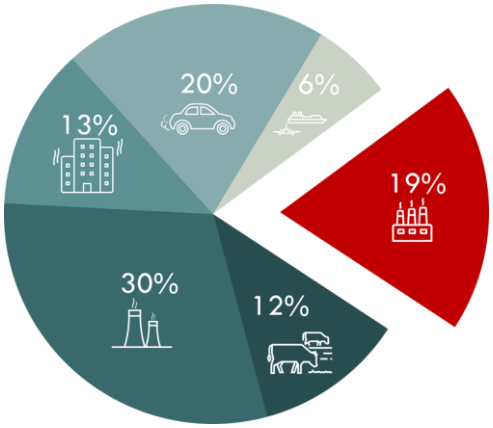
Climate action in the steel industry

Reaching net-zero emissions by mid-century requires every sector to drastically reduce their carbon footprint and practically eliminate all GHG emissions within the next thirty years. Interim targets for 2030 combined with new carbon taxes and rising EU ETS allowance prices over the next decade are putting pressure on energy intensive industries to act, including the steel sector. To ensure Europe retains the value these industries generate and has the clean materials available to achieve this major transformation of the economy, systematic policy action across a range of needed technologies and product chains is required.



Industry is key to unlocking net-zero

Industry remains crucial in supporting Europe's standard of living. Today, it emits about a fifth of the EU's CO_2. Without decarbonizing the sector, Europe will not be able to reach net-zero. Nor will it be able to do so without an industry, particularly since we rely on industrial products to reduce emissions – from renewable electricity to efficient housing and zero-carbon transport.

Instead, we need to ensure that industry produces products such as steel in a net-zero compliant way.

Steel is at the heart of industrialised society and climate action

Steel is all around us. In our houses, cars, refrigerators and the wind farm outside our window. Its link to rising living standards across the globe means that the demand for steel is expected to increase by more than a third by 2050. To avoid a corresponding increase in emissions, we need to improve how we use, re-use and produce steel.

Aviation

1.9%

of global emissions

Iron and steel*

7.2%

of global emissions

*energy and process

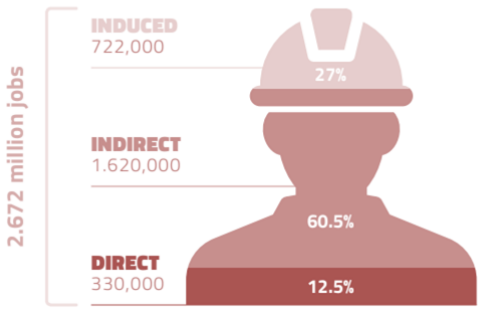
Did you know?

Every tonne of new steel results in around 1.85 tonnes of CO_2 emitted to the atmosphere. Based on this average, European steel production in 2019 (159 million tonnes) emitted almost 200 million tonnes of CO_2. This is 15% more than the total emissions of the Netherlands.

Steel and the Economy

Steel's value chains are extensive. As an essential component in a range of products, access to high quality and specialised, low cost – and soon low carbon – steel will decide the location of many downstream manufacturers and their associated job and value creation. Providing the means to significantly reduce emissions will be essential to safeguard these economic contributions and benefits of the sector in times of rising climate pressures and avoid reliance on imports with questionable carbon footprints and adverse effects on the trade balance.

The EU steel industry supports nearly 2.6 million jobs



*Indirect jobs are connected to the steel industry, induced jobs result from direct/indirect employee spending.
Source: EUROFER & Oxford Economics, 2019

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Many roads lead to green steel: and we need them all

Reducing steel's climate impact requires simultaneous actions from production to use and end of life.

- Improving resource and energy efficiency
- Capturing and storing carbon
- Using alternative materials
- Developing new, innovative and clean production technologies

Replace

- Fossil energy sources with sustainable biofuels, hydrogen or electricity from renewables
- Steel use in products with other materials such as sustainably sourced wood
- Coke with low-carbon hydrogen as a reducing agent

Reduce

- Demand for steel by reusing steel structures to construct new buildings
- The amount of steel used in construction by optimizing material efficiency

Recycle

- And reuse steel from products to reduce need for new steel

Did you know?

Recycling one tonne of steel can save 1.5 tonnes of CO_2, 1.4 tonnes of iron ore, 740kg of coal and 120kg of limestone compared to primary steel produced in a traditional blast furnace.

