
The Swedish mining sector in sustainable futures

SEI report
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Executive summary

The mining and minerals sectors are in a challenging position when it comes to sustainable development. On the one hand, transitions to low- or zero-carbon energy systems and fulfilment of the UN 2030 Agenda will require large amounts of material resources. On the other hand, mining operations are associated with a range of sustainability issues including negative local environmental impacts, emissions of greenhouse gases and socioeconomic tensions. This is a dilemma for the mining sector and for society at large.

This report presents the results from a collaborative project run by Svemin, the Swedish association of mines, mineral and metal producers, and SEI. The project examined the interactions between the mining sector and wider society and how these could play out in a sustainable transformation. The project was carried out from January 2018 to May 2019.

The project used exploratory scenarios as a tool to develop a set of action points for how the Swedish mining sector can navigate towards a sustainable future in an uncertain world. Input from several stakeholder workshops resulted in four scenarios that outline how society might evolve up until 2050 and how different circumstances might affect the Swedish mining sector. The process generated more than 200 suggested action points. These were screened for robustness, which resulted in a selection of 31 particularly important action points that were compiled into what could act as a draft sustainability roadmap for the Swedish mining sector. The 31 action points cover a broad array of topics that were compiled under six different headings. These are as follows:

- Develop a collaborative approach to sustainable raw materials supply
- Define “sustainable mining” in dialogue with the global community
- Develop the permitting processes, taking a wide range of sustainability considerations into account
- Make the mining sector an increasingly circular raw material hub for society
- Build credibility and create business value through transparency and traceability
- Strengthen engagement locally and nationally

SEI researchers then analysed the action points from a broader perspective, taking into account the UN 2030 Agenda as well as human rights and Indigenous rights. The analysis found many promising initiatives among the set of action points, including strong climate change mitigation ambitions, initiatives towards improved supply chain transparency and traceability, as well as more equitable dialogues with local actors impacted by mining projects. However, additional steps are recommended, notably the need for the Swedish mining industry to demonstrate leadership and take responsibility with regard to land use conflicts, especially pertaining to human rights and Indigenous Sami rights. Without a strengthened approach in this area, human rights issues and Indigenous rights issues are likely to remain unaddressed, reflecting poorly on the reputation of the mining industry and causing deeper regulatory uncertainty. As part of a strategy to reduce the risk of land use conflict in the longer term, the SEI analysis also recommends that the Swedish mining sector continues to build on existing conceptual ideas of “zero-impact mining”, that envision a radical reduction in surface impacts of new mining projects.

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1. Introduction

The mining and minerals sectors are in a challenging position when it comes to sustainable development. On the one hand, transition to low- or zero-carbon energy systems and fulfilment of the UN 2030 Agenda will require large amounts of material resources. On the other hand, mining operations have historically been, and are still, associated with a range of negative local environmental impacts, emissions of greenhouse gases and socioeconomic tensions (Azapagic 2004). Herein lies a dilemma for the mining sector and for society at large (Ali et al. 2017).

1.1 Socioeconomic development and raw material demand

In September 2015, the UN General Assembly formally adopted the 17 Sustainable Development Goals (SDGs) as the central component of the 2030 Agenda (UN General Assembly 2015). At the end of the same year, the adoption of the Paris Agreement (United Nations 2015) put into place a global action plan aimed at combating climate change. In terms of global governance relating to sustainability transitions, 2015 was thus a very noteworthy year. However, the agreements alone will have little value unless they are implemented on the ground. Shifting ambition from text in a document to actual improvements in the way societies access energy, provide food and shelter and produce goods will require strong commitments, vast capital investments and large amounts of raw materials (OECD 2019).

Past, present and future perspectives on societal material demand

The naming of various phases in the history of civilizations (e.g. the stone, bronze and iron ages) illustrate that materials of various sorts have been absolutely fundamental to human development. Improvements in human prosperity have invariably been accompanied not only by increases in the demand for raw materials, but also in a growing diversity of materials used. As societies have become increasingly complex, the ways in which they use materials have become more and more sophisticated. Demand for materials that perform very specific functions has led to the development of a large number of specialized materials (Kesler and Simon 2015; Smil 2013).

In terms of current global use, mineral-based materials of various forms dominate completely. Bulk construction aggregate such as stone, gravel and sand makes up a large majority of total global use of materials (OECD 2019; Smil 2013). Among metals, iron – primarily in the form of steel – is by far the most widely used: the world uses approximately 20 times as much iron as all other metals put together. Other metals used in large volumes and for a wide range of applications include aluminum, copper, zinc and nickel (Smil 2016). But sheer quantity does not say everything about the importance of a material. Much of the recent discussion on current raw material demand has been on “specialty” metals, including cobalt, platinum and the 17 so-called rare-earth elements, largely because of their importance as functional materials in modern electronics and renewable energy technologies (Deetman et al. 2018).

Projected demand for raw materials in the coming decades would require both new forms of materials (Ali 2018) and the use of increasing amounts of materials (OECD 2019). This is partly due to a continuing strong historical association between raw material use and economic growth; a connection that tends to be especially strong in emerging economies where large investments are needed to meet growing demand for infrastructure, housing and societal services (OECD 2019). Furthermore, transitions towards low-carbon energy systems will entail an increase in material intensity compared to traditional (i.e. largely fuel-based) energy infrastructure (Drexhage et al. 2017). This is a consequence of an expected growing reliance on “manufactured” energy technologies (Benham 2018) such as solar photovoltaics, wind turbines and Li-ion batteries, resulting in a relative shift in resource use from fossil fuels to material resources (2019).

Meeting growing demand for raw materials in a sustainable way

The expected continued growth in global material demand poses the question of how this demand can be met. While there is broad consensus that there will be a continued increase in global demand for minerals, it is very difficult to quantify long-term demand. Drastically different conclusions can be drawn depending on assumptions made about technological pathways and material substitution (Månberger and Stenqvist 2018). Another key question is the balance between recycling and extraction of primary raw materials.

Aspirations for more circular resource flows are based on assumptions that a growing share of global demand for raw materials will be met by substitution, recycling and other forms of circular approaches to resource use (OECD 2019). Having said this, given the strong connection between economic growth and raw material demand, continued extraction of primary resources is likely to increase for the foreseeable future (Smil 2013; Kesler and Simon 2015; OECD 2019).

Several recent studies have highlighted the expected expansion of global minerals extraction as cause for concern, because the global mining sector is associated with a number of sustainability challenges (Ali et al. 2017). These range from environmental issues such as adverse effects on air, soil and water quality and biodiversity, to socio-economic issues linked to labour conditions and distribution of benefits, and competition for land and resources with other actors, including impacts on the livelihoods and rights of Indigenous and local communities (UNEP 2013; Rodrigues and Mendes 2018).

The UN 2030 Agenda has brought about several analyses of the connections between mining and the 17 Sustainable Development Goals (SDGs; see page 20). Sonesson et al. (2016) mapped best practices for how the mining sector could contribute to fulfilling each of the goals. The study argues that priority should be on the goals that address environmental issues (SDGs 6, 7, 13 and 15), social inclusion (SDGs 1, 5, 10 and 16) and economic development (SDGs 8, 9 and 12). Taking a different perspective, de Mesquita et al. (2017) review the extent to which available research on the mining sector has addressed different SDGs and find that while there have been many studies on the impacts of mining on local environments, there has been less focus on issues such as poverty alleviation, hunger and malnutrition, and marine biodiversity.

What is clear is that the discussion is intensifying on the opportunities and risks around the role of mining in transitions to sustainability. The discussion partly concerns the actual availability of mineral resources, in relation to which Ali et al. (2017) argue that strong international governance is needed to make sure that adequate supply is available over the coming decades. In contrast, Tilton et al. (2018) take a more market-based perspective and make the point that although there may be short-term raw material scarcities, higher prices will incentivize new production or substitution. Notwithstanding these different perspectives on availability, both studies emphasize the need for policy interventions to deal with negative effects (externalities) from mineral extraction. This has also been highlighted in a recent report on the global mining sector by the UNEP International Resource Panel (IRP 2019), which argues that policy instruments have not been sufficient to establish on-the-ground practices that are in line with principles of sustainable development.

1.2 The Swedish mining and minerals economy

Mineral extraction and metals processing have been key components of the Swedish economy for most of the country's history and this remains the case today. There are in total 15 metal mines in operation in Sweden, the oldest one of which has been producing since at least the thirteenth century (SGU 2019). Six of the 15 mines produce iron ore and the remaining nine produce base metals and/or gold. In addition, in 2017 production of industrial minerals such as limestone, dolomite and quartz was ongoing at 36 different sites (SGU 2018). Geographically, the metal mines are mainly located in three regions: the two northernmost Swedish counties Norrbotten and Västerbotten, and the south-central Bergslagen region, the latter being the historical centre of the Swedish mining and metals processing sector. Production of industrial minerals primarily takes place in the southern half of the country, with substantial limestone production on the Baltic Sea island of Gotland (SGU 2019).

In terms of companies, products and markets, the Swedish mining and minerals sector is relatively concentrated, but in several ways also quite diverse. The two most prominent actors are arguably *Boliden AB*, a privately owned (publicly traded) producer of a rather wide range of metals, including substantial volumes produced through recycling and reprocessing of, e.g., electronic equipment (Boliden 2019), and *LKAB*, a state-owned company that primarily produces iron ore (LKAB 2019). In industrial minerals, key actors include *Nordkalk* and *Cementa AB* (a subsidiary of Heidelberg Cement) both of which produce limestone for various applications, including as the key input in cement production.

