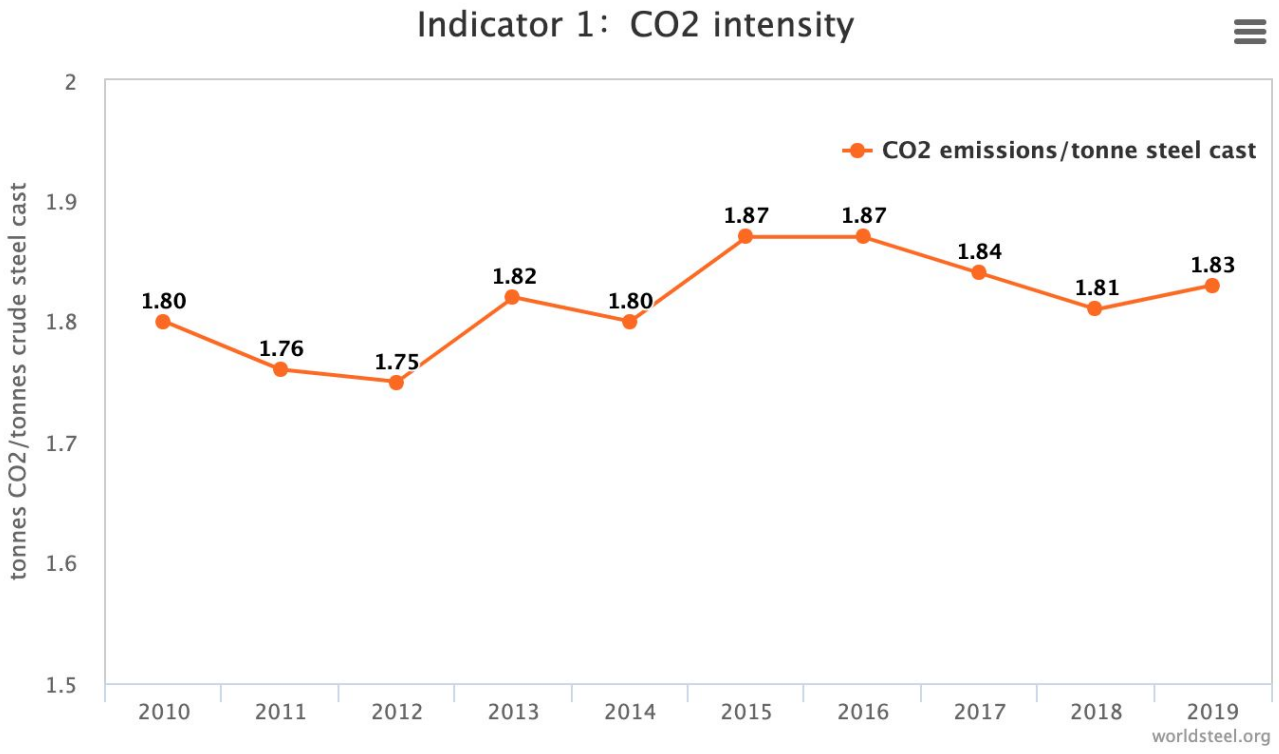
Green steel – the next largest industrial investment?

An introduction to steel making and its impact on global greenhouse gas emissions

The steel industry is of key importance for the global economy as steel is a key input in many other industrial sectors essential to the functioning of the wider economy, such as mechanical and electrical machinery, motor vehicles, domestic appliances and the construction industry. Indeed, according to a report published by Oxford Economics, steel making contributes directly to 3.8% and indirectly to 10.7% of global GDP. However, the contribution of the steel industry is not homogeneous across countries, but it tends to be much higher in industrial countries, such as China and India, where the share of global steel production in 2019 was respectively 53.3% and 5.9%.

