Metals & Minerals

impact innovation

With the mission is to ensure a sustainable and resilient metals and minerals supply for the societal transition

Table of contents

1 The program and its mission

This is a summary of the scope and objectives of Metals & Minerals, a program within Impact Innovation, Sweden's innovation investment for the 2030s.

Refer to this document when applying for projects in Metals & Minerals.

1.1 Mission

Ensuring a sustainable and resilient metals and minerals supply for the societal transition.

1.2 Background

Since the industrial revolution, society has enjoyed unprecedented increases in living standards and life expectancy through technological development, minerals and metals, and exploitation of inexpensive energy sources: carbon-based fossil-fuels. Unfortunately, reliance on these energy sources is not sustainable. The toll on nature, including impacts on biodiversity, water, and the emission of greenhouse gases cannot continue. We must find new and sustainable ways to maintain a prosperous and secure existence and ensure that development is continued sustainably in all nations without incurring further damage.

The outlines of sustainable pathways are becoming visible, such as rapid developments in energy generation and use via fossil-free energy and electrification of transportation and industry. To support the pathways, legislation and other measures are being taken to protect land, water and air, to preserve biodiversity, clean freshwater and prevent other types of negative environmental damage and climate change. Most notably, the EU has launched a Green Deal to transform Europe into a modern, resource efficient economy by 2050. Our mission aims to meet this deadline.

For these pathways to be successful, however, enormous amounts of materials are needed – for green energy generation and use both industrially and across society. In addition to the amount, the new technologies – wind, solar power, batteries, hydrogen, digitalization, and communications - require metals and minerals that have not hitherto been used in large quantities, such as Rare Earth Elements and lithium. Thus, pathways to sustainable energy and industry include extensive extraction and recycling of these "new" metals and minerals.

The entire system for transforming society to sustainability is based on materials that should be extracted, used and recycled in sustainable ways. This presupposes extraction not violating human rights or indigenous people and contributing to sustainable local communities. Ensuring the supply of sustainably produced minerals and metals to support the system transformation is the core of our Mission.

This is all the more urgent as mineral extraction and metals production face not only techno-economic challenges such as heavy investment costs and long lead-times, but also environmental challenges such as greenhouse gas emissions, discharges, and biodiversity depletion, and social issues such as land use conflicts and, consequently, general lack of public acceptance.

Additionally, access to raw materials from current, global sources can no longer be taken for granted. China recently restricted export of gallium and germanium, two metals key to the manufacturing of semiconductors and other electronic products, in response to the US prohibiting export of advanced microchips to China. The US, Canada, Australia, and the EU among other countries are developing strategies to secure access to critical raw materials, as countries having access to key raw materials and the technology to process and recycle them will be less sensitive to trade restrictions and geopolitical pressures.

Thus, the European Union has recently launched a Critical Raw Materials Act (CRMA), which identifies a large number of raw materials as critical, some even strategic, for the union and sets challenging goals for domestic supply of these raw materials. As one example, the base metal aluminum and the mineral alumina are listed in the CRMA, since high energy cost has meant that aluminum production in Europe has more than halved in recent years. This means that Europe and Sweden need to import aluminum with larger environmental footprint from less democratic nations.

Within the EU, Sweden is a key player as the country holds mineral potential for the majority of the minerals and metals identified as critical and strategic by EU commission and has access to a virtually fossil-free energy system. This combination has contributed to Sweden being at the forefront in sustainable mining and low-emission metals production. New technology also means that Sweden has minerals with huge potential to reduce the environmental impact of aluminium production. In addition, Sweden leads the development and fossil-free production of advanced metallic materials for a global market. Thus, the country has many of the prerequisites to closing the gap between supply and demand of minerals and metals in place.

Impact Innovation goals: Of the societal challenges addressed by the Impact Innovation initiative, our mission focuses on Production, consumption, and value chains within the boundaries of the planet, with a secondary focus on Attractive and well-functioning communities and contribution to Good and equal health.

Global impacts: In a wider perspective, the activities in Metals & Minerals contribute to the UN’s 17 Sustainable Development Goals and the activities undertaken should show a connection to one or more of these.