It is also important to mention *Epiroc AB*, *Sandvik AB* and *ABB*. These are three Swedish companies that are world-leading suppliers of mining equipment and that have a successful history of collaboration with

Swedish mine operators (Svemin 2012; Tillväxtanalys 2016). This is an example of how mining operations in Sweden are part of a broader Swedish mining and minerals economy, sometimes referred to as “the Swedish mining cluster” (IF Metall 2015; Tillväxtanalys 2017). This includes metals processing industries (e.g. steel production and smelting facilities) as well as manufacturers and developers of mining equipment and machinery. The latter have tended to be very competitive on global markets, partly as a result of experience gained from developing products for challenging geological conditions in Sweden (Nuur et al. 2018).

A consequence of the integration of the mining sector into these associated value chains is that it is not straightforward to estimate its size. For example, Tillväxtanalys (2016) estimates that in 2013, the mining sector by itself generated about SEK 21 billion in value-added, an amount that grows to SEK 44 billion if the whole mining cluster is included.

In terms of job creation, the Swedish mining sector directly employs around 7000 people (SGU 2018) but to this can be added indirect and induced employment in sectors that supply equipment, technical expertise and other services to the sector (Ejdemo 2013). These effects become particularly important when seen from a more local perspective, because the concentration of the mining sector in specific regions means that it plays a very large role for some local and regional economies. For example, whereas nationally the 2016 share of mineral extraction in total business-sector value added was 0.7%, it was 4.5% in Västerbotten county and 16.7% in Norrbotten county (Statistics Sweden 2018). This is reflected especially in towns like the Norrbotten town of Kiruna that was founded around mining (Kiruna kommun 2000). Finally, in addition to its value as measured in national accounts, the Swedish mining sector is important from an EU-wide perspective because, for example, 90% of EU iron ore mining takes place in Sweden (Tillväxtanalys 2016).

While acknowledging the role of the mining sector geographically and as part of a broader value chain, this report will focus on mining operations in Sweden and in a Swedish institutional setting. After a long period of decline in the number of mines in operation in Sweden, the past decade has seen growing interest in establishing new mines, as well as several projects aimed at resuming operations in abandoned ones. However, few mines have come into operation, mainly because plans have been held up due to legal appeals, court challenges and opposition from, among others, Indigenous Sami reindeer herding communities and environmental groups (Haikola and Anshelm 2016). Moreover, the Swedish state has received repeated criticism from international bodies regarding its failure to comply with obligations to protect Sami rights.¹ Whereas this criticism is directed at the state as the duty-bearer under international law, it could also damage the credibility of the mining industry unless it is able to show how it ensures ethical performance through voluntary commitments and actions in the face of the state’s regulatory failures. While Sweden is generally viewed as a very favourable country for mining companies to operate in, developments in recent years have reduced its attractiveness (Stedman and Green 2019).

1.3 What is the role of the Swedish mining sector in a sustainable future?

The project presented in this report aimed to take a closer look at the interactions between society and the mining sector in a sustainable transformation, by exploring the possible futures of a sustainable Swedish mining sector in an uncertain world.

The Swedish mining industry and the value chains it supplies has stated ambitions to stay at the forefront of technological and innovative development in a transformation to a sustainable society (Svemin 2018). As noted in section 1.1, a sustainable future will need raw materials from the mining sector for many applications, including sustainable energy supply and electrification of formerly fossil-based economic activities. At the same time, the current footprint and operations of the mining sector present clear sustainability challenges. This dilemma raises important questions such as:

- How can the Swedish mining sector be part of the societal transformation to sustainability?
- How can it continue to add value to the economy while embracing the sustainable development agenda?
- How can it be a driver of change, rather than simply respond to societal change?

¹ See e.g. the United Nations Committee on the Elimination of Racial Discrimination, Concluding observations on the combined twenty-second and twenty-third periodic reports of Sweden (CERD/C/SWE/CO/22-23). Renewed criticism was also provided by the Council of Europe on 12 Sept. 2018, see Resolution CM/Res(2018)9 on the implementation of the Framework Convention for the Protection of National Minorities by Sweden.

This project was a collaboration between Svemin (the Swedish association of mines, mineral and metal producers) and SEI. The project was financed by SIP-STRIM, a strategic innovation programme for the Swedish mining and metal producing industry run by The Swedish Research Council Formas, the Swedish Energy Agency and Vinnova, and was carried out from January 2018 to May 2019.

This report is structured as follows:

- **Chapter 2** presents the overall methodological approach of the project and an overview of the project's work process.
- **Chapter 3** includes narrative descriptions of the four scenarios that form the contextual background for the process.
- **Chapter 4** presents a set of action points for mining in sustainable futures developed over the course of the project and that can act as a draft sustainability roadmap for the Swedish mining sector
- **Chapter 5** summarizes the result of two workshops at which the draft sustainability roadmap was checked against the 17 Sustainable Development Goals (SDGs)
- **Chapter 6** contains an analysis of the draft sustainability roadmap by a group of SEI researchers
- **Chapter 7** includes comments by Svemin on the SEI analysis
- **Chapter 8** summarizes the overall conclusions of the project.

2. Methodology

2.1 Exploratory scenarios

The future role of the Swedish mining industry will depend on developments in Sweden and around the world on a range of environmental, economic and socio-political issues. These issues will affect not only the markets in which Swedish mining companies are active, but also the broader political and institutional context that they operate in. A key component of this project has been the use of *exploratory scenarios* as a tool to develop a set of action points for how the Swedish mining sector can navigate towards a sustainable future, taking into account as broad a set of future developments as possible.

The approach to scenario building for future planning adopted in this project has its roots in the military sector, in which there has been particular interest in how different combinations of outcomes could be combined into a worst case scenario from a security perspective. In the 1970s, multinational companies started to use scenarios as a tool for long-term strategic planning. Most well-known for its long-term work with explorative scenario development is Royal Dutch Shell, which, using scenarios in its strategic analysis, managed to cope with the oil crisis in 1973–74 better than its competitors (Wack 1985).

However, scenario development is not a unified method, but should rather be seen as a collective term for a number of different approaches that can be used to better understand the implications of future events.²

Predictive scenarios or forecasts take the current situation as a starting point and try to predict how the future might develop based on assumptions about what drives societal development. In their simplest form, predictive scenarios can be based on pure extrapolation of time series, but they can also be based on complex dynamic models. Predictive scenarios are commonly used for near-term time horizons, e.g. in weather forecasts or when projecting next-quarter economic developments of a business or a nation.

Normative scenarios or “back-casting” reverses the reasoning. Normative scenarios take a desirable future state as the starting point, and then try to analyze how best to navigate from today’s situation to the desirable future. Normative scenarios are often used to study how different policies or strategies could affect development. For this reason, they are also often called “policy scenarios”. The time horizon for normative scenarios is longer and usually stretches out one or more decades into the future. Normative scenarios can sometimes come in sets, differentiated by policy orientations that lead in different directions.

A drawback of both predictive and normative scenarios is that they may have limited capability to take into account the wide range of uncertainties which can fundamentally change conditions that determine future developments. This is a problem that grows the further into the future the scenario study extends. A third category, *exploratory scenarios*, aims to offset this problem by basing scenarios on current best knowledge of the uncertainties that might affect future events. Exploratory scenarios combine different uncertainties to create a set of scenarios, each based on a logically consistent combination of the different states that the various uncertainties can assume. The simplest variant of this type of scenario is based on creating a two-by-two matrix of two independent dominant uncertainties, in which each of the four fields receives a unique combination of states as the starting point for the scenario. The shared socioeconomic pathways (SSPs) used by the Intergovernmental Panel on Climate Change (IPCC) are an example of this approach (2013).

The purpose of explorative scenarios is to understand the span of *possible*, but distinctly different, outcomes, in order to increase one’s own readiness for alternative developments. Exploratory scenarios can also be used to test how robust or stress-sensitive a company or policy is when it comes to coping with different potential futures.

2.2 Process description

The process in this project was centred around a series of participatory workshops aimed at exploring potential development paths for the Swedish mining sector in a time horizon ranging from the present (2018–2019) until 2050 (Figure 1 gives an overview of the process).

² See Börjeson et al. (2006) for a comprehensive overview of different scenario methodologies.

The purpose of **workshop 1**, (May 2018), was to develop explorative scenarios. The workshop hosted about 40 participants from the business community, academia, the public sector and civil society. The main input was a set of four global scenarios previously developed by SEI together with the Swedish steel industry (2015). These scenarios were used because, while they take a global perspective, they had also been developed in a Swedish context and would thus be relevant for the purpose. Participants adapted the scenarios, describing them in greater detail so that they were particularly relevant for the Swedish mining sector and identifying issues that need to be considered in order to assess what the sector would face in each set of circumstances.

Workshop 2 (September 2018) was attended by almost the same group of participants as workshop 1. The workshop identified actions (such as strategic partnerships, public and corporate policies and procedures, research efforts or business models) that were considered most important for managing the situations presented in each scenario. These strategic action points were discussed from three different perspectives:

- *economic-ecological* sustainability: including resource efficiency, recycling, process technology, emission intensities and capital investments.
- *socioeconomic* sustainability: including employment, communal acceptance, skills requirements, education collaboration, health and safety, and investments in human capital.
- *local-to-global* sustainability: including economic democracy and local involvement and development, as well as trade partnerships and governance thereof.

Participants in the workshop submitted more than 200 action points, all of which can be viewed in Appendix 1 (in Swedish). After SEI had merged submissions with common themes, the remaining action points were categorized under approximately 30 sub-headings.

In **workshop 3** (October 2018), the set of action points was subjected to a robustness test conducted by a core team from Svemin and facilitated by SEI. Here, the different sub-headings were analyzed and scored depending on how functional (i.e. effective, efficient, suitable and purposeful) they would be in each of the four scenarios. The exercise aimed to find a list of action points thought to work well in as many scenarios as possible, i.e., a list of robust “no-regret” action points. The outcome of this exercise was a list of 31 actions that were categorized under six different headings suggested by SEI. These were then reviewed by the Svemin core team and iteratively adjusted between mid-November and mid-December 2018.