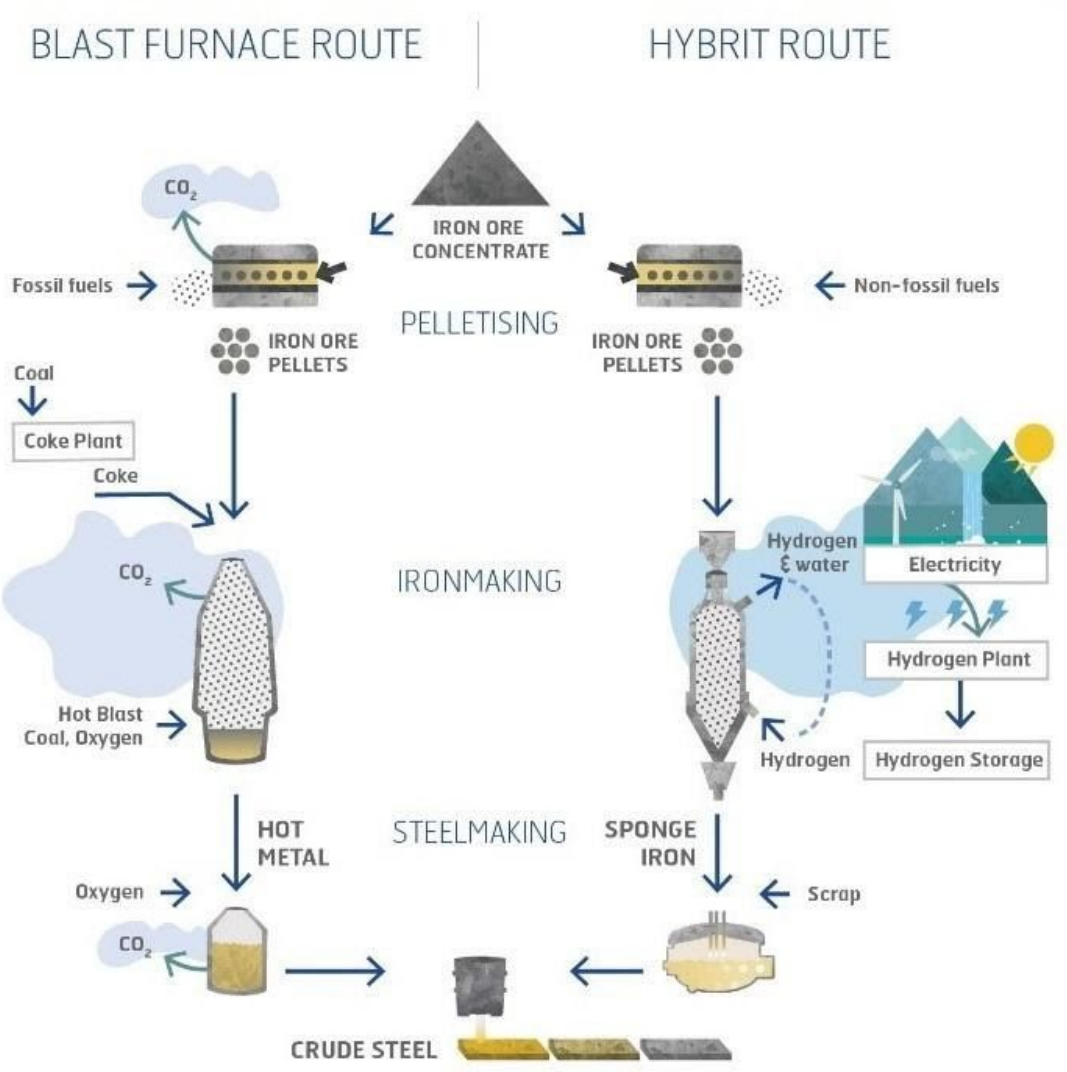
One of the main issues of steel making is that this process is extremely polluting. Indeed, more than 70% of the world's steel is made in blast furnaces where coking coal is used to strip oxygen away from iron ore to yield metallic iron. This process is responsible for up to 9% of global greenhouse gas emissions, with huge amounts of carbon dioxide produced when coke is burnt in the furnaces. Moreover, in the last 10 years, the intensity of CO2 emissions slightly increased, as it can be seen in the following graph extracted by a report of the World Steel Association.