1.3 How the mission will be achieved

To achieve the mission, actions must be taken in many areas, including combinations of science, education, and other innovation-strengthening approaches supporting technical, business, policy, and social development.

The goal is to demonstrate that properly orchestrated, the actions will lead to a system capable of fulfilling the mission and achieving increased material output with lower footprint.

1.4 Specific program goals

The program goals are expressed as the following measurable milestones:

1. Significant Swedish contribution to EU:s CRMA goals that at least 10% of the EU's annual strategic raw materials consumption is domestically produced (in EU) and at least 25% is from secondary sources, by 2030.
2. Fossil-free process chains for minerals and metals production by 2045.
3. Significantly reduced environmental footprint of mineral & metals production and use by 2040.
4. Threefold increase in qualified job applicants to the metal and mining industry by 2035 compared to 2020.

2 Scope and action areas

The actions initiated by Metals & Minerals are divided into two main categories:

- Technological Action Areas
- Social and Policy-related Action Areas

Technological action areas include actions to improve process, materials, environmental controls, measurement and digitalization and similar scientific and technical advances.

Societal and policy-related action areas are related to how industry and society interact in order to improve societal benefits and minimize negative consequences of metals and minerals production and use. This category includes consultation processes and civil society engagement, permitting processes, policy and regulations, and education,

There are clear overlaps between these areas because advances in technology often lead to benefits for society, for example lower environmental impact, safer work places, economic benefits, and better quality consumer products. However there are also trade-offs and optimal choices to be taken in order to reach a fossil-free society and simultaneously enabling the sustainable and resilient supply of metals and minerals needed to achieve the mission. This requires a strong attention to system aspects.

2.1 Technological Action Areas

These domains involve initiatives to enhance processes, materials, environmental controls, measurements, digitalization, and comparable scientific and technical advancements.

2.1.1 Exploration and mining

Improving efficiency, safety, and environmental sustainability in the mining industry requires advances in exploration, mining and waste management operations to enhance efficiency, safety, and environmental sustainability in the mining industry.

Development of new models and tools for exploration

Methods, tools and sensor development are needed to improve success rate, ore characterization and lower cost, also modelling tools to predict the presence of mineral and metal deposits (including CRMs), by defining geoscientific vectors. Further integration of multi-disciplinary exploration data at an early stage will also improve mine planning, design, and reduce environmental impact.

System Integration

Exploration is the first link in the mineral and metal value chain. Development of integrated socio-economic mineral exploration models can increase the understanding of, and expand, future search spaces. Improving knowledge of the resource potential and effectively communicating this to decision makers could potentially lead to better resource governance and actively promote investments in the whole exploration industry.

Deep mining

As existing underground mines extend deeper, seismic conditions become more challenging with higher pressures that need rock reinforcement and new mining techniques to reduce risk of collapse or rock bursts.

Fossil-free Mining operation and productivity

Introduction and development of electrical underground machinery is one of the keys to obtaining a fossil-free mining operation. With changes in rock conditions, development of continuous excavation methods and implementing mine planning is a prerequisite for increased productivity. Safety is to be improved by automation, improved ground control methods, and reduced human exposure at mining faces. This will also require the development of new mining methods and remotely controlled and/or autonomous mining equipment.

Waste management

Cost-efficient treatment, reclamation, and prevention technologies to meet more stringent legal requirements are and will be further developed and implemented with integration of closure plans already in the mine planning phase.

Another significant challenge in mining is large volume waste including waste rock and tailings where new and innovative solutions are called upon.

2.1.2 Raw materials resilience

The EU CRMA aims to secure domestic production of critical and strategic raw materials. Another way to increase resilience to material shortages is to enable reduction and substitution of critical substances.

Access from domestic sources

The materials and CRM potential in Sweden and other Nordic countries is high, but several technological and financial challenges must be met to realize the potential. An increased effort in exploration is needed, which in turn requires more investments. New extraction and metallurgical processes for both primary and secondary material streams are required. The EU Battery Directive sets challenging targets for metal recovery rates. The EU CRMA also rises several questions connected to regulation and policies that should be investigated within the framework of this program (see Section 9).