In **workshop 4** (December 2018) the set of action points was mapped against the SDGs by participants from members of Svemin’s sustainability network, mainly composed of sustainability directors at the largest Swedish mining companies. The objective of the workshop was to get an understanding of the extent to which the set of action points making up a draft sustainability roadmap addressed the aims of the 17 SDGs and to gather suggestions for how the set of action points could be improved.

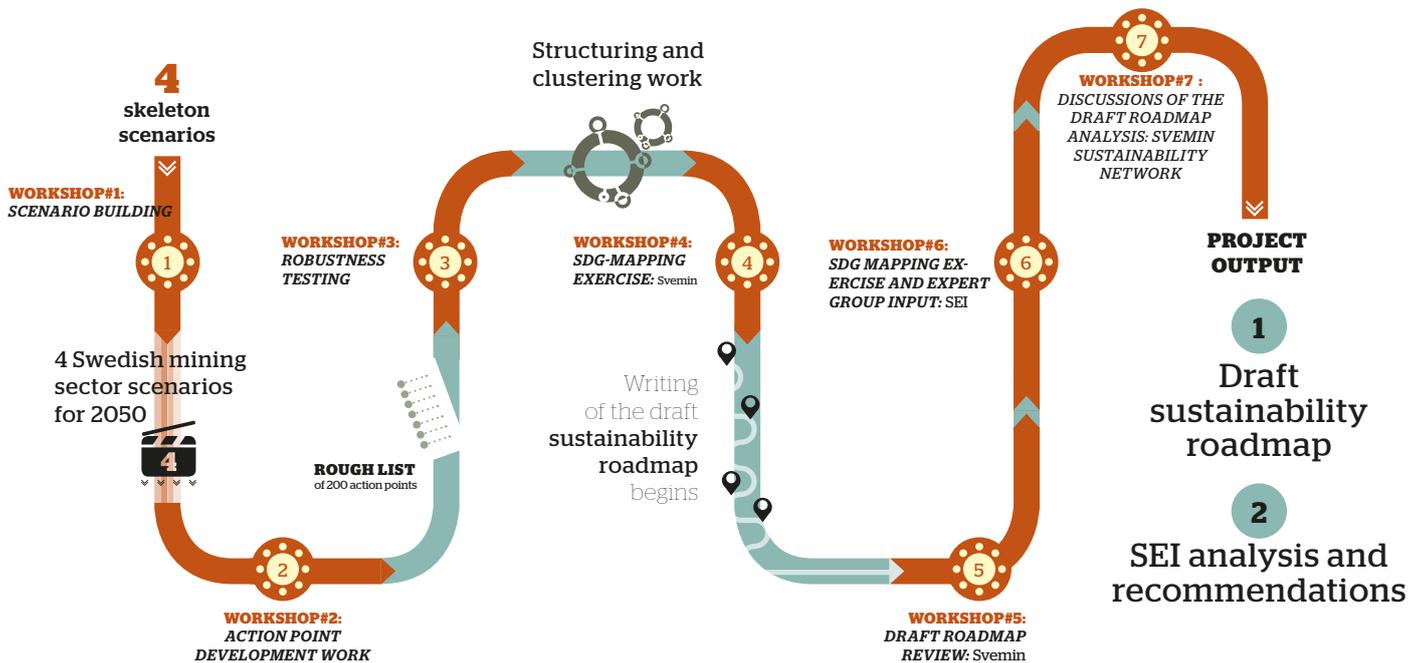
During **workshop 5** (March 2019), a group of directors from Sweden’s mining companies discussed and suggested minor edits to the draft roadmap, including a reordering of some of the action points.

Workshop 6 (March 2019) was internal to SEI. Six researchers analyzed the draft sustainability roadmap, including from the perspectives of the SDGs and international norms on corporate accountability. There was a particular focus on what was missing among the set of action points, and how it could be improved and implemented. The workshop included a session where the SEI researchers carried out the same SDG mapping exercise as done by the Svemin sustainability network in workshop 4.

The objective of **workshop 7** (April 2019) was for Svemin’s sustainability network to feedback on the analysis of the action points done by the team of SEI researchers in workshop 6.

After the final workshop, SEI drafted a full version of the project report (this document – the final component of the project) which Svemin then commented on. These comments can be found in section 7 of this report.

Figure 1. Flowchart description of the project work process.



2.3 Methodological reflections: managing diverse perspectives

In participatory processes a central methodological principle is to be transparent when perspectives and opinions diverge and to manage differences (Roling and Wagemakers 1998). In this project, while several arguments found common resonance, there was substantial diversity in perspectives among Svemin, SEI and workshop participants (notably in workshops 1 and 2, which included people external to the industry). In this project and report we have aimed to benefit from this diversity and be transparent about it. The following points are especially worth emphasizing.

- The scenarios developed in workshop 1 and the more than 200 suggested action points that came out of workshop 2 are – as in all participatory processes – a reflection of the constellation of participants. Approximately half the participants represented the Swedish mining industry and associated business sectors, about a quarter were from the public sector (governmental agencies & municipalities) and approximately an eighth each from academia and civil society (e.g. environmental NGOs). However, despite efforts made to attract diverse participation, other important actors (e.g. Sami organizations) had limited presence.
- Discussions at both workshop 1 and 2 revealed diverging perspectives on a range of issues. While SEI has made an effort to pull together workshop inputs, it is important to note that this does not suggest that there was consensus. Partly for this reason, names of individual participants are not listed in this report, because doing so could give the impression that they have consented to the findings.
- The robustness test carried out in workshop 3 was designed to screen the action points from workshop 2 and identify those that would work in as many scenarios as possible. This exercise was carried out by the Svemin core team in a process facilitated by SEI. It is important to note that the outcome of the screening process could have been different if carried out by another set of people.
- Finally, to be explicit about the points where Svemin and SEI hold diverging opinions, this report allows SEI and Svemin to express their views independently (see sections 6 and 7).

3. Four different futures for the Swedish mining industry

This section presents four scenarios for the development of the Swedish mining industry up to the year 2050. The four scenarios, originating from a project carried out by SEI and the Swedish Steel Producers' Association (2015), were adapted in the first workshop to focus on the development of the mining and minerals sector. In addition, the objective was to frame developments in a Swedish-oriented geographical context, whereas the original scenarios were more globally focused. The purpose of the scenarios was to create a narrative that could be used as a basis for formulating long-term sustainability strategies for the Swedish mining and minerals industry. In this section, one-page summaries of the four scenarios are presented. Annex 2 includes longer narratives of the four scenarios as they were developed in workshop 1.

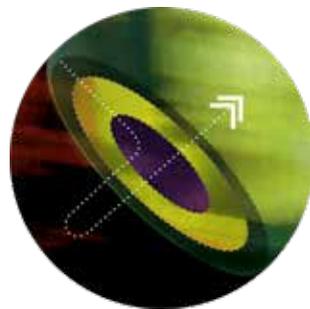
Figure 2. Illustrations of the four scenarios developed in this project.



Mining for a globalized sustainable world



New solutions in the wake of re-regionalization



A business-driven revival of the 2030 Agenda



The "glocal" mine



3.1 Scenario 1: Mining for a globalized sustainable world

In this scenario, Sweden's economy is driven by a strong global economy, in which international treaties are both agreed on and followed. Sweden has invested heavily in infrastructure necessary for sustainability transitions and policy measures, such as taxation of virgin materials extraction, have been introduced to support circularity.

Government funding has enabled decarbonization of heavy industry, road transport is largely electrified and hydrogen plays an important part both in industry and for energy storage. Most countries have signed the UN's renewed global sustainability agreement, Agenda 2060, which has made sustainability central for any selling proposition. This benefits companies from Sweden, which is known for its high-quality natural resources, technically advanced production methods and for delivering tailored solutions with associated service plans. Access to decentralized clean energy is becoming ubiquitous. Globally harmonized licensing and accounting rules are agreed upon and adhered to by almost all industry actors. These frameworks include issues like human rights, socio-economic development and environmental externalities. The UN allocates innovation-critical metals to all member countries that cooperate in the UN spirit.

Multinational materials companies compete among themselves to cooperate with those who own mineral resources. Production is largely localized through the use of additive manufacturing but transportation work still increases although technological development has enabled decoupling from emissions. A stronger sharing economy enables efficient use of vehicles and housing and makes durability and warranties key selling points. Digitalization has enabled progress in traceability and consumers expect to know exactly what they are buying and its origin. Consumers demand products with positive externalities across the supply chain, placing particular value on aspects such as human rights and Indigenous rights and support of local development. All major players in the materials business can offer traceability, and there is competition for the highest sustainability performance. Producers that can prove that they are fully circular and whose primary minerals come from underground mining with the highest environmental standards can charge premium prices. Data security is a struggle in these fast-moving times and companies are concerned about security and industrial espionage.

Population growth, competition over land and growing income gaps lead to conflicts and migration, but the UN is capable of dealing with most crises in an acceptable way. Innovation and knowledge concerning materials are key, especially for transformative technological solutions. Industries compete with governments for staff that understand both industrial logic and all sustainability dimensions. The gender balance in both academia and within heavy industry is improving quickly. Rapid technological changes and a UN-led global development put new strains on society. Many feel detached from a fast-changing world and experience a power divide. Improved traceability of products is thus contrasted with poor transparency concerning how decisions are made at the top of business and politics. Remaining fossil-fueled industries oppose the strong sustainability agenda. Sustainability-driven companies need to communicate and involve employees and the local community in decision-making. In places where the social divide has grown too wide, protectionism, fact resistance, extremist movements and even riots become common. Progressive parties realize that technological investments are not enough to ensure a sustainable development, and that social investments will also be needed.