Reinventing primary steel production will still be necessary

According to industry, steel is already the most recycled product on the planet. On average, new steel products contain 37% recycled steel. Yet accumulating impurities and copper degradation mean specialized steel products will still require virgin material inputs. It is imperative to ensure this production is carbon neutral, and ideally, fossil-free.

Reinvent

the way steel is produced to stop CO_2 from being emitted to the atmosphere.

Current steel production

Steelmaking is a two-stage process, traditionally using a blast furnace (BF) and a basic oxygen furnace (BOF).

In the first step, in the BF, iron is made from iron ore and other materials, including coking coal. This iron is then turned into steel in the second stage in the BOF.

CO_2 is emitted at three points across the production chain: in the preparation of materials for the iron-making process, called sintering, (between 30% to 40% of total emissions); during the ironmaking itself (about 50%) and then in the subsequent steelmaking (the remaining10%+).

Sustainability is key

Climate measures need to have a positive environmental and climatic impact. This requires the sustainable sourcing of substitution material and the careful consideration of their overall carbon footprint. In the case of steel, this relates primarily to biomass as an energy source and timber as an alternative building material.

Custom-build Green Steel

Given regional technological, resource and commercial limitations, steel mills may decide to follow different combinations of options and paths, such as combining hydrogen blending and CCS in the blast furnace with a switch from the BOF to the EAF.

What the future of steel looks like

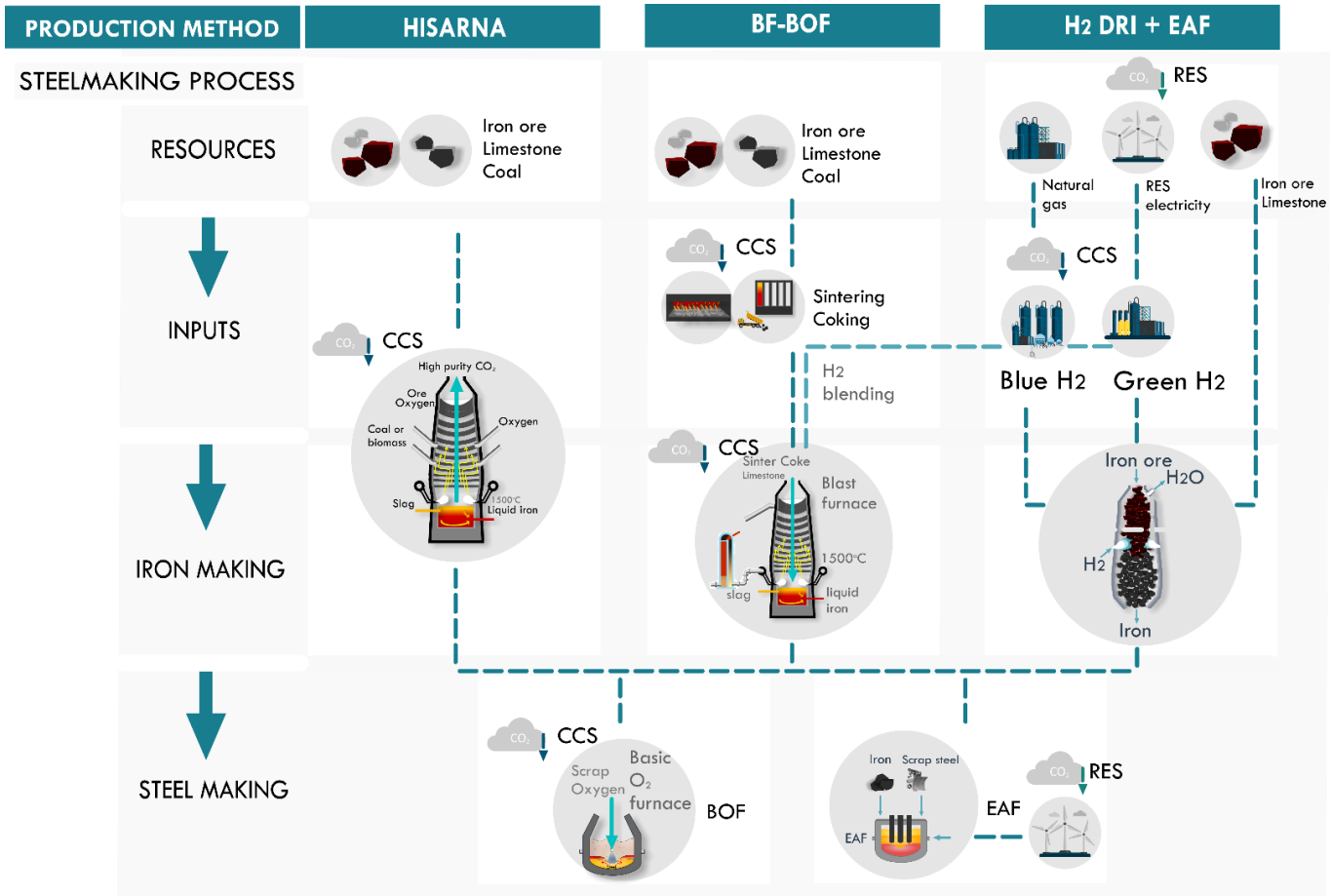
There are different technologies, and technology paths, that can eliminate CO_2 emission from specific stages of the steelmaking process or altogether.