Substitution and tolerances – elements

The chemical composition of an alloy is often specified as weight-percentages of specific constituent elements. However, the desired properties may often be achieved through different alloy recipes or with wider tolerance intervals, sometimes in combination with a modified process route. Better knowledge of these options would allow the actual composition to be selected according to current element availability, thereby increasing resource efficiency and resilience to supply shortages.

2.1.3 Zero emission processing

One part of completing the mission is to eliminate emissions from metals production. A current focus is to eliminate greenhouse gas emissions, although reducing other emissions and impact to air, water, land, and protecting biodiversity are also important to ensure minerals and metals production respect planetary boundaries.

Electrification and fuel substitution

This is a key to eliminating greenhouse gas emissions associated with heating in metals production. The dynamics of electrical heating are, however, different from those of gas heating and have to be well understood to ensure that electrically heated metal will receive the desired properties. Also, current electrical heating systems cannot cover the full temperature range used in metals production. For fuels, substitution is a well-established practice. Combustion fuels are being replaced by resistive or inductive electric heating in many processes, to reduce emissions and dependence on imported fuels. For processes where this has proven insufficient, biofuels are an attractive alternative, particularly as technologies to avoid harmful substances such as VOC are becoming available.

Bio-carbon

Even in a sustainable world, metals production requires carbon, as alloying element, in lubricants, and in many other small but necessary functions. Not least in the Nordic countries, bio-carbon from sustainably extracted biomass is an attractive means to eliminate net greenhouse gas emissions. Work is ongoing to replace fossil carbon with bio-carbon in different processes, but more is needed.

Hydrogen

Replacing carbon with hydrogen as reducing agent in metallurgy has advanced fast and there are many initiatives around the world to implement hydrogen use, at least to some extent. This process change will drive development in process technologies as well as new demands on raw material properties.

Carbon Capture technologies

In cases where it is not feasible to avoid fossil fuels, reductants, or other forms of non-negligible additions of carbon, carbon capture technologies remain a solution to avoid CO2 emissions. In some cases, captured carbon could be reused in the same process or collected for completely different purposes.

Melting

Most metal producing processes include a melting step. All types of melting furnaces have losses of both heat and material. In many cases, the metal composition is adjusted during the melting process. Reactions between metal and its surrounding may decrease the yield of the additions or cause internal defects after solidification. Improved processes could lead to less defects, especially in cast parts.

Sustainable electrode material

The steel and aluminium industries' move toward CO2-free processing has put a significant focus on electrode material. The graphite currently used is fossil-based with China as dominant producer. One big challenge for steel, and the biggest for aluminum, is thus to develop technology and supply for fossil-free electrode materials.

Resource and energy efficiency

An obvious part of the work to eliminate emissions is thrift in resource and energy use. Fossil-free raw materials, process chemicals and energy will lead to new or modified process practices which will need development to achieve energy and resource optimization.

End-of-pipe technologies

To eliminate emissions to air, soil, and water, end-of-pipe technologies are typically used. New and modified processes may generate new types of emissions and thus require new or improved end-of-pipe-technologies, which in turn may generate new types of waste that requires improved recycling practices.

Residuals – metals

The minerals and metals producing industry aims to extract as much valuable elements as economically justifiable from its raw materials. Remaining waste rock, slags, and other residuals could be used for purposes such as construction, water purification, or geopolymers.

2.1.4 New metallurgy

Sweden has been a leading producer of iron and copper for centuries, so the metallurgical process chains for these and similar base metals are well established in industry and education. With the increased demand for more scarce metals, new methods need to be adopted or developed from scratch. Domestic research and education should be established, to ensure sufficient supply of competence.

Extractive metallurgy – Mineral processing

Reducing energy consumption, loss of valuable minerals and lower environmental footprint could be accomplished by more efficient processes and by turning rejects and by-products into products. To improve environmental performance, enhanced water management and environmentally friendly reagents with better performance are called for.