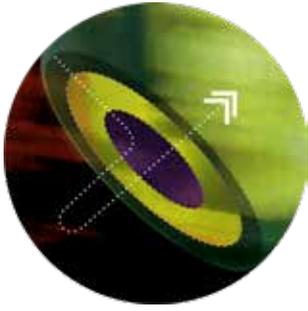
3.2 Scenario 2: New solutions in the wake of re-regionalization

In this scenario, material efficiency and longer life of products are important due to limited trade. Local and regional business flourish as globalization falls apart into regional trade. Export markets are limited. Import substitution is a key driver for development of new domestic supply chains for food but also minerals and metals.

Global trade has virtually ceased and is replaced by trade within power blocks that are mainly regional and that constitute separate markets with widely differing price levels. This has resulted in economic stagnation which necessitates structural changes as previous imports need to be provided domestically or regionally. This has spurred re-industrialization in certain sectors. A core EU remains – focused on Northern Europe – with Sweden as one member. It is crucial for any country to be part of the right alliance, as trade routes mirror geopolitical allegiances that are instrumental to secure access to markets and raw materials. Climate policy is largely absent and fossil fuels are still in use. Domestic energy supply is becoming increasingly important, and Sweden has resources that can also be exported its neighbors. North Sea oil production is low despite increased exploration activities spurred on by high prices whereas Russian production fares better but is geopolitically problematic. Poland's coal is a rare remaining option for countries whose energy transition efforts have been hampered by the economic slump. There are severe environmental problems, especially climate change, which reduces productivity of ecosystems. Forestry, agriculture and fisheries struggle with declining production and there are rising costs for healthcare and reconstruction.

Global companies set up local units to maintain market shares and use local features in marketing. Product quality demands have increased, as have criteria on reparability and recyclability. Industrial symbiosis is becoming important with ambitions to make use of “wastes”. Economic slowdown is accompanied by growing wealth disparity which has increased the risk of conflict, especially where populism has gained ground. Addressing social issues is a key priority. Geopolitics is a key factor in national politics, as are demographic issues because the working part of the Swedish population is shrinking relative to other groups. Concurrently, other parts of the world are severely stressed by overpopulation which drives conflicts. Sweden experiences conflicts related to resources and land use, and local environmental concerns are more highly prioritized than global phenomena like climate change, but resource availability and social issues hold higher precedence still. Re-ruralization is increasing as people move away from problematic economic situations in urban areas. This has caused a change in power dynamics from centre to periphery. Extraction of minerals crucial for socio-economic development is a highly prioritized but politically sensitive issue. Another national priority is to ensure that strategic Swedish resources – raw materials, energy, industrial expertise and holistic solutions – are used wisely to promote trading opportunities.

Government struggles with the distribution of revenue from high commodity prices which trickle down unevenly throughout the country. The state owns some of the mining companies and can distribute these dividends freely, but there is debate on how to tax excess profits of private companies. To limit state interference, large companies voluntarily take more responsibility for local development, which is needed because the state is financially weakened by sluggish global economic development. People can't live without their technological devices, most of which have a mineral “heart”. “Minerals are the heart of our vital material needs” is the metal and minerals industry's communication mantra.



3.3 Scenario 3: A business-driven revival of the 2030 Agenda

Strong – but unevenly distributed – economic growth characterizes global development throughout the 2020s. However, this unfettered economic growth results in high resource use and escalating environmental problems which in the mid 2030s starts to curb economic progress. Cost-driven natural resource extraction is struggling from environmental degradation and resource depletion, and demand slackens from unevenly distributed economic growth. In a last-minute effort to transition to sustainability, society shifts priorities towards transformative clean technologies.

Lawmakers put strong pressure on businesses to conform. Despite overall global trends, Sweden persists with strong environmental policies and is relatively well prepared for the impending sustainability crash programme. Sweden can use its traditional comparative advantages and its green image to market its products. Many other countries have hitherto failed to abide by international agreements, instead prioritizing border controls to stymie migration, but are now beginning implementation. Global trade is threatened but still ongoing in the interest of international business. Swedish companies are competitive globally, largely thanks to well-developed logistics. There is strong demand for both raw materials and high-tech consumer products, but decoupling might lead to reduced demand for raw materials.

The mining industry is recognized as a facilitator of a sustainability transition, but the sustainability-based development paradigm also means that businesses have to be on their toes. Mining companies start to make commitments on human rights, Indigenous peoples and local development. There are substantial income differences both between and within countries, especially between thriving urban regions and struggling rural areas. Those who are well-off direct more of their consumption to experiences. The labour market is centred on urban areas, but a few rural hubs, based on resource extraction, thrive. Attracting and retaining skilled labour in rural Sweden is an ongoing struggle, even more so as a global economic tilt towards Asia makes Sweden peripheral.

Disruptive business models such as material-leasing and functionality-selling put pressure on traditional extractive industries, but these can find opportunities in selling expertise on materials generally, but also about work-related health and risk management, the latter especially to developing countries. Improving ecosystem health, securing resource supplies (including food) and resolving freshwater supply issues are political priorities. It has belatedly become clear that failure to address these issues results in enormous costs related to health and political instability. The Nordic countries' strong sustainability credentials, tradition of public-private collaboration, and relative stability become attractive in this transitory period, especially as the welfare state alleviates societal stress from rapidly changing job markets.

In 2050 this societal reorganization succeeds in shifting the growth-focused economy onto a sustainable path. Automation and other technological developments not only increase production at lower cost, but serve as a sustainability tool. As a consequence Sweden has become specialized in designing system solutions whereby a circular-oriented metals and minerals industry delivers products sold with a sustainability glow.



3.4 Scenario 4: The “glocal” mine

The world has evolved towards an open network, where hubs are urban centres, linked virtually. In the best-performing regions, sustainable cities exist in symbiosis with surrounding rural areas. Preference for local and regional values means that opportunities from globalization are downplayed in favour of regional approaches. Information spreads rapidly across the world, but high shipping costs limit long-distance physical trade flows.

Limited exports and a more service-oriented economy shifts the Swedish economic growth path downwards. The “sharing” economy reinforces this and erodes traditional tax bases, and people use productivity gains to spend more time on leisure. Societal decision-making is decentralized and based on negotiation and consensus. There is local collaboration around industrial symbiosis to meet challenges of limited economies of scale. Repairs and product upgrades become more prevalent. Domestic demand for Swedish products is growing because of emotional appeal of local features and global demand is strong thanks to Sweden’s “clean” image. Circulated metals have become a brand, and strict environmental considerations throughout the supply chain are key, especially upstream.

Welfare has decoupled from wealth. Increased reliance on long-lived products and repairs enables high material well-being without increased production. People place more value on collaboration and sharing than on “gadgets” and live in highly efficient multi-family houses in cityscapes where green areas abound. Rural and urban regions have converged in lifestyles and material wealth but there are regional differences in architecture and design. Business models shift from selling to leasing, and producers retain ownership throughout product life cycles. There is strong political support for investment in clean public transport, and small-scale production of clean electricity is ubiquitous, which has kept global warming below 2°C.

Production takes place both in large plants and in micro-installations using additive manufacturing. Functional solutions and software developed in Sweden are used globally but local workforces using local resources give the functional solution physical form. Welfare is not measured in GDP; instead indicators of perceived well-being are in focus. Customers willingly pay a premium for products and services with strong sustainability credentials. The mining sector is a driving force in communities and cooperates with local actors to ensure a social license to operate and keep rural regions alive, in addition to providing materials for sustainable applications. The sector’s broadened scope needs new expertise. Students graduate to work as eco-designers, ecosystem service compensation suppliers and industrial tourist guides. Sweden has signed the follow-up to ILO169, which brings all local stakeholders together in the boardroom. NIMBY tendencies have become easier to address because all interest groups are consulted in decision processes. This ensures that business logic goes hand-in-hand with sustainability logic.

Despite societies’ focus on collaboration, there are tensions due to increasing gaps between regions as they develop on the basis of their particularities. Even within regions, there may be tensions as everyone is not able to thrive in collaborative settings. Redistribution systems can look very different not only between regions but also between cities in the same region. As materialistic values have been downgraded, social ability determines how much an individual can benefit from the resources shared in different communities. Persons with poor social ability or interest in education risk being excluded.

3.5 Overall summary of the scenarios

The four scenarios summarized above present distinctly different futures, both for society as a whole and for the mining sector specifically. However, there are certain themes that recur in the scenarios. These include increasingly circular material flows, traceability and sustainability labeling, stronger collaboration through supply chains and improved systems used to address land use conflicts. The prevalence of these themes indicates that workshop participants and/or Svemin view these as particularly important for the future of Sweden’s mining sector. However, these themes manifest in different ways in different scenarios, which in turn affects how opportunities and challenges around the themes would need to be addressed. In particular, there are differences in whether development is primarily driven by consumer demand or by public policy, but also in the relative importance of international or national and local jurisdictions.

4. Action points for mining in sustainable futures – a draft sustainability roadmap for the Swedish mining sector

As described in section 2, workshop 2 resulted in more than 200 action points. SEI then facilitated a process in which the Svemin team screened the action points for robustness; that is, how viable and relevant a particular action point would be in each of the four scenarios. This screening process resulted in a set of 31 action points deemed to be important in any upcoming future based on our current knowledge and experience. The aim is that these action points will form the basis for developing a long-term sustainability roadmap for the Swedish mining sector. This chapter categorizes the 31 action points under six different headings. Note that the order of appearance is not an indication of relative importance.

