



INNOVATION FUND

Driving clean innovative technologies towards the market

HYBRIT Demonstration: Swedish large-scale steel value chain demonstration of Hydrogen Breakthrough Iron-making Technology

The Innovation Fund is 100% funded by the EU Emissions Trading System



Project summary

The HYBRIT (Hydrogen Breakthrough Ironmaking Technology) Demonstration project aims to revolutionize the European iron and steel industry, by replacing fossil-based technologies with climate neutral alternatives. The project plans to replace the coal-based blast furnace technology with direct reduction based on fossil-free hydrogen. The project will produce approximately 1.2 Mt of crude steel annually, representing 25% of Sweden's overall production, with the potential to avoid 14.3 Mt CO₂eq of greenhouse gas (GHG) emissions over the first ten years of operation. A new, first-of-a-kind hydrogen production facility in Gällivare will be established, using a 500 MW electrolyser capacity powered by fossil-free electricity. The use of hydrogen enables the conversion of iron ore into sponge iron. The project will enable SSAB to replace two blast furnaces in Oxelösund with an electric arc furnace, using the sponge iron as the feedstock to produce high-quality steel without using coking coal in the reduction step. As access to renewable energy continues to increase, the project will lead the way to a full energy transition of the hard-to-abate, iron ore-based steel production across Europe. Iron ore-based steel will remain of strategic importance for the EU as it is the main approach to produce both high quality and high strength carbon steel; and not all steel can be produced via recycling and melting of scrap steel. The project will also support the local economy and help secure jobs that are otherwise at risk if the existing steel plants would have to be discontinued to enable Sweden's transition to a climate-neutral economy.

COORDINATOR

Hybrit Development AB (SE)

BENEFICIARIES

SSAB EMEA AB (SE), Luossavaara-Kiirunavaara AB (SE)

LOCATION

Sweden

SECTOR

Iron and steel

AMOUNT OF INNOVATION FUND GRANT

EUR 143 000 000

GHG EMISSION AVOIDANCE

14.3 Mt CO₂eq (first 10 years of operation)

STARTING DATE

April 2022

PLANNED DATE OF ENTRY INTO OPERATION

Q3 2027 (commercial operation)

A solution to introduce fossil-free steel to the market

Currently, crude iron production in coal-fired blast furnaces, followed by steel manufacturing using oxygen converters, represents 95% of the global steel production from iron ore. This route is particularly suitable to produce high quality and high strength carbon steel, however even a state-of-the-art blast furnace process results in generation of about 1.6 tons of CO₂eq per ton of crude steel (global average approximately 2.2 tons of CO₂eq per ton crude steel). The HYBRIT technology for iron and steelmaking have the potential to make this traditional way of producing steel obsolete.

To this end, the HYBRIT Demonstration project plans to realise the breakthrough of fossil-free steel production by developing a complete, new value chain based on fossil-free hydrogen, resulting in an annual production of 1.2 Mt crude steel. This entails a significant degree of innovation at both technological and logistical levels: with regards to plant design, operating approach, construction, quality, reliability, availability, and maintenance.

The HYBRIT Demonstration project includes the construction of a greenfield, first-of-a kind, full-scale plant for the direct reduction of iron ore with 100% hydrogen. This is a major innovation compared to the best available natural gas-based technologies, which can use hydrogen to only a limited extent. Moreover, the project includes fossil-free hydrogen production via a water electrolysis plant in Gällivare (500 MW), making use of the high shares of wind and hydropower in the electricity production of the region. This constitutes an unprecedented production capacity of fossil-free hydrogen, given that the global production capacity of electrolytic hydrogen amounted to less than 150 MW in 2018.

Moreover, steel production with oxygen converters will also be phased out, as the sponge iron will be designed to be melted in an electric arc furnace. This is a technology that is already established for scrap-based melting but must now be adapted to high shares of hydrogen reduced sponge iron and the production of complex steel qualities.

A significant contribution to decarbonise the iron and steelmaking industry

The HYBRIT Demonstration project will contribute to decarbonise a hard-to-abate sector, the iron and steel industry, by using hydrogen produced with fossil-free electricity. This is a very much-needed building block in industry to deliver the EU's Hydrogen Strategy and help to achieve the objective of EU-wide climate neutrality by 2050. The project will facilitate the transition from fossil-based steel production to a fossil-free one, with the aim of enabling SSAB to introduce fossil-free steel to the market already in 2026. Fossil-free steel will be key to downstream manufacturers' sourcing of fossil-free,

climate neutral and recyclable input material. The solution will potentially avoid 14.3 Mt CO₂eq of GHG over the first ten years of operation, representing 2.5% of Sweden's total annual emissions.

The HYBRIT initiative was mentioned as a leading initiative in the Implementation Plan on energy efficiency for the European Strategic Energy Technology Plan (SET Plan) and it supports the development of renewable fuels based on hydrogen, in line with the priority objectives of the Plan. In addition, the high-grade sponge iron produced by the project can enable the recycling of increased volumes of lower grade secondary steel scrap by mixing the two in the EAF. The project therefore contributes to the EU's circularity objective by providing sustainably produced reusable and recyclable raw material.

The project will have positive impacts on the regional economy, both in terms of employment and contribution to a green economy. Given the fossil-free economy commitment of Sweden for 2045, the steel industry in Sweden is fully dependent on the development of a fossil-free technology. Without the HYBRIT Demonstration project and the succeeding transition it enables, the Swedish steel industry risk a potential loss of over 10 000 direct, indirect and induced employments. On top of reinforcing the existing European steel value chain, the HYBRIT Demonstration project will support the creation of new European value chains, such as electrolyser production and hydrogen storage.

A replicable solution with substantial impacts on the steel production worldwide

The HYBRIT Demonstration project is scalable at project level and at regional level. Besides planning to expand the project by building further production capacity in Gällivare, the on-site hydrogen production and a potential future hydrogen storage is transferable within the sector to other sites, especially considering that the simultaneous development of hydrogen production, storage, transport and end use will de-risk investment and drive self-reinforcing developments. For example, many hydrogen-based industries will benefit from co-locating and "tapping into" an efficient, incremental expansion of the hydrogen production.

At the level of the Swedish economy, the project proposes many technological solutions that are transferrable. For example, the application of hydrogen production that can be replicated in other industrial processes across Sweden and beyond.

The replicability of the technology is associated with huge climate benefits, offering a considerable impact on the steel production worldwide in the steel making from virgin iron ore. As an example, at sector level the technological solution is estimated to be able to reduce emissions by 1 000 Mt CO₂eq per year by 2050.