Hydrometallurgy

The emerging need of more scarce metals from primary and secondary sources requires extensive development of hydrometallurgical methods, which should be low-cost and with high environmental performance. Some can be developed in collaboration with international experts but will also require extensive increase in domestic capacity for R&D as well as in education and infrastructure.

Side and waste streams

Residues from minerals and metals production include tailings, slags, sludges, dross, air filter dust and metallic shavings. All of these may pose risks to the environment and human health, but also constitute a resource opportunity. Building on Sweden's strong track record there is much to gain by enhancing valorization of residues. To achieve this, we need to develop our ability to extract metals from secondary materials and create circular business models.

Process chain optimized metal extraction

To further increase metal recovery from ores and increase recycling of metals, looking at the entire processing and recycling chain from a holistic perspective could potentially reduce variations in raw material streams and increase flexibility in processing.

2.1.5 Digitalization

AI, automation, and digital networks can revolutionize minerals and metals production, enhancing efficiency, safety, and product quality while navigating regulatory frameworks.

Artificial Intelligence (AI)

With its revolutionary ability to manage large amounts of data, AI could potentially increase efficiency and create completely new opportunities in many areas of minerals and metals production and use. The possibility to analyze thousands of variables affecting the outcome of a single process step enables deepened understanding of capability, resulting in improved resource efficiency, product quality and performance. This requires access to advanced AI tools and high digitization maturity in companies and among employees. Important regulations via for instance the AI Act and the Cyber Resilience Act are under preparation.

Automation

Two main priorities across the industry are safe working environments and stable and uniform production, both of which can be achieved by a higher degree of automation. As an example, autonomous machines are currently being introduced in Swedish mines. Automation could also increase productivity and eliminate subjective judgements, biased assessments, and obsolete or erroneous quality criteria.

Digital networks

To make full use of AI and other digitalization opportunities, well functioning digital networks are indispensable. Key areas for improvement are interoperability and standardization of data formats, cyber security, data integrity, data ownership and responsibility. Linked to the EU's Green Deal, digital product passports are being developed. Several of the EU acts/directives such as the Data Governance Act, the Digital Market Act, and the Platform-to-Business (P2B) Regulation will set requirements but also open opportunities for data sharing in value chains.

2.1.6 Materials use and development for new applications

The sole purpose of producing minerals and metals is that they are to be applied to fulfil a useful function in society. Functionality can often be achieved by alternative technologies, each dependent on different combinations of elements giving different environmental footprints in production and in use. A central part of ensuring sustainable and resilient metals and minerals supply for the societal transition is therefore to find ways to fulfil required functionalities as sustainably as possible.

Optimal choice and optimization models

Selecting the right material for a given application is a balance between cost and performance. To move towards sustainability, traditional performance criteria such as durability, appearance, and weight are being complemented with sustainability criteria such as CO2 emissions and recyclability.

To get the balance right, models that can weigh together footprints during making, use, and recycling and also consider cost and its effect on market penetration are paramount. By virtue of their deep knowledge regarding their process chain and the design possibilities of their products, the minerals and metals industries are central to creating such models.

Materials development for new applications

Higher-performance materials pave the way for increased efficiency in current applications and open possibilities for future technologies. Examples include the transition to electrical mobility, storage and transport of hydrogen, efficient energy production systems and safe provision of food and water globally. Developing advanced niche materials that act as enablers for society has been a Swedish export success story for decades.

Challenges in materials development which need to be addressed include the need for better theoretical tools to shorten time from idea to market, methods to counteract compositional limitations due to tramp elements in circular materials flows and improvement of properties to ensure longer lifetimes. This includes increasing resistance to corrosion, fatigue, hydrogen degradation and wear, as well as enabling higher and more efficient service temperatures.

Process development for new applications

Materials development goes hand-in-hand with process development to ensure optimal yield and competitive cost profiles. This applies to established processes, such as casting, metal working, joining, and machining, where development is needed to meet new and higher demands. Powder metallurgical routes have enabled many new materials solutions and have yet much unexploited potential. Additive manufacturing has advantages in terms of short production times, near net shape and lightweight construction. However, to be competitive in the market this needs to be achieved with higher process efficiency and improved integration with the powder production.