4.1 Develop a collaborative approach to sustainable raw materials supply

- **Draw on established modes of multi-sector cooperation to maximize competitive advantage from Sweden’s industrial tradition (“made in Sweden”) and to leverage natural resource assets and develop both real and human capital.**

Who? The mining sector initiates

- **Ensure availability of reliable, fossil-free energy supply at competitive prices to create the conditions for industrial electrification.**

Who? Energy market actors in cooperation with policymakers, based on industry demand

- **Ensure financing solutions for investments that enable sustainability.**

Who? The mining sector, policymakers and financial market actors

- **Support efforts in the education system to adapt to a sustainable future, in which expertise in engineering and natural resources will play an increasingly important role.**

Who? The mining sector and academia

- **Drive industrial policy in a direction that promotes the development and adoption of new materials, as well as new technological solutions necessary for sustainability transitions.**

Who? Policymakers in dialogue with key industrial sectors, including mining



4.2 Define “sustainable mining” in dialogue with the global community

- **Develop methods to both measure sustainability and assess future sustainable demand for raw materials**

Who? Industrial sectors, policymakers and academia

- **Broaden the concept of “profitability”, because people in 2050 may place (global) sustainability values over strict monetary value.**

Who? All industrial sectors, academia and policymakers

- **Create a dialogue on the kinds of local conditions that would enable all actors, by mutual agreement, to carry out all the different activities on which community livelihoods depend.**

Who? Initiated by the mining sector

- **Find platforms that enable equitable dialogue with all stakeholders affected by mining sector operations.**

Who? The mining sector and policymakers

- **Build legitimacy for decisions by adhering to, and driving development of, international standards to deal with, e.g. land-use conflicts.**

Who? The mining sector and policymakers

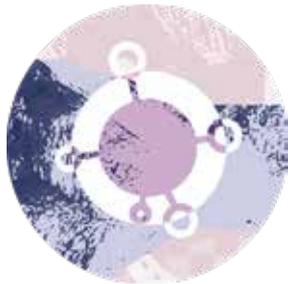


- **Analyze how, in permitting processes, to balance total (sustainable) societal benefit against adverse effects of an activity and agree on (development of) methods for “societal sustainability assessments”.**

Who? Policymakers, governmental agencies, the legal system and the mining sector

- **Develop a rule set for locating land-use dependent activities which provides foreseeability and legal certainty. This should include both how preparatory consultation procedures are to be carried out and how compensation is regulated.**

Who? Policymakers, the legal system and all affected actors



4.3 Develop the permitting processes, taking a wide range of sustainability considerations into account

- **Analyze how permitting processes can provide legal certainty for all parties involved, and how these processes also can take a holistic approach to sustainability.**

Who? Policymakers, the legal system, government agencies, the mining sector and affected actors

- **Further develop the impact assessments used in permitting processes and become more proactive in preparing them.**

Who? The mining sector, government agencies and affected actors

- **Find approaches that minimize the ecological and social footprint of both the mining sector and wider society.**

Who? The mining sector in cooperation with other sectors, policymakers and academia

- **Develop a regulatory framework for how to use ecological compensation when there are inevitable impacts from activities and projects that are deemed vital for society.**

Who? The mining sector in cooperation with other sectors, policymakers, academia and other actors



4.4 Make the mining sector an increasingly circular raw material hub for society

- **Focus business strategy towards becoming the central supplier of raw materials in an increasingly emerging circular economy**

Who? The mining sector

- **Develop a broader, more future-oriented approach to materials, and operationalize this in developing skillsets, mining operations and circular business models to meet global demand for materials**

Who? The mining sector needs to both extract more value from what is mined and strengthen circular business components

- **Embrace ideas of industrial symbiosis and clusters as a means both to enable shared economies of scale and closer contact with end-customers.**

Who? The mining sector in cooperation with value chain partners

- **Develop more integrated, knowledge-intensive, service-oriented and exportable business models**

Who? The mining sector in cooperation with value chain partners, especially those downstream and close to final consumers

4.5 Build credibility and create business value through transparency and traceability

- **Use digital technology to visualize the environmental footprint of raw materials to consumers and to reduce this footprint**
Who? The mining industry, in cooperation with value chain partners. Also academia and policymakers, who are important for developing sustainability criteria.
- **Develop methodologies for traceability and associated systems of sustainability certification and evaluation**
Who? The mining industry in cooperation with value chain partners, policymakers and academia, in Sweden as well as globally
- **Inform customers about added value in products originating from sustainable supply chains, and gain acceptance for the added product cost (i.e. willingness to pay)**
Who? The mining industry
- **Enhance credibility by communicating the sustainability performance of products more strongly to customers – including on job security, occupational health, equality, human rights, and the environment.**
Who? The mining industry and value chain partners in general, though especially important for consumer-oriented customers
- **Strengthen internal performance and skillsets on gender equality and diversity, innovation, digitalization, sustainability transitions, and communication of performance in these areas.**
Who? The mining industry



4.6 Strengthen engagement locally and nationally

- **Communicate that all technology-based solutions needed for sustainability transitions – in Sweden as well as globally – require raw materials, and that Swedish value chains are world-leading on climate and sustainability.**
Who? The mining sector
- **Build and communicate a sustainability brand based on examples of previous successful activities that have brought societal benefits with the aim of creating YIMBYism (“yes in my backyard”), locally as well as nationally.**
Who? The mining sector
- **Develop forms of corporations and systems for local revenue sharing that can contribute to economic, ecological and socially sustainable development in regions rich in natural resources.**
Who? The mining sector, its value chain partners, policymakers and regional actors
- **Agree on a business policy for processing natural resources that strengthens regional development and builds sustainability.**
Who? The mining sector and policymakers
- **Improve and develop the lifestyle benefits of living in industrial communities**
Who? The mining sector in cooperation with other local actors
- **Propose, and participate in developing, a tax reform for strengthening regional development and addressing the labour market effects of automation**
Who? The mining sector in cooperation with policymakers



5. Assessing the set of action points in relation to the 2030 Agenda

5.1 Introduction and methodological setup

There has been increasing focus on how the mining sector interacts with the fulfilment of the UN 2030 Agenda. To put the draft sustainability roadmap presented in section 4 into this context, the set of action points was assessed against the 17 Sustainable Development Goals (see Figure 3). The objective is forward looking: to assess the draft sustainability roadmap and its potential, not the current practices of the Swedish mining sector.

The assessment was done in a workshop exercise where the participants were divided into pairs, and each pair was allotted one of the six main subthemes of the draft sustainability roadmap. Rotating around a table with sheets of paper containing the 17 SDGs and associated targets, the groups were instructed to assess the impact of the subtheme in question on each SDG using a grading system from -3 to +3, inspired by the scale developed by Nilsson et al (2016). It should be noted, though, that the framework presented by Nilsson et al. was developed to assess interactions between different goals and targets in the 2030 Agenda. A score of -3 would indicate that implementation of the subtheme would mean it would be impossible to fulfil the relevant SDG, whereas a score of +3 would mean that implementation would be absolutely necessary if the SDG is to be reached. A score of 0 would indicate that the subtheme has no or negligible impact on the SDG.

Figure 3. The 17 Sustainable Development Goals, along with their 169 targets, are the heart of the UN 2030 Agenda and are set up as a blueprint for how the global community should work in the time period 2015–2030 towards a sustainable future for all.

SUSTAINABLE DEVELOPMENT GOALS



The workshop exercise was carried out in two separate sessions with two separate groups. The first session took place on 17 December 2018 with a group of participants from the Svemin network of sustainability directors and the second took place on 20 March 2019 with a group of SEI researchers. Slight changes to the set of action points were made between the two sessions. These changes were based on input from the Svemin sustainability network but were mainly related to choices of wording and would only have had minor impact on the essence of the individual action points.

5.2 Results from the SDG mapping

The results from the assessments are presented in Figure 4 and Figure 5 below.

Figure 4. The result from the SDG assessment of the set of action points as carried out by the Svemin sustainability network. Numbers 1 to 17 on the x axis represent the 17 Sustainable Development Goals (SDG). The y axis indicates the total estimated scores from the six main themes in the draft sustainability roadmap on each SDG. Green bars indicate positive effects from the action points on the SDG in question, purple bars indicate negative effects.