Carbon Capture and Storage

CO_2 can be captured at all three point sources of the traditional **BF-BOF** process. CCS for the BF and the coking ovens could already reduce emissions by over 70%. Tata Steel's **HIsarna** process, which integrates the coking, sintering, iron- and steelmaking in one oven, reduces resource inputs and creates a single CO_2 source-point, making it more suitable for for capture. This reduces operational costs and can deliver over 80% emission savings.

Hydrogen-based Steelmaking

Direct Reduced Ironmaking (**DRI**) is an alternative to the traditional blast furnace. Using hydrogen instead of coal or natural gas, paired with an Electric Arc Furnace (**EAF**) for the steelmaking, can effectively eliminate emissions if the hydrogen is supplied in a zero-carbon way, and the electricity supplied to the EAF is equally zero carbon.



EMISSION REDUCTION SOLUTIONS

- CCS on HIsarna furnace, ≈80%*+ emission reduction
- CCS on Sintering and Coking ovens ≈20% emission reduction
- CCS on Blast Furnace, ≈50% emission reduction
- CCS on Basic Oxygen Furnace, ≈10% emission reduction
- Replacement of BOF with EAF, ≈10% emission reduction
- Replacement of Blast Furnace with DRI with H2**, ≈98%+ emission reductions

* Compared to the average emissions from the coal-based BF-BOF steelmaking process.
** Assuming high capture and storage rates and use of renewable electricity for direct use or the production of hydrogen used to reduce iron ore
*** Molten oxide electrolysis is excluded from this analysis.

Did you know?

Carbon capture on a steel mill has been operating at industry scale of 0.8 $MtCO_2$/year since 2016 at the Al Reyadah CCUS Project in Abu Dhabi.

Unlocking the hydrogen economy

It takes between 3.5MWh and 5.5MWh of renewable electricity to produce one tonne of steel via DRI with 'Green H2'. This is can be over 3x the amount of electricity the average European uses per year (about 1.6MWh).
In the absence of sufficient additional renewable electricity, hydrogen can also be produced through natural gas reforming. The resulting CO_2 can be captured and stored. Given steel mills are already well connected to natural gas networks, the reformation can even be done on-site. Since CO_2 can be transported more flexibly than hydrogen, this would allow more rapid scaling of hydrogen production for net-zero compliant steel manufacturing.
More information on hydrogen production on www.frompollutiontosolution.com and www.Bellona.org.

CCS can help deliver the green steel transformation. European CO_2 Networks are critical to retain jobs and economic benefits.

As the availability of coal and iron ore was once the determining factor for the location of steel mills, in the future, given the global trade of high-grade ores, a region's access to cheap hydrogen and CO_2 networks will determine their location. In addition to the indisputable need for faster renewable electricity expansion, hydrogen and CCS networks are critical for net-zero industry, and particularly steel. CCS takes a special role in this relationship due to its potential for direct application to a steel plant and indirect application in making low carbon hydrogen. It can thus also help scale clean hydrogen production and prevent continued or even growing unabated fossil gas use in an increasingly 'hydrogen-ready' industrial landscape.