2.1.7 Circularity

The concept of circularity is to maintain as much of the value invested in primary materials for as long as possible, to minimize the need for new material, thus saving resources such as energy and avoiding CO2-emissions and other environmental loads.

Durability

If materials outlast the service lifetime of the product they are built into, the product design should consider and enable reuse of constituent materials. If not, it should enable easy separation of the constituent materials so that they can be recycled when product or material lifetime is reached. In both cases, industrial design could be applied to blend functionality requirements with material conditions.

Metals recycling & contamination

Due to mixing of metals during recycling, scrap slowly becomes more contaminated by undesirable elements so techniques to remove undesirable elements will be required to ensure product quality. For example, regulation of lead in brass is now being tightened, but methods for removing the lead have so far been tested only on a lab scale. Keeping different metals apart increases their recycling value. Sorting of scrap into finer and thus more valuable fractions is becoming more feasible as image and laser analysis enable faster and more accurate sorting.

One key for efficient recycling is appropriate legislation. As the preceding step to recycling per definition is waste, legislation for waste handling should be designed so as to not complicate recycling, nor make it unnecessarily expensive (see section 9).

Scrap supply

One way to increase scrap supply is to consider previously ignored or unavailable material flows. In the foundry industry, internal scrap has typically been considered as a complementary raw material, or even waste. Recently, however, it has been shown that internal scrap could become a full-fledged raw material source. Similar developments are underway for metallic leftovers from waste incineration. There are also major efforts made to increase the recycling of aluminum.

New business models including closed loops

Some key metal-containing items are handled in closed loops, so end-of-life products are sent back to the producer to be reprocessed. One example is car batteries, another is cutting tools, both of which are small and well-defined components that contain large fractions of valuable metals. A main challenge is that most assemblies contain many different metals and alloys that have to be separated before recycling.

With increasing demand for recycled metal and requirements on traceability in place, such as Europe's Eco Design Directive, technologies to sort disassembled parts in a simple and straightforward manner are becoming more interesting. Accompanied by business models that make it attractive for metal users to take advantage of the new opportunities, metal circulation could be significantly strengthened.

LCA and global standards for material sustainability

Durable materials reduce the need for new materials but are often more complex and demand more resources to make and/or are more difficult to recycle compared to less durable. To select the most sustainable material for a given application, Life Cycle Analysis (LCA) is required. By introducing standards with stricter data requirements that cover all or most significant variables, also including the use phase and end of life of materials, the values of LCAs and thus the ability to make sustainable material selections would be strengthened. For environmental aspects which are not fully developed in LCA, as well as for social impact, methods or standards need to be further developed.

Traceability

To secure information on metal content and environmental footprint throughout the value stream, tracing of individual products is necessary. Tracing is also important for returning critical conflict metals to their origin or preventing theft. Traceability is also actualized through Digital Product Passports. Today attempts at tracing are made, but to succeed on an industrial and commercial scale, technology development, standards for information flows, and understanding of how different traceability techniques affect product tolerances are required. Critical metals such as precious metals, rare earth metals and lithium generally lack established recycling systems. Traceability or other methods to know the accurate composition of metal parts are possible solutions.

2.1.8 Other environmental priorities

Biodiversity

The Swedish mining and metals industry is striving to include biodiversity and ecosystem services in its daily operations. Performing rehabilitation with social and ecological added value and ecological compensation is becoming an established practice. To strengthen this, tools to identify, quantify, estimate, and evaluate the benefits and improvements of biodiversity and ecological compensation are called for, as well as models to evaluate environmental impact on the downstream ground water, surface water, and soil in relation to biodiversity.

Water management

To avoid pollutants from minerals and metals production in water, integration to maximize water recycling in closed loops and prevention of dissolution and mobilization of metals are promising development steps. To treat water as early in the process as possible, novel treatments using bioreactors, fungus, and bacteria, and nano technology for removing harmful elements will be evaluated.