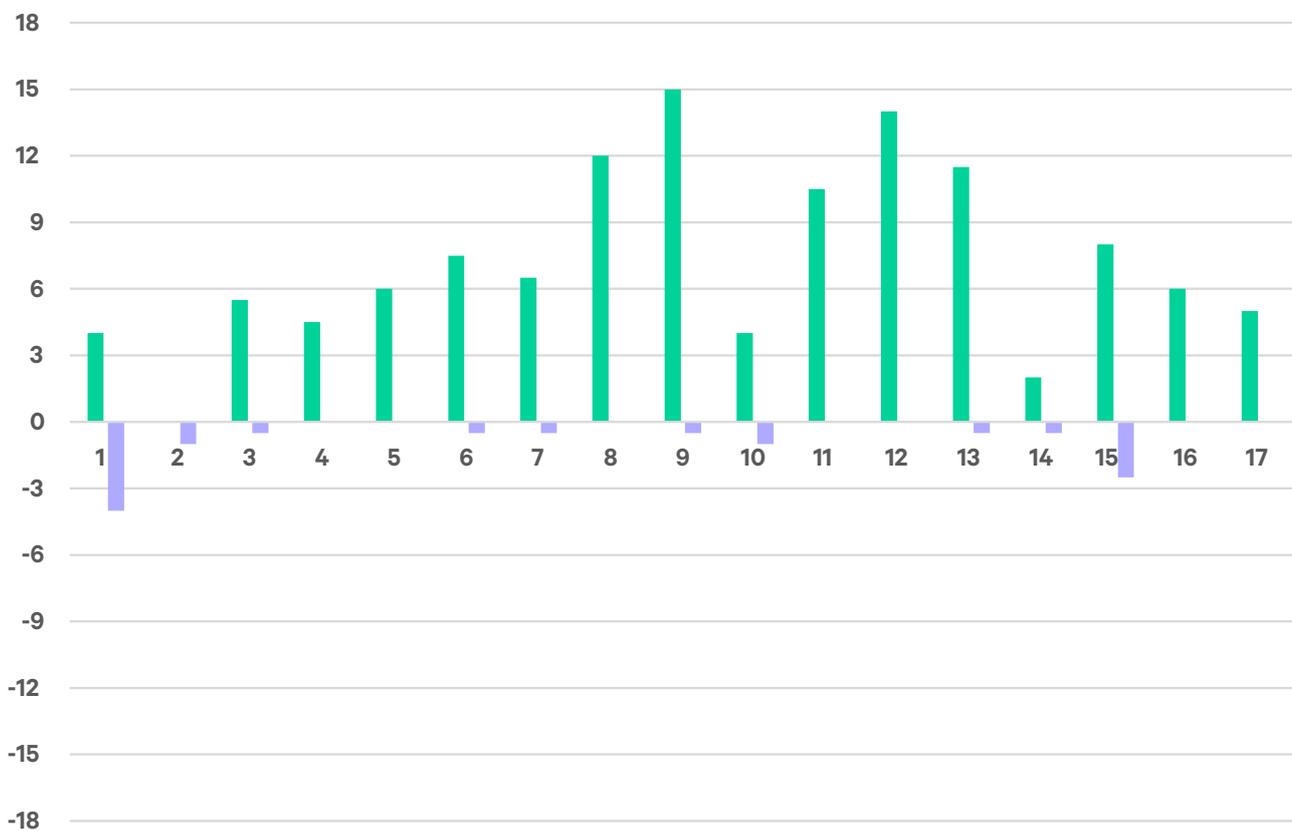
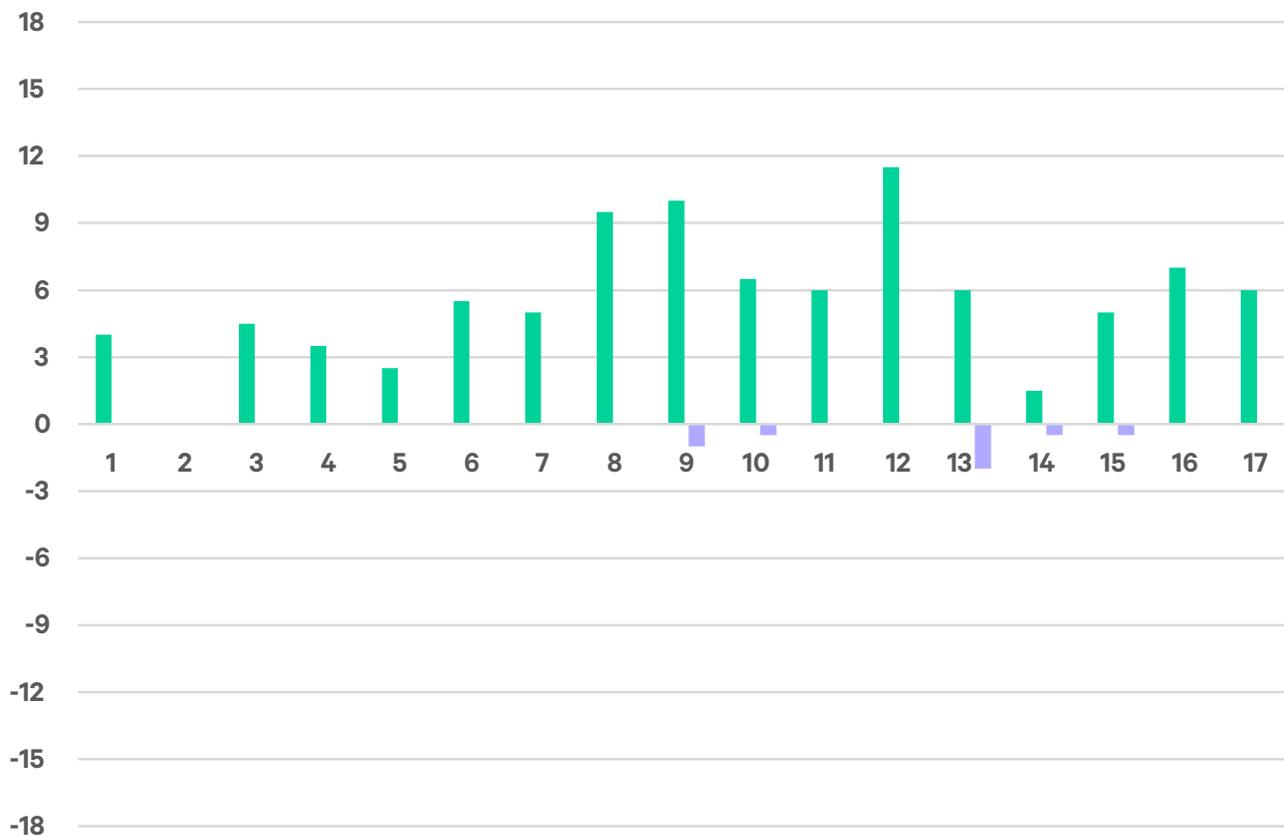


Figure 5. The result from the SDG assessment of the set of action points as carried out by the team of SEI researchers. Numbers 1 to 17 on the x axis represent the 17 Sustainable Development Goals (SDG). The y axis indicates the total estimated scores from the six main themes in the draft sustainability roadmap on each SDG. Green bars indicate positive effects from the action points on the SDG in question, purple bars indicate negative effects.



There are similarities and differences between the two assessments. In both workshops, the assessments indicate that the draft sustainability roadmap will have positive effects especially on goals 8 (Decent work and economic growth), 9 (Industry, innovation and infrastructure) and 12 (Responsible consumption and production). Another common theme is that neither group expected the roadmap draft to have any, or only marginal, effect on goals 2 (zero hunger) and 14 (life below water). The set of action points was judged to positively affect 16 out of 17 SDGs, both according to Svemin and SEI. Neither Svemin nor SEI thought that the draft roadmap would have negative side effects on more than a few of the SDGs, and these were generally considered to be mild. In terms of differences between the two groups, the Svemin group tended to take a more global perspective on the themes whereas the SEI group focused more on local issues. One issue worth mentioning here is how the Svemin group emphasized the importance of properly designing and implementing traceability systems and sustainability criteria. These should encourage transfer of knowledge and technology so as to support development in poor countries. Otherwise, the implementation of such systems could have a negative effect on SDGs 1 (end poverty) and 2 (zero hunger).

More detailed reflections of SEI researchers from the assessment can be found in section 6.1.

6 SEI analysis of the draft sustainability roadmap

This section includes an analysis by SEI of the set of action points presented in section 4. The aim is to provide Svemin with additional input on how the Swedish mining sector could improve its sustainability work and implement the action points in the draft sustainability roadmap. SEI researchers reviewed the set of action points from the perspective of their individual expertise, including on the Sustainable Development Goals and international norms on corporate accountability.

6.1 General reflections on the action points

The overall SDG mapping of the set of action points resulted in a predominantly optimistic view of their potential to have a positive impact on the 17 SDGs. Perhaps this is what should be expected from a sustainability roadmap, but the overall positive score is nevertheless an important indication that the general direction is promising. For further analysis, it would be worthwhile to begin by taking a closer look at the extreme ends of the scoring.

Both the SEI researchers and the Svemin sustainability network expected the draft roadmap to have little or no effect on SDG 2: Zero hunger and SDG 14: Life under water. These two goals are also among the five SDGs not deemed highly prioritized in the mapping done by Sonesson et al. (2016) on the interconnections between the mining sector and the SDGs. While this could be interpreted as meaning that these two SDGs are somehow “disconnected” from the mining sector, there are important connections that might not be immediately evident. For example, an important connection between the global mining sector and SDG 2 is how crucial extraction of phosphorus for fertilizer is for the global food system (Cordell et al. 2009). For SDG 14, one important connection – at least over the longer term – is the prospect of deep-sea mining as a new arena for minerals extraction (Van Dover 2011).

At the other end of the spectrum, both groups saw great potential for positive effects on SDGs 8, 9 and 12. All of these are categorized as belonging in the “economic” sphere, according to the SDG categorization done by Folke et al. (2016). However, the three goals take in a broader range of issues relating to social and economic development. A key issue highlighted by SEI researchers is the ambition in the draft roadmap to achieve increasingly circular resource flows and supply chain traceability as part of future sectoral business models.

However, while SEI’s assessment was generally positive, a recurring theme in the discussions was that it is difficult to properly assess the impact of the action points on the SDGs because this would be contingent on implementation. In several cases, the scoring was discussed along the lines of “+3 if implemented properly, 0 or -1 if implemented poorly”. This point leads into the analysis below.

6.2 How can the set of action points be improved and implemented?

Alongside the SDG mapping exercise, the SEI researchers had a more open discussion, the overarching theme of which might be summarized as: what are the key sustainability challenges currently facing the Swedish mining sector and to what extent do the action points in the draft sustainability roadmap respond to these challenges?

The discussion covered a wide range of topics, including fundamental issues around how to define “sustainable mining” and the challenges of acting as a forerunner for sustainability in a global commodity market. The discussion also mirrored some of the themes that arose during the SDG exercise, especially how the effects of the different action points largely depend on how they are implemented. For example, revenue sharing is highlighted as important for strengthening engagement with local stakeholders, but as Söderholm & Svahn (2015) highlight, how and with whom revenue sharing is done are decisive factors in its success.

