environment & Markets** during 29 & 30 April 2024 at Ahmedabad; the conference witnessed 21 technical presentations from overseas & Indian Speakers. The Conference was cosponsored by JSW Steel Coated Products Ltd, Jindal Steel & Power Ltd , Tata Steel, Cee Dee Metalloys Pvt Ltd, Step Techno Solutions LLP, Gimeco Impianti, Metals & Chemicals Technology SDN BHD, Unique Galvanizing Solutions Pvt Ltd, Kalpataru Projects International Ltd, Arvind Anticor, Shyam Steel Industries Ltd & Vishal Engineers & Galvanizers Pvt Ltd. M G Sales & Topline Switchgear Pvt Ltd supported the event. Association Partners were Recycling & Environment Industry Association of India, The Indian Thermal Spray Association (iTSA), Material Recycling Association of India. Media Partnership was extended by Metalworld, Steelworld & Steel & Metallurgy.

There were 6 Technical Sessions focused on Markets, Continuous Galvanizing, General Galvanizing, Zinc Spraying, Environment & Recycling. In all 125 delegates participated including some from Nepal, Oman & Singapore. On 30 April 2024 delegates visited M/s Topline Switchgear Pvt Ltd in order to get a practical orientation.

March Mining Output Growth Slows to 1.2% in signal for IIP

Mining accounts for 14.3% of the Index of Industrial Production and had grown 8% in February, lifting IIP growth to a four-month peak of 5.7%; the expansion in mining output hit a 19-month low.

India's mining output growth slid to a 19-month low of 1.2% in March, from February's 8% pace, hinting at a possible slowing in the month's overall industrial output, the data for which is due to be released by the National Statistical Office on May 10.

Mining constitutes 14.3% of the Index of Industrial Production (IIP). Industrial output growth hit a four-month high of 5.7% in February with mining (8%) and electricity growth (7.5%) lifting growth. Manufacturing constitutes 77.6% of the IIP and grew 5% in February.

With growth in the eight core sectors slowing to 5.2% in March from February's 7.1%, economists expect a deceleration in industrial output growth, with some estimating it to slow to 3.5%-5%. The eight infrastructure sectors make up 40.27% of the IIP.

The index of mineral production for March was 156.1, which is 1.2% higher than its level in March 2023, the Ministry of Mines said. Some of the non-fuel minerals that logged positive growth included copper concentrate, gold, manganese ore, diamond, graphite, limestone and magnesite.

In FY24, mining output rose 7.5%, faster than 5.8% in 2022-23. Iron ore, limestone and aluminium production hit new records during the year, the ministry said, rising 7.4%, 10.7% and 2.1%, respectively.

Source: The Hindu, 3rd May 2024

Know Your Members

Deepak Jain

Shri Deepak Jain is a Vice Chairman of Delhi Chapter of The Indian Institute of Metals. He superannuated from Bureau of Indian Standards (BIS) as Deputy Director General in the year 2022. He is a Metallurgical Engineering graduate [1983 Batch] from Punjab Engineering College, Chandigarh.

He enjoys around 40 years of experience in Standardization, Conformity Assessment, Quality Assurance of various engineering products, etc.

Shri Jain joined Bureau of Indian Standards (BIS) in 1988. Before joining BIS, he worked for 5 years in Quality Assurance of a reputed automobile company.

In BIS, he worked for about 34 years in Conformity Assessment, Standardization, Standards Policy, Planning and Promotion activities. In between, he opted for deputation in Central Govt. as Assistant Regional Development Commissioner (Iron & Steel) during the year 1991-1995.

While working in Standard Formulation activity of BIS, as Member Secretary of Technical Committees, Shri Jain dealt with Standardization in the field of wrought steel products, copper, aluminium, ores and raw materials, mechanical testing of metals etc. He was instrumental in developing some of the very important Indian Standards for the country e.g. IS 2062 [HR Structural Steel], IS 513 [CR Steel Sheet], IS 1079 [HR Steel Sheet], IS 648 [CRNGO Steel], IS 3502 [Steel Chequered Plates], IS 11513 [HR Steel for Cold Rolling], IS 6240 [LPG Steel], IS 15391 [CRNGO-Semi Processed], IS 15647 [HR Narrow Strip for Tubes & Pipes], IS 191 [Copper], IS 737 [Aluminium & its Alloy Sheet and Strip]. While dealing with steel products, he worked closely with Ministry of Steel for bringing various Steel Quality Control Orders [QCO].

He handled product certification activities at Jaipur, Delhi, Chandigarh and evaluated quality of products. As Head of the branch office, monitored and administered certification activities in the states of Haryana, Punjab, J & K and Chandigarh.

As Deputy Director General (Western Region) BIS, he looked after the conformity assessment activities [which includes product certification, management system certification and hallmarking activities] in respect of states of Gujarat, Maharashtra, Dadra Nagar Haveli and Daman & Diu.

He represented BIS in many National and International Technical Committees.

He published a number of technical papers in various journals of repute.

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