2.2 Social and policy-related Action Areas

The societal and policy-oriented focus areas pertain to the interaction between industry and society, aiming to enhance societal benefits and mitigate adverse impacts of metals and minerals production and utilization. These encompass consultation procedures, civil society involvement, permitting processes, policy formulation and enforcement, as well as educational initiatives.

2.2.1 Social goals

Recognizing the community-wide impact of the minerals and metals producing industries is important to improve community relations and other social goals which are being increasingly scrutinized by customers, investors, and prospective employees. This involves recognizing positive and negative impacts of mining and metals production on society at primarily local and regional but also national and global levels. To do this, improved consultation processes and stakeholder engagement is needed. Furthermore, adoption of Swedish technology into operations in other countries is an opportunity for improving environmental conditions, increasing the competitiveness of Swedish suppliers and a part of ensuring a sustainable and resilient supply.

2.2.2 Competence supply

Sufficient competence supply is a prerequisite for a successful transformation. This requires that individuals view the industry sector as an interesting and rewarding career opportunity, which in turn requires the industry, and the places where it operates, to be attractive. Promising approaches to determine and develop community and company attractiveness are under development.

2.2.3 Education

Indispensable to competence supply is a well-functioning education system. One current issue is the shortage of masters' and doctoral students as well as vocational students in relevant fields. Other issues are young peoples' low interest in natural sciences and technology, and poor mobility of researchers between industry and academia as well as of students and researchers between national universities. Doctoral courses that provide overview by putting the individual's research in a wider context, and modules for professional engineers to update their knowledge in yet unknown but emerging fields in their respective areas, are also called for.

In short, education must keep pace with the increasing demands and complexity of industrial development. The current empirical understanding must be complemented by deeper theoretical understanding in tandem with cross-disciplinary learning.

2.2.4 Policy development and standards

Policies and regulations typically aim at eliminating risks, negative impacts, and inappropriate practices to promote and contribute to a desirable development. Standards aim for harmonization of methodologies, reporting and communication methods and can sometimes be used to demonstrate compliance with legal and other requirements. Unfortunately, they may sometimes also stand in the way of desirable developments.

2.2.5 Predictable permit processes

It is completely understandable that processes to obtain permission to mineral exploration, open mines, or establish or expand other industrial activities along the minerals and metals process chain are challenging, complex and comprehensive. However, these processes are today unpredictable. Criteria are unclear and inconsistently applied, and processing times unacceptably long and uncertain. This unpredictability inhibits the investments required for accessing the metals and minerals needed. To improve this, policies and working processes need to be updated. This is a key goal for the program's policy development efforts.

Effective permit processes also require better understanding of the operations' societal impacts, including legislation and its application, employment and income generation, distributional effects, land use conflicts, indigenous rights, demographics, and cultural heritages, which connects them with societal development.

2.2.6 Harmonizing policies

As a result of the ambitions set out in the EU Green Deal, new legislative proposals are being put forward and existing legislations are being revised, including, but not limited to, the Industrial Emissions Directive, the Water Framework Directive, the Soil Monitoring Law, the Nature Restoration Law, and the Critical Raw Materials Act.

There is clearly a risk that this multitude of legislative proposals may overlap and interact. Analyses and measures to ensure that no legislation defeats the purpose of any other are therefore urgently called for. In this context it is imperative that Science Based and other targets include trade-offs to enable adjustment of limits in cases where much larger benefits in other areas are within reach.

One challenge is that a classification as waste shifts the burden of proof to the producers, which is an obstacle to efficient utilization. Policies aiming to promote circularity of resources and thus reduce waste and demand for primary raw materials are being introduced by the EU.

2.2.7 Standardization

New requirements for sustainability declarations and reporting, and requests for possible comparability between products, materials and companies, have led to many proposals for new standards and other protocols. For a successful transition, it is imperative that adopted proposals drive development in the desired direction, are transparent and understandable for stakeholders and makes it possible to compare and evaluate against “business-as-usual". This area has a strong cross-over with the needed technology to enable traceability and proper evaluation of environmental impacts and trade-offs for optimal choices.

2.2.8 Internationalization

The internationalization work in the project aims to tackle global challenges and lead internationally by leveraging existing connections. It involves establishing and nurturing international networks, forging partnerships within and outside the EU, and expanding reach across various levels, from national to regional.