Another issue that emerged in both the SDG exercise and in the open discussion was the centrality of local context for mining sustainability. While the discussion covered questions around water quality and biodiversity, it was land-use conflicts that was identified as arguably the central sustainability challenge for the Swedish mining sector. This is a broad and complicated issue and themes discussed included the

legal situation of land owners as well as the need for a stronger commitment to Indigenous rights. Section 6.3 covers this issue in more depth.

Finally, part of the discussion touched on if and how the mining sector could initiate an ambitious long-term sustainability-focused project that could also help build support for, and interest in, the mining sector. It was suggested that this project should focus on approaches that can help resolve conflicts around land use.

6.3 In-depth analysis of topics for further development and implementation of the draft sustainability roadmap

This section provides more in-depth analysis of how the Swedish mining sector could develop its sustainability work, covering a few particularly important themes and building on the ambitions presented in the draft sustainability roadmap.

Material demand, de-coupling and the definition of sustainable mining

Global discussions on the role of mining in a sustainable future are growing in intensity. A central concept in these discussions is the connection between growing prosperity and demand for raw materials. Historically, the two have been tightly connected and despite technological developments, there are few or no indications of so-called absolute de-coupling, i.e., whereby economic growth would continue absent growing demand for materials. In fact, it has been argued that absolute decoupling will never be possible as long as GDP remains the central measure of prosperity (Ward et al. 2016).

However, it can be argued that absolute de-coupling is not necessarily an appropriate target to aim for. According to the line of reasoning presented by Tilton et al (2018), the amount of materials used is not what is important as this will in the end be a question determined by economic mechanisms that in the long-run are self-correcting. In other words, shortages will result in increasing prices that in turn will incentivize increased production, improved material efficiency and/or substitution. Instead, from this perspective, the focus should be on minimizing the negative socio-economic and environmental impacts from raw materials extraction, processing and use. This would then entail a form of relative de-coupling, where use of materials would continue to grow with GDP, but where there are absolute reductions in the associated negative impacts. The latter perspective tends to be more mainstream, as echoed by two recent analyses of future material demand patterns published by the OECD (2019) and the UNEP International Resource Panel (IRP 2019).

If one looks at the scenarios developed over the course of this project, absolute decoupling could be a component of Scenario 4 (The “Glocal” Mine) that sees substantial changes in the economic system towards steady-state economies with low or no GDP growth and thoroughly circular resource-use patterns. In the other scenarios though, absolute decoupling seems unfeasible, although relative decoupling could occur. However, even if absolute decoupling is possible, striving to minimize negative impacts from mineral extraction would still be worthwhile. From this perspective, a strong drive towards increasingly sustainable mining would seem a low-risk strategy. However, as discussed below, the very systems by which mineral products are bought and sold on global and highly competitive markets, places limits on the extent to which individual producers can act as sustainability leaders.

Supply chain traceability as a means of driving sustainability in commodity markets

An issue common to all industrial sectors that operate in globally competitive markets is that sustainability ambitions must be weighed against concerns of reduced cost competitiveness. This situation is especially typical of *commodity* market configurations that are a characteristic of markets for metals and other mining products. Therefore the ambition in the draft sustainability roadmap to use traceability and transparency as tools to gain competitiveness from more sustainable mining has much potential, but is also a complex issue.

A central characteristic of commodity markets is that any one batch of a given commodity can be replaced by any other batch that fulfills the specified standard quality criteria. A consequence of this

is that how and where a commodity has been produced is no longer relevant and price becomes the decisive factor for prospective buyers, and cost the key factor for producers (Porter 2008; Freidberg 2017). In order to stay competitive under global cost competition, the Swedish mining sector has a history of using both technology upgrades and business model innovation to differentiate and thereby meet challenges from industries located in low-cost countries (Hellmer 1996; Ericsson 1996; Rönnbäck 1992; Hellmer 1997). Swedish mining companies thus now tend to operate in what could be considered “premium” segments of commodity markets, in terms of physical quality specifications (see e.g., Boliden 2019; LKAB 2019). However, the market logic is still much the same in terms of individual producers having the role of individual price takers. Consequently, companies are continuously exposed to rapid fluctuations in global metals prices, a *modus operandi* that could interfere with long-term sustainability ambitions (Freidberg 2017).

One debate that has intensified in recent years centres on how to square the anonymous and cost-focused structure of commodity markets with growing demands from society on environmental performance across supply chains (Gardner et al. 2018). Various approaches to address this dilemma have been suggested. One is that commodity markets will become more and more “decommoditized” in response to demands from society for sustainable supply chains. In other words, it may turn out that sustainability can only be ensured in supply chains that are either vertically integrated or characterized by strong contractual commitments among participating companies (Freidberg 2017). One recent example of this is how Chilean copper giant Codelco has signed bilateral supply contracts with BMW, whereby the latter buys traceable copper produced according to extra stringent sustainability criteria, and which is priced at a premium (Ayre 2017). At the time of writing, the details around this bilateral supply contract remain unclear so it is too early to draw strong conclusions about this approach, but broad adoption of it would entail a significant change to the ways in which many of the world’s most important metals are traded.

Another suggested approach basically entails integrating sustainability certification into the existing commodity market structure. This could be realized as additional quality criteria in, e.g., financial contracts traded on futures markets (Mathews 2008; Olsson et al. 2016). It is interesting to note that in April 2019 the London Metals Exchange (LME) announced that from 2022 it will include sustainability criteria in the quality specifications used for metals traded on the exchange (Hume 2019).

But regardless of implementation, the general idea is to make the sustainability credentials of a particular commodity producer visible to prospective buyers. Buyers would then be able to take sustainability performance into account and make it possible for commodity producers to improve their sustainability performance and pass the additional costs on to consumers. The appeal of this is strengthened by the fact that raw materials tend to make up a rather small portion of the cost of consumer products, which means that higher costs of raw material extraction need not result in large price increases for consumers. This has been analyzed thoroughly in the context of decarbonization transitions in heavy industry (Rootzén and Johnsson 2016; Rootzén and Johnsson 2017; ETC 2018), but the same basic logic may very well be applicable to supply chain sustainability more broadly.

A key challenge, though, is that according to recent studies there seems to be little consumer interest in paying a premium for products made from more sustainably produced materials. This is one reason why consumer-oriented companies thus far have shown only marginal interest in driving sustainability in raw materials sectors above and beyond removing conflict minerals from supply chains (Tillväxtanalys 2019). In the absence of a willingness among consumers to pay a premium for sustainability, another way to drive demand for more sustainably produced materials is through public policy. Measures could include public procurement regulations that mandate that only materials that adhere to certain sustainability criteria can be used for construction of public projects (Cheng et al. 2018). However, it is important to note the difference between various subsectors in the Swedish mining industry. For example, cement markets tend to be national, which means that public procurement guidelines could be a powerful policy tool to drive demand for cement with improved sustainability performance, even if they were only enacted in Sweden. In the context of globally traded metals, on the other hand, coordinating regulations for public procurement regulation would prove substantially more challenging.

Even though there are substantial challenges in using traceability and supply chain transparency to improve sustainability in the mining sector, it is a path worth pursuing. The growing focus on metal

extraction sustainability that has come in the wake of the debate on raw materials used in batteries for electric vehicles (Amnesty International 2019) may only be the start. In the coming decades, decarbonization of the energy sector is likely to make the environmental impact of the utilization phase a gradually smaller share of the total life cycle impacts of products. This means that the extraction and processing stages will gain in relative importance, possibly prompting policymakers and consumers alike to demand stronger sustainability performance in raw material extraction.

Decarbonization as competitive advantage

While supply chain transparency and product traceability can be very important components of a business strategy aimed at gaining competitive advantage from higher-than-average sustainability performance, it is actual sustainability performance that counts in the end. In terms of greenhouse gas emissions, the Swedish mining sector should have a competitive edge thanks to a relatively low footprint compared with its international competitors. The low footprint is largely a result of the dominance of non-fossil electricity generation in Sweden and on the Nordic power market. In addition, the Swedish mining sector has relatively high ambitions when it comes to climate change mitigation, as shown in its roadmap to become fossil-free by 2045 (Svemin 2018).

This 2045 target is currently being realized in the mining sector through highly promising cross-sector efforts that draw on a Swedish collaborative model. Ongoing projects include both electrification of mining equipment (Boliden 2018; SUM 2018) and involvement of mining-sector companies in ambitious long-term projects aimed at decarbonizing key processing stages. Examples worth mentioning are the HYBRIT project (owned by LKAB, SSAB and Vattenfall) which aims to develop a carbon-neutral iron ore reduction process (HYBRIT 2018), and Cementsa's projects that aim to electrify supply of process heat and combine this with carbon capture and storage (CCS) (Cementa 2018).

If both these projects come to fruition, they would lead to a 15% reduction of total Swedish greenhouse gas emissions and so contribute substantially towards the country's goal of becoming a net-zero emitter of greenhouse gases by 2045. However, as ambitious as the decarbonization targets of the Swedish mining sector may be, its social license to operate is likely to depend primarily on its interaction with the environment and communities in the vicinity of mine sites. This is of particular concern in establishing new mines.

