Example from Germany

Global Alliance Powerfuels

powered by dena German Energy Agency

Steel production

The use of green hydrogen in steel production is one promising option for achieving a significant reduction of CO_2 emissions.

Approximately 45 million tons of steel are produced in Germany per year.[1] Today, steel production is mostly carried out through coal or coke-based processes for the reduction of iron ore in the furnace. This involves the emission of large quantities of CO_2.

One alternative to the widely practised reduction of iron ore in the furnace using carbon is direct reduction of iron ore using hydrogen. In addition, hydrogen is already used today in steel processing as an inert gas.[2] That hydrogen is currently obtained from natural gas steam reformation. In principle, the requirement for hydrogen of today and the future requirement for direct reduction can be successively covered by green hydrogen.

Through a complete substitution of the requirement for coal / coke, 2.4 million tons of additional annual demand for hydrogen will be generated in Germany.[3]

The currently commonplace truck transports of hydrogen to the steel production plant could also become almost entirely a thing of the past with the use of on-site production.

Approximately 67 million tons CO_2 equivalent are emitted by the 'German steel industry per year.[4] 49-51 % of CO_2 emissions are to be saved in the industrial sector by 2030 relative to 1990.[5]

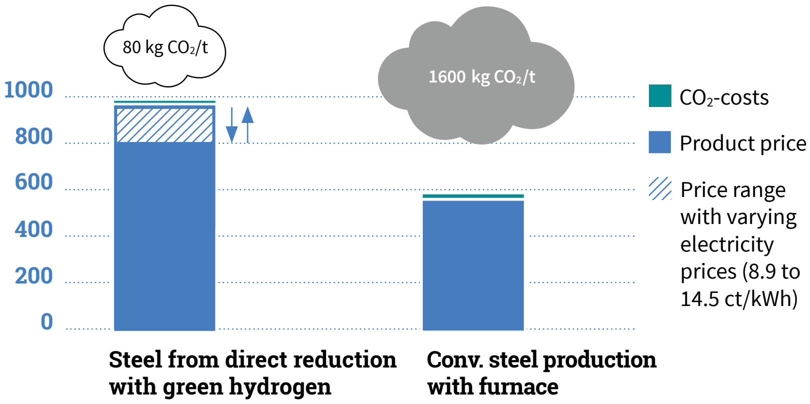
Up to 95 % of CO_2 emissions could be saved through direct reduction with green hydrogen instead of steel production via the furnace.[6]

H_2 **Hydrogen**

- ✓ Easily achievable reduction of emissions; due to production at the place of consumption, no transportation of hydrogen is required.
- ✓ Substantial CO_2 savings potential through gradual implementation in new steel production processes.
- ✓ In the event of power shortfalls, the process can be switched to natural gas.
- ✓ Due to its ease of storage, the reduced iron ore (DRI or iron sponge) can act as a buffer.
- ⚠ The EU emissions trading system offers little incentive for the use of CO_2-neutral hydrogen in the steel process.

Cost comparison for steel production, current status in Germany[7] in €/t

In the calculations of economic viability, the total costs of steel production including the costs of the CO_2 emissions in production are taken into account.

