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This is how we can  
reduce Sweden's  
CO<sub>2</sub>-emissions by  
**10%**

And the global emissions  
by **7%**

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# HYBRIT – A FOSSIL FREE FUTURE

The Swedish iron and steel industry is already climate-efficient by international standards, but that's not enough. The steel industry currently accounts for about ten percent of Sweden's carbon dioxide emissions and seven percent of the global emissions.

To contribute to a greener future, we need to pull together. HYBRIT is a collaborative initiative between SSAB, LKAB and Vattenfall, with financial support from the Swedish Energy Agency, that started in 2016. In 2017 Hybrit Development AB was founded. Together we aim to develop processes and conditions to produce the fossil-free steels of the future using fossil free electricity and hydrogen, thus minimizing the carbon dioxide emissions through the whole value chain.

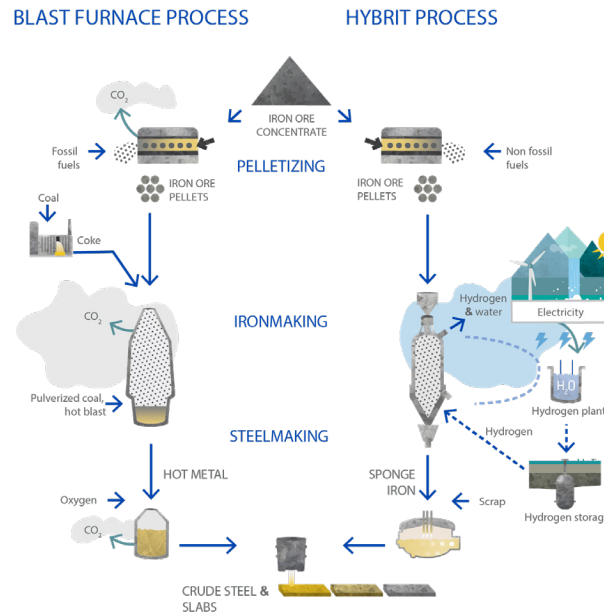
The three owners contribute with different parts of the value chain, and the strength lies in the cooperation. HYBRIT is bringing together skills and resources to develop a value chain where synergies are harnessed. Together, the owners carry the risks and costs, while the result will be much stronger.

## How can it be done?

Steel can be manufactured by recycling or by using iron ore as raw material. In the HYBRIT-process, iron ore is used as the raw material. The ore, which is mined in LKAB's mines, is enriched and sintered into iron ore pellets and then sent for further processing in SSAB's steelworks. In the traditional process the sintering is done using fossil fuels. In the HYBRIT-process fossil free fuels such as bio-oil or hydrogen are used instead.

The iron ore is an oxide in which the iron is combined with oxygen and, to produce steel, the oxygen must be removed (reduced) from the ore. In the traditional process this is done using carbon and coke and that step accounts for approximately 85 percent of the emissions from the Blast Furnace based value chain. The raw iron that is tapped from the blast furnace is liquid and moves on in that form through the steel manufacturing process until, as raw steel, it is casted to slabs, ready to be rolled to coils.

## HYBRIT Hydrogen Breakthrough Ironmaking Technology



The HYBRIT-process means that the oxygen is removed from the iron ore using fossil-free hydrogen instead, this takes place in a reduction shaft. The result is sponge iron (direct reduced iron), which is a solid product. The sponge iron is then smelted in an Electric Arc Furnace (EAF), using fossil free electricity. The smelted product is further processed into fossil free steel according to the customer's requirements.

ced by electrolysis of water, that is split into hydrogen and oxygen. The electrolysis is done using fossil free electricity from Vattenfall. The hydrogen that will be used in the process is produced close to the direct reduction plant and can be used directly in the process.

The fossil-free value chain of the future also includes hydrogen storage. Storing hydrogen gives an opportunity to stabilize the energy system by producing excess hydrogen when there is plenty of electricity, for example when it is windy, and using the stored hydrogen when the electrical system is under strain.

## So, where are we now?

In 2018 Hybrit started construction of a pilot plant in Luleå for trials of direct reduction of iron ore, using hydrogen. The trials in the plant started in 2020 and in May 2021 the first pellet-based sponge iron, reduced with hydrogen, was produced. In August 2021 SSAB delivered the first fossil free steel to customer, for use in prototypes. In the pilot plant we produce one ton of sponge iron per hour during operations.

Within HYBRIT tests are made to develop the production of iron ore pellets by using non fossil fuels instead of the fossil fuels used traditionally. In the autumn of 2020 successful trials were made to produce the world's first fossil free iron ore pellets, using fossil free fuel.

HYBRIT has also built a pilot plant for hydrogen storage in Luleå. The hydrogen is stored in a lined rock cavern 30 meters underground and the plant can hold 100 m<sup>3</sup> of hydrogen. Storing hydrogen in the pilot plant is tested 2022-2024.

The next step is a demonstration plant for direct reduction with hydrogen. The plant is planned in Gällivare Municipality in Sweden and here the industrial prerequisites for fossil free steel for the market are formed. In the plant the fossil free value chain from iron ore pellet to fossil free steel will be demonstrated on a larger scale for the first time, with a production of 1.3 million tons of sponge iron per year. The sponge iron from the demonstration plant will be transported to SSAB Oxelösund where it will be processed in the electric arc furnace as part of SSAB's conversion to fossil free steel.