2.2.9 Attractiveness

Attractiveness is in itself an important societal topic for the mission. Mining and metals producing companies are typically the dominating employer in smaller towns and communities, and the attractiveness of the community is equally important to that of the company when it comes to recruiting and retaining staff.

3 Program Office

The Program Office for *Metals & Minerals* brings with it trust built up during a decade by the two program offices that since 2013 have been running the successful strategic innovation programs (SIP): Swedish Mining Innovation and Metallic Materials, which between them have had 500 companies, 25 universities and 10 research institutes investing more than 2 000 man-years in research and development, and other activities, to strengthen global competitiveness and sustainability.

As program stakeholders are distributed all over Sweden, Program Office staff will be present at five geographic locations. The main office will be situated in Stockholm, in the Jernkontoret building.

Another office will be located in Luleå in the north, close to the largest mining operations and a third in Örebro. A fourth will be located in Jönköping in the south, where most aluminium, foundry, and recycling industries are located, and the fifth in Sandviken, in mid-Sweden, where much of the steel industry is located. This way all players involved in the program will have Program Office representatives nearby.

3.1 Program Office partners

The *Metals&Minerals* Program Office partners are industry associations, representing the whole value chain from exploration of mineral deposits to commercial metal and even semi-finished and finished metal components, plus two universities and one organization specialized in supporting regional and SME development.

This means the partners have well established networks within their respective industries and with regional, national and EU authorities, policymakers, and academia, in addition to the experience with innovation program management described above.

The partners also have access to experts in social development and innovation, both internally and through external consultants and scientists.

The program office partners are backed by the industry associations' members, including both larger companies and SMEs, as they see the ongoing transformation as a huge opportunity to make the world more sustainable and at the same time strengthen their global competitiveness. Their common commitment to reducing the footprint of their activities in general, and bringing greenhouse gas emissions to zero in particular, is therefore strong and unambiguous.

3.1.1 Other actors engaged in the program

Other actors supporting the *Metals&Minerals* program include manufacturing companies, academia, research institutes, municipalities, trade unions, and authorities.

Manufacturing companies set ambitious sustainability goals for their operations, and materials are key to meeting them. Current European standards take footprint parameters such as the CO2 of input materials into consideration in what is defined as "Scope 3 upstream emissions" so the expertise in the metals and minerals process chain is necessary. Therefore, many manufacturers support the program and bring the "demander-perspective", helping upstream players in the value chain to understand what matters and thus to keep focus on development lines that could potentially make a difference.

Authorities need the expertise in the metals and minerals process chain to make balanced and fair decisions on any matter involving the minerals and metals producing industry. They also bring legislators' perspective to the program.

Academia supports the program as it offers relevant and interesting research questions, whose answering will also make substantial contributions to sustainability. Academic participation and engagement in the program is crucial, as research partners and educators.

Institutes The consolidated research institute *RISE* and particularly the dedicated mining and steel institute *Swerim* play a key role in maintaining focus on transformation issues within the industries and their immediate surroundings. The *Stockholm Environment Institute* has been working together with the mining and steel industry in Sweden for nearly a decade.

Municipalities and regions are facing challenges. Some analysts claim that northern Sweden has to grow by 100 000 inhabitants until 2030, to ensure competence supply for the transformation. This also challenges those areas in Sweden where the sought-for people are working today. Municipalities have to improve their attractiveness, by understanding their authentic, true values and use them to build attractive and sustainable communities for the future.

Trade unions see the transformation as an opportunity to increase competitiveness and create more and better job opportunities, but at the same time want to ensure that it brings fair chances also for those already employed.

3.2 Contact

If you would like to get in touch with the program, please contact one of the contact persons below.

Maria Swartling
Program director
maria.swartling@susreg.se
+46 70 256 43 73

Lawrence Hooey
Technology and Innovation Manager
lawrence.hooey@ltu.se
+46 76 129 66 02

Lars Teglund
Communication Manager
lars.teglund@ltubusiness.se
+46 73 810 61 91