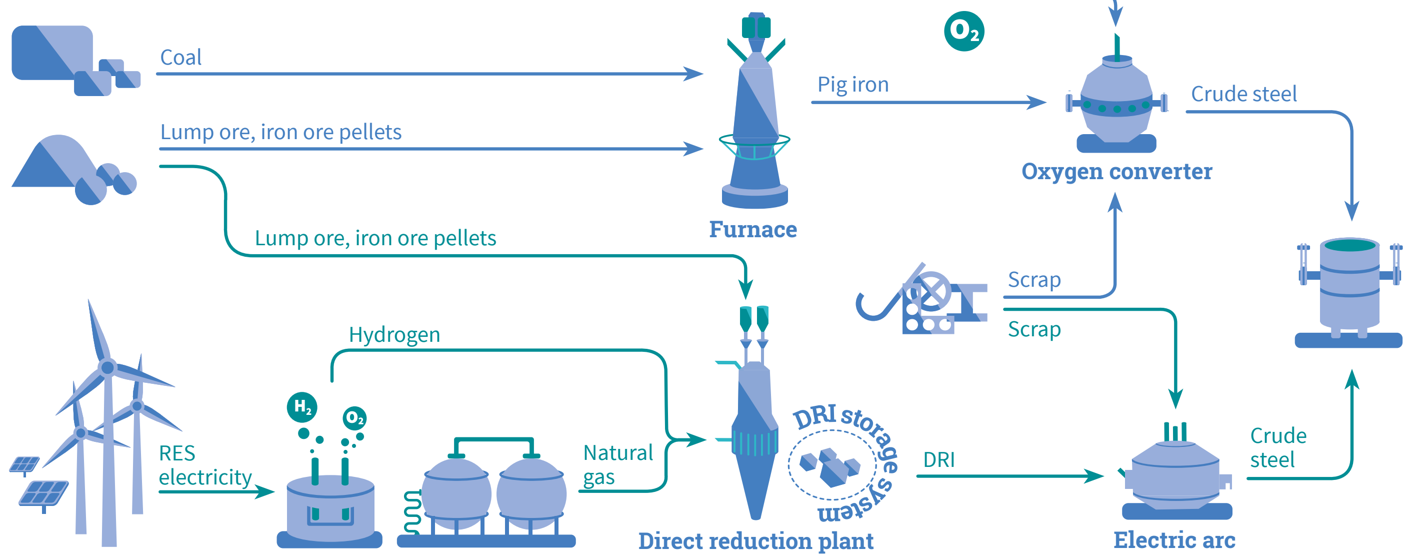


There are two different processes for steel production (direct reduction or via furnace). Because the direct reduction process with green hydrogen is still in development, this concerns our own estimate.

Alternative technologies

Instead of pig iron (such as iron sponge), exclusively steel scrap can be melted down in an electric arc furnace for the production of certain steel products. The supplied electrical energy is converted by the electric arc, with a very high level of efficiency and high energy density, into melt energy.[8] The forecast global share of this scrap-based electric steel production in total steel production increases from 25 per cent in 2016 to 50 per cent in 2050.[9] However, due to contamination detrimental to steel (such as copper from electric cables), the production of high-quality flat steel products through melting down of steel scrap in electric arc furnaces is limited. Here the need for steel production from iron ore will remain.[10]

Steel production processes



Source: Own presentation according to Salzgitter AG (n.y.)

In the direct reduction process, with the aid of natural gas and/or hydrogen, iron ore is reduced to iron sponge (direct reduced iron, DRI), which can then be further processed in the electric arc furnace. The hydrogen used in the direct reduction plants can be successively substituted with green hydrogen.[11] Depending on the development stage, 10 to 95 per cent of CO_2 emissions (with regard to the entire process chain in steel production) can be saved.[12]

Infrastructure

The steel industry can be supplied with green hydrogen on site. Because the direct reduction process must run constantly, in the event of electricity shortfalls the process can be switched to natural gas. Also, when electricity production is high, a larger quantity of iron sponge can be produced and thus a certain degree of flexibility can be generated in the production process due to its ease of storage.[13]

Legislative framework

In principle, the renewable electricity used for the electrolysis involves high ancillary electricity costs. However, various reductions for electrolysers are possible (see Factsheet “Power to X: Electricity Purchases”).[14]
For electricity cost-intensive industrial companies, in principle the RES charge reduction under Article 64 of the Renewable Energy Sources Act (EEG) 2017 is also applicable. The steel industry participates in the emissions trading of the EUETS[15] / TEHG[16]. The use of green hydrogen thus has a positive impact on the CO_2 costs of a plant, as fewer CO_2 certificates have to be purchased because less CO_2 is emitted. However, according to the current version of the Emissions Trading Directive, fewer certificates would be allocated free of charge for the process of direct reduction, because the benchmark for that process is lower. The ETS trading system therefore offers little incentive to companies which convert their process from the current furnace method based on coking coal to a direct reduction process.[17]

1 DWV (2018). **2** Inert gas which takes part in few chemical reactions. **3** LBST (2017). **4** DWV (2018). **5** Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) (2016) **6** Salzgitter AG (n.y.). **7** For the calculation regarding the production of power fuels, the data of the relevant PtX technologies is used. **8** German Steel Federation (n.y.). **9** HYBRIT (n.y.). **10** Expert survey. **11** E.g. Salzgitter AG, project SALCOS® (Salzgitter Low CO_2-Steelmaking). **12** Salzgitter AG (n.y.). **13** Salzgitter AG (n.y.). **14** z. B. § 118 Abs. 6 S. 7 EnWG oder § 9a StromStG. **15** Emissions Trading System of the EU, Directive 2003/87/EC (Emissions Trading Directive). **16** Greenhouse Gas Emission Act (TreibhausgasEmissionshandelsgesetz). **17** CO_2 certificates are allocated across the EU according to uniform allocation rules. In the current third trading period since 2013, most of the certificates are no longer awarded free of charge, but instead are auctioned. On a transitional basis, there is still free allocation for the sectors of industry exposed to strong international competition. Free allocation occurs on the basis of rigorous “benchmarks”, which are based on the average of the 10 per cent-best technologies in a sector across the EU.

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