The EU CCS Framework

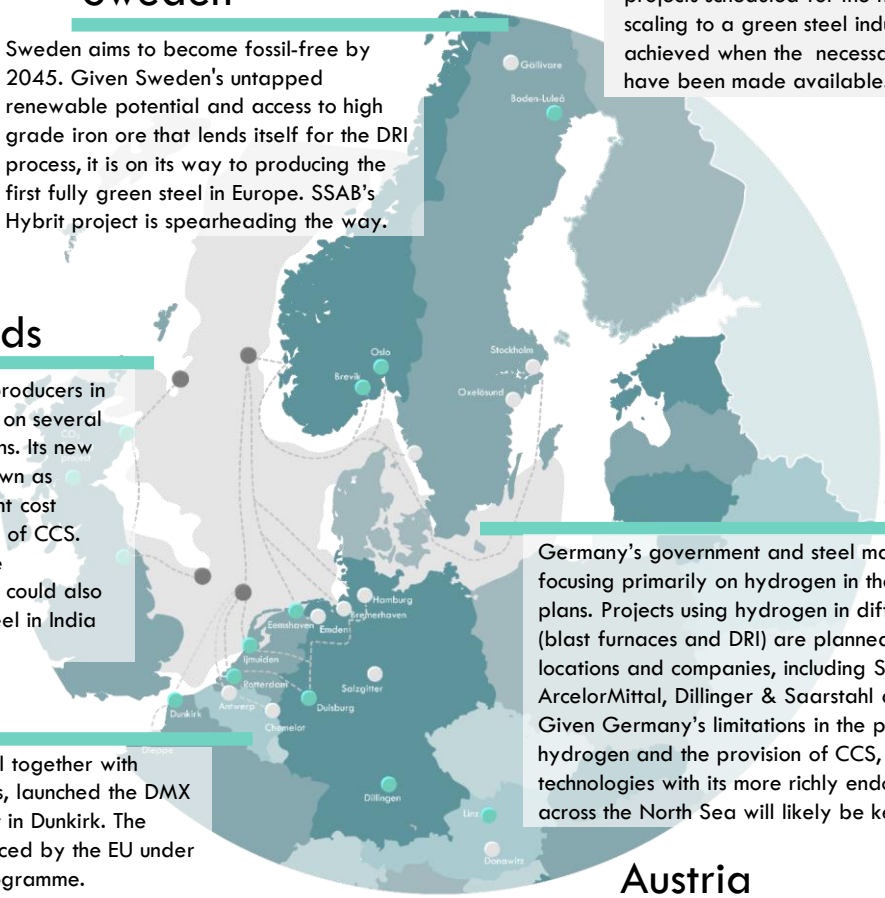
- The European CO_2 Storage Directive regulates CCS projects and ensures strict environmental and monitoring requirements are met.
- The Innovation Fund supports innovative, effective and scalable climate technologies.
- The Connecting Europe Facility (CEF) funds projects of common interest (PCI) that include cross-border CO_2 transport infrastructures.
- Additional national and regional funding mechanisms exist, and can be made available.

With regional & national governments in support, a demonstration capture plant can be up and running in the 2020s if action is taken today. Sharing an open CO_2 network that links emission point sources with permanent offshore storage will reduce the cost of stopping emissions, allow more industries to make deep cuts in emissions and help transform high carbon employment into low carbon investment hubs.

Developing alternative ways of producing steel are underway in many countries across Europe with new DRI processes and the use of hydrogen and carbon capture technologies. With pilot and demonstration projects scheduled for the next couple of years, a scaling to a green steel industry will only be achieved when the necessary climate infrastructures have been made available.

Sweden

Sweden aims to become fossil-free by 2045. Given Sweden's untapped renewable potential and access to high grade iron ore that lends itself for the DRI process, it is on its way to producing the first fully green steel in Europe. SSAB's Hybrit project is spearheading the way.



The Netherlands

As one of the largest steel producers in the world, Tata Steel counts on several options to reduce its emissions. Its new way of producing steel, known as Hisarna, allows for significant cost reductions in the application of CCS. Developed in Ijmuiden in the Netherlands, the technology could also break the knot for green steel in India and beyond.

Germany

Germany's government and steel manufacturers are focusing primarily on hydrogen in their decarbonisation plans. Projects using hydrogen in different steel processes (blast furnaces and DRI) are planned across several locations and companies, including Salzgitter AG ArcelorMittal, Dillinger & Saarstahl and Thyssenkrupp. Given Germany's limitations in the production of clean hydrogen and the provision of CCS, cooperation in these technologies with its more richly endowed neighbours across the North Sea will likely be key.

France

In 2019, ArcelorMittal together with several other partners, launched the DMX Demonstration project in Dunkirk. The project is partly financed by the EU under the Horizon 2020 programme.
From 2021, it will capture 0.5 tCO_2 per hour. The goals are to increase this to 125 tCO_2 per hour or over 1 $MtCO_2$ per year by 2025 and 10 MtCO2 per year by 2035.

Austria

Austria's Voestalpine is developing a hydrogen-based DRI plant at its Donawitz site. The energy demand for green hydrogen production appears a major bottleneck, and the country will be similarly dependent on European resource networks as its neighbour to the north.

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