



Illustration: Josefín Herólf

Roadmap for a competitive fossil-free mining and minerals industry in Sweden

Sweden's mining and minerals sector - an important part of the solution

The Swedish mining and minerals sector has an important role to play in the transition to a sustainable future. Fossil-free systems for energy and transportation, climate-friendly buildings and increased recycling all depend on sustainably produced, high-quality metals and minerals – not least those metals and minerals in modern batteries and infrastructure. The Swedish mining sector is a world leader in the production of raw materials, intermediate products and equipment with a low carbon- and environmental footprint. As part of its efforts to transition to fossil-free production the branch has jointly developed a *Roadmap to a Competitive and Fossil-free Mining and Metals Sector*.

Climate-efficient today

Today the mining and minerals sector generates about 8% of Sweden's CO₂ emissions. Many processes and technologies in use are already fossil-free, particularly in mining operations, which are already extensively electrified. Digitalisation continues to drive efficiency, reducing the sector's overall energy and fuel requirements, and initiatives to further reduce the use of fossil fuels in mining are underway. Fossil fuels and related emissions still arise in transportation, in parts of the mining process, and in the thermochemical processing of ores and minerals, though in a global perspective at relatively low levels.

In the area of metals and mineral processing, more work remains to be done. Both the development of existing technologies and an eventual shift to new technologies and processes will be required. Biofuel can replace some of the fossil fuels used today, but fuel properties and reliable supplies need to be developed. Electric heating technologies can play a role in the long-term, but these are immature today. The HYBRIT project is investigating hydrogen as a reducing agent in ironmaking. Research and development are needed to identify process routes and system solutions for fossil-free production of other metals and minerals. The CemZero project is looking into the possibility to electrify cement production. For process emissions that do not come from fuel combustion, for example when limestone is converted to cement, technologies for capturing and storing and/or utilising CO₂ will be needed.



In 2045 mining and processing of ores and minerals is sustainable for the long-term and climate neutral, and, alongside recycling, able to meet global demand.

The Journey to Fossil-free

One of the most important ways to achieve fossil-free operations is via electrification. Supported by biofuels where electricity can't be used, machines and transportation within mining operations can be fossil-free by 2035. Further automation and digitalisation will reduce energy needs and result in more efficient and optimized vehicle fleet. Infrastructure for charging, possibly alongside hydrogen tanking, will complement a strengthened electricity distribution network. Iron ore processing can be CO₂-free through hydrogen-based reduction by 2045. Process heat for pellets production can be provided by CO₂-free energy, either bioenergy or indirectly from electricity. Processing of other metals can be done without fossil fuels in a broadly similar way. In the processing of limestone indirect electric heating and/or biomass can be used. Process emissions will be managed through CCS or CCU. These investments will be significant, and individual companies will not be able to bear the risks themselves: public sector support will be crucial to the transition.

Needed for the Transition: Electricity, Bioenergy, Research and Innovation

The transition to fossil-free requires extensive investment in research and development. Development of bio-based, electricity-based, and hydrogen-based processes for producing iron, copper, and other metals and minerals is an urgent priority. Efforts at the national level to enable CCS and CCU need to begin. Application, upscaling and commercialization will be challenging. The sector has the ability to contribute to both fundamental research and testing and demonstration, as long as public resources can also be mobilized.

A fossil-free mining and metal sector will need to use more electricity and bioenergy than it does today. As a complement to the roadmap development, a rough estimate of these requirements has been attempted. Compared to today the industry estimates that a fossil-free sector in 2045 would require:

- 1-2 additional TWh of electricity
- 6-7.5 additional TWh of bioenergy

These estimates assume current production volumes and are based on today's knowledge of and best guesses about future technologies. Depending on technological development and pathway choices the results may turn out to be quite different.

Opportunities and barriers

The mining and minerals industry is optimistic that the transition to fossil-free operations will be successful. The required development will take time and capital, however. A long-term approach to political decisions and prioritisation is essential if the industry is to retain its global competitiveness.

The sector is prepared to invest but obstacles will need to be removed along the way. Here politicians have a clear responsibility to maintain a long-term and holistic view.

The most important factors where the public sector can make a difference are:

- Effective and fair permitting processes so that new and necessary, climate-efficient investments can be made possible.
- A holistic approach to political decision-making that avoids suboptimal instruments that weaken competitiveness and make fossil-free operations more difficult
- Investments in research and development for fossil-free production processes and CCS, including test and demonstration facilities
- Conditions that facilitate access to fossil-free electricity at a low total system cost and high reliability.
- Access to bioenergy at a competitive price

Industry, the public sector and other actors need to collaborate to bear the cost of the transition and create the conditions for achieving global and national climate objectives.

This is SveMin

SveMin is a national branch organization for mining, mineral, and metal producers in Sweden with more than 40 member companies active throughout Sweden. Members included mining companies, prospecting and exploration companies, limestone and cement companies and various equipment and service providers.