Source: www.worldsteel.org

Hydrogen-based steelmaking

However, there is an alternative to the traditional, highly polluting, steelmaking process: this involves the use of hydrogen, rather than coal, to strip the oxygen out of iron ore, and it has water rather than carbon dioxide as a byproduct. Nonetheless, "green steel" is possible only if also hydrogen is produced without significant CO2 emissions. This can be done through electrolysis, a process that sends an electric current through water to split hydrogen atoms from oxygen. If the electricity needed comes from renewables, such as wind and solar energy, the hydrogen is made without any emissions.



Some of the main steel producers, including the Luxembourgian ArcelorMittal, the German Thyssenkrupp Steel, and the Chinese Baowu, are currently trialling this new method. ArcelorMittal, the largest steelmaking company that produced 97.31 million tonnes of steel in 2019, has recently announced that this year it will be able to offer the first 30,000 tonnes of carbon-neutral steel to its customers, to reach 120,000 tonnes in 2021 and 600,000 tonnes by 2022.

Sweden is currently leading this transformation, with a joint venture between national steelmaker SSAB, iron ore producer LKAB and utility Vattenfall. Recently LKAB has announced that it will invest $47bn over the next 20 years to use "direct reduced iron" produced using emissions-free hydrogen, in what could end up being the largest-ever industrial investment made in Sweden.

This "green" alternative is being closely considered also in Australia. The Grattan Institute has recently concluded, from the analysis of several emissions-intensive sectors, that "green steel" is the best opportunity for large-scale exports and job creation in key regions in this country. Indeed, Australia is currently the main iron producer and exporter worldwide; moreover, it has vast access to high-quality wind and solar resources, essential to produce the hydrogen needed in a decarbonized steel industry. The analysis shows that capturing about 6.5% of the global steel market would generate about $65 billion in annual export revenue and could create 25,000 manufacturing jobs in Queensland and New South Wales.

Problems related to green steel and possible solutions

The catch is that Green hydrogen is costly. According to an analysis from BloombergNEF, green hydrogen costs between $2.50 and $6.80 a kilogram to make, due to the relatively high costs of renewable-powered electrolysis. That would need to fall below $2 dollars in order to make renewable hydrogen competitive with coal.

Furthermore, large quantities of green hydrogen are needed to produce green steel, and these require an even larger amount of electricity. The European Steelmakers' Association estimate that the steelmaking sector alone will require 400 terawatt-hours of renewable electricity, of which 250 terawatt-hours for the production of 5.5m tonnes of hydrogen: this quantity is the same as the current electricity demand of Germany. This may strain electricity grids that are already facing a big challenge in preparing for a broad societal shift to powering more things with electricity rather than fossil fuels, most notably electric cars.

BloombergNEF estimates that Green hydrogen could become economical in the 2030s, assuming policymakers will provide incentives to support it. Costs are expected to tumble as electrolysis technology becomes more efficient and production is scaled up. Moves by European governments to increase the cost of carbon dioxide emissions could further tilt the economics of the market in favour of hydrogen.

Another issue is that steel producers in India and China have a relatively young fleet of blast furnaces that could run for another 30-40 years before they need replacing, so they may lack the incentives to convert their traditional steelmaking plants to hydrogen-based ones. However, the fact that Baowu, the largest Chinese steelmaker, has recently signed an agreement with BHP, the Anglo-Australian iron miner, to invest in low-carbon steel making technologies, shows a real commitment to reducing global greenhouse gas emissions even in China, the largest steel-producing country by far.

BHP

BHP has agreed to partner with one of its biggest customers, Baowu, and invest $35m in low-carbon steelmaking technologies. The 5-year partnership includes a potential carbon capture and storage project at one of Baowu's production sites in China and the utilization of low carbon fuel sources such as hydrogen. Moreover, as a leading

company in the sector, Baowu will have an active role in implementing those low-carbon technologies by working with its partners in the value chain.

However, the planned $35m investment can be considered as tiny if compared with the company's net profits, which amounted to more than $9bn in 2019. As such the partnership with Baowu is likely to be criticized by activists, who have accused BHP of not doing enough to curb its emissions. Notwithstanding, the general debate seems to have shifted from Scope 1 and Scope 2 emissions, which are generated directly by the mining operations, to the so-called scope 3 emissions. Scope 3 emissions are all indirect emissions that occur in the value chain of the reporting company, including the greenhouse gases created by its customers and its vast shipping fleets. However, even though some major mining companies have refused to set goals for these emissions, BHP pledged not only to develop technologies to make steelmaking 30% less carbon-intensive but also to decrease general emissions made by shipping by 40% per voyage compared with traditional marine bunker oil.

LKAB

In the meanwhile, the state-owned LKAB said that it would invest more than $47bn over the next 20 years to use Direct Reduced Iron (DRI). At the heart of LKAB's new plan to drastically reduce its carbon footprint is a switch to emission-free hydrogen DRI, which would go into electric arc furnaces rather than coke-fueled blast furnaces. But the so-called green hydrogen requires large amounts of energy. Indeed, LKAB estimated that the energy required in the production of iron using emission-free hydrogen would be equivalent to about one-third of Sweden's current 160TWh of annual production. Nevertheless, the company remarked the fact that the resulting reduction in greenhouse gases would be equivalent to two-thirds of all the country's emissions and three times greater than the effect of abandoning all cars in the country permanently. Moreover, Jan Mostrom, the company CEO, said in a press conference that this huge investment might result in LKAB's revenues more than doubling over the same period. LKAB is confident of securing competitively priced hydrogen produced from hydropower and Norrbotten, where the company's mines are situated, has an abundance of water energy. Moreover, consultancy firm Wood Mackenzie estimates that green hydrogen prices will fall by 40% by 2040. Therefore, LKAB's DRI strategy might bring some significant cost advantages in the long term that will make its steel more competitive in the market.

ArcelorMittal

ArcelorMittal's strategy that will enable the steel manufacturer to offer its first green steel solutions to customers in 2020 is mainly focused on using green hydrogen in two main technology paths. The first consists of the use of green hydrogen in DRI, whereas the second consists of increasing the use of hydrogen in the expansion of the company Smart Carbon route. Moreover, the European branch is developing a series of industrial projects that involve the use of hydrogen in blast furnaces; projects are expected to deliver a substantial reduction in CO2 emissions within the next five years. ArcelorMittal is also developing new facilities to produce green hydrogen that will be used in these processes. Therefore, hydrogen plays a huge role in the ArcelorMittal decarbonization strategy.

Conclusion

Decarbonizing the steel industry is one of the biggest challenges faced by corporations in tackling climate change. Even though hydrogen-based steelmaking using DRI is widely seen as the only plausible path to carbon-free steelmaking, big producers predict that these low-carbon alternatives will need massive investments and, therefore, will not fully substitute traditional steelmaking soon.

Furthermore, the approach to "green steel" is currently very different across geographies. For example, the European Commission has already launched in July 2020 its "Hydrogen strategy for a climate-neutral Europe", which sets out a plan to establish an integrated hydrogen energy network in Europe by 2050. On the other hand, it is not yet clear if countries such as China and India, the largest steel-producing countries, will put the same effort in the decarbonization of this industry.

Will the transition to "green steel" prove successful? Analysts have different views on this. BloombergNEF forecasts that hydrogen could become economical in the 2030s and that moves by European governments to increase the cost of carbon dioxide emissions could further favour hydrogen-based steelmaking. However, companies such as BHP, expect the highly polluting coal-fired blast furnaces will still account for more than half of steel production in 2050.

TAGS: Steel, Carbon footprint, Steelmaking, Emissions, Hydrogen, DRI, LKAB, SSAB, Vattenfall, BHP, Baowu, ArcelorMittal, Thyssenkrupp Steel, BloombergNEF, Green steel, Industrial, Sustainability, Treaty of Paris, Australia, China, India, Sweden, Iron,