The Swedish mining sector's responsibilities on human rights and Indigenous rights

One of the landmark changes confronting extractive industries, globally, in recent years has been rising expectations on corporate responsibility in relation to human rights in general, and Indigenous peoples' rights, more specifically. With the endorsement by the United Nations Human Rights Council in 2011, the United Nations Guiding Principles on Business and Human rights has become the expected standard for industry, regardless of sector, size or geography. They have also been integrated into key guidelines from bodies such as the Organisation for Economic Co-operation Development (OECD) and the EU.³ In brief, these guidelines clarify that companies are expected to: 1) embed a policy commitment into company processes, 2) execute ongoing human rights due diligence, and 3) remedy adverse human rights impacts. Moreover, while the state is the duty bearer under international law, mining companies genuinely committed to be leaders in their field should also voluntarily respect international norms on Indigenous rights, even when not part of national law.⁴ Among other things, this involves respecting that Indigenous peoples and affected Indigenous communities (such as Sami reindeer herding communities) have a right to give or withhold so-called Free Prior and Informed Consent (FPIC). This right is important, first and foremost, because it functions as a means of ensuring Indigenous influence in decision making and gives effect to their substantive rights to land, resources and culture (Åhrén 2016).

The set of action points in the draft sustainability roadmap includes several points that could help the mining industry make much-needed progress towards meeting these expectations. The most important of these are: more equitable dialogue and mechanisms to seek prior agreement with affected groups,

³ See e.g. the Shift project: www.shiftproject.org/resources/publications/european-commission-sector-guides-implementing-guiding-principles

⁴ Svemin has stated its ambition of being a global leader as regards sustainable mining. See e.g. www.svemin.se/svensk-gruvnarng

developing more inclusive approaches to environmental assessment, and developing models for revenue sharing. The draft roadmap also includes several action points that, directly or indirectly, call on the Swedish Government to review sectoral legislation applicable to the mining industry, aiming to enhance predictability and legitimacy for permit decisions. Were the industry to lobby the government for a revision of the minerals legislation to better recognize the interests and perspectives of locally affected groups, then this would no doubt be welcomed by many of those currently pitting themselves in opposition to new mining projects (e.g. Haikola and Anshelm 2016). It would also demonstrate a commitment on behalf of the industry to persuade the Swedish Government to address its failures in complying with international obligations to protect human rights and Sami rights (see e.g. Statskontoret 2018; Allard 2018)

However, the potential value of these action points is open to question. Most importantly, the actions do not make any specific reference to, or view these actions in the light of, the expectations of the industry based on human rights or Indigenous rights. Furthermore, the action points only acknowledge the presence of “stakeholders”, ignoring the status of, e.g., Sami groups, as *rights holders*. This distinction is crucial, because companies are expected to approach Indigenous groups in ways congruent with their *rights* to land, resources and culture, and not simply as local interest groups (see e.g. Allard 2006). These omissions are symptomatic of how Swedish mining companies operating on traditional Sami lands have so far been complacent in acknowledging Sami rights and have generally not applied the principle of FPIC (e.g., Lawrence and Moritz 2019). Instead, the Swedish mining industry has tended to explain the mounting conflict between mining interests and reindeer herders solely as a problem of communication, rather than genuinely engaging with Sami rights claims (County Administrative Board of Norrbotten and SWECO 2016). And in terms of human rights more broadly, a recent baseline review⁵ showed that less than half (41%) of Svemin’s members have a policy commitment on human rights and less than one third (31%) currently report on human rights in their annual reports.

It is clear that the Swedish state bears the foremost responsibility to update legislation applicable to mining so that it adequately protects human rights and Indigenous Sami rights. Meanwhile, there is no reason why Svemin could not exercise (voluntary) industry leadership by demonstrating its genuine commitment to be a global leader and a market mover in this field. As a start, Svemin could consider embedding a clear commitment to respect human rights and Indigenous rights in its policies (see e.g. the position paper adopted by the International Council on Mining and Metals (ICMM 2013)). Furthermore, Svemin could offer support to its members in clarifying their individual commitments. This would open up a much-needed role to facilitate capacity-building and implementation, for example by organizing training and developing guidance documents on human rights, due diligence, grievance procedures and Indigenous Sami culture and consent procedures. Given that the mining industry generally (Kemp & Owen 2017) and Swedish companies specifically (e.g., Lawrence and Larsen 2017) tend to have limited ability to implement new commitments on human rights and Indigenous rights, it would also be worthwhile to organize independent quality assurance and follow-up, for example via a certification system for responsible Swedish mining.

Whereas such steps would indeed require effort and resources from Svemin and its members, they are likely to be in the long-term benefit of the industry. Without a strengthened approach on land use conflicts, human rights and Indigenous rights issues are likely to remain unaddressed, reflecting poorly on industry reputation and provoking deepened regulatory uncertainty. Moreover, Swedish courts are increasingly ruling in line with international law (2011) and the legal landscape in relation to human rights is shifting and expanding (GBI and Clifford Chance 2019). It may well be in the best interests of the industry to play a proactive role in shaping the future implementation of human rights and Indigenous rights and norms in Sweden.

In sum, it is welcome that the action points show ambition to take proactive steps towards more equal engagement with actors affected by the operations of Svemin’s members. It is imperative, though, that the action points be pursued in full recognition of the industry’s responsibilities, based on international human rights and Indigenous rights standards.

5 Enact (2018)

A “moonshot” project for Sweden’s mining sector?

In a series of recent studies, Mazzucato (2017; 2018a; 2018b) advocates the value of directing research and innovation policy towards solving societal “grand challenges” around issues such as health, the environment and global food supply. The idea is that societies should strive to meet these challenges by drawing on lessons learned from historical “mission-oriented” projects and processes like the Apollo Program – hence the use of the term “moonshot”. Key characteristics of moonshot projects are that they are bold, inspirational, clearly defined, time-bound, ambitious and high-risk, while still being at least theoretically feasible. In addition, they should be set up in cross-disciplinary settings that build on and encourage bottom-up solutions (Mazzucato 2018b). The rationale for this approach is to both make serious efforts towards resolving large societal challenges, but at the same time maximize the societal benefits accrued in the process. Industries involved in moonshot projects can benefit not only from the possible success of the project, but also from spinoff projects and products, greater cross-sectoral collaboration and increased attractiveness as an employer. The latter is especially worth mentioning considering how millennials tend to be more concerned with employer values and sustainability performance than previous generations (Johansson et al. 2018). For example, it is interesting to see that the HYBRIT project – which arguably has many characteristics of a “moonshot” project – is already increasing the appeal of the metals processing industry as an employer (Sundberg 2018).

The conceptual study *The Smart Mine of the Future* (2010) is worth noting here. It presents a vision of a zero-waste, fully automated and “invisible” mine that aims to have as many processes as possible automated and located underground in an effort both to reduce the need for transport and to minimize surface environmental impacts. The zero-waste and fully automated components of this vision are now in the process of being implemented, for example in the *Sustainable Underground Mining* project (SUM 2018). As the Swedish mining sector continues its journey towards sustainability, it might be worthwhile for it to consider a moonshot initiative to radically reduce surface impacts, thus approaching the “invisible mine” vision.

6.4 Future research

The analysis conducted in this project has highlighted a range of issues that could form the starting point for future research.

To begin with, the SDG mapping could be further developed by using tools that are currently in development – at SEI as well as other research organizations – that enable more thorough analysis of how interactions between the SDGs affect the overall impacts of a strategy or an action. This would enable analysis that comprehensively embraces the stated ambition of the SDGs to be “indivisible” (UN General Assembly 2015).

The question of how sustainability issues can be integrated into the structures of existing commodity markets is becoming increasingly relevant. Notably, the announcement by the London Metals Exchange that it will take certain sustainability issues into account may open up potential for high sustainability performance to become a competitive advantage. The move also has interesting parallels with the broader discussion on the role of financial markets in sustainability transitions.

Finally, further development of the concept of the invisible mine outlined in the *Smart Mine of The Future* could be a compelling approach and a possible moonshot project (see section 6.3). A first step towards this could be a pre-feasibility study to outline the technological implications, implementation costs, and the institutional opportunities and risks of implementing this vision in an actual proposed mining project. A next step could be to analyze how the higher costs would affect prices on end-consumer goods, similar to the approach of Rootzén and Johansson (2016).

7 Svemin comments on the joint project

Svemin would like to start by extending sincere gratitude to all those who participated in the project. This joint effort has been important and groundbreaking for the Swedish mining and minerals industry.

The project, through its structure, has generated much interest and many opportunities for discussion. We particularly appreciate an examination of the industry from an outside perspective. This has yielded unexpected insights outside the usual boundaries.

We would, in particular, like to mention:

- the participation of important stakeholders, with a broad range of actors in society represented, including those that are critical of the mining industry
- the structure of the process, in which future scenarios were developed in workshops, and the subsequent discussion that led to the concrete set of action points;
- the advanced and multifaceted analysis of the set of action points by SEI researchers representing various disciplines, in particular the attention paid to areas for improvement in the suggestions.

All in all, the most important factor has been having an industry-wide discussion on the above issues and analysing what is needed in order for the mining industry to contribute to sustainable development, including what should be achieved and improved for it to also be perceived as a sustainable industry.

The conclusions have provided Svemin with important input for further development of the sustainability work within the industry.

Comments on SEI's analysis of the set of action points

SEI's analysis highlights some of the issues that the industry has also identified as matters of key significance. These are areas which we believe many mining companies are already taking active steps to address and where there are established methods. Through this project it has become obvious that external actors do not always understand that established, approved methods already exist to address several of the issues. This is an important insight that the industry has gained. It is our understanding that the two issues emphasized the most in SEI's analysis are 1) the importance of traceability in how metals and minerals are produced, and 2) the challenges relating to competition for land use in the areas where minerals exist, as well as considerations linked to the right of indigenous (Sami) people. We share the view that these two factors are crucial for the industry's future and that there are areas where the industry has the potential to have a relatively significant impact through its own efforts.

We also believe that the industry's significance in, and contribution to, the climate transition is key – both in terms of how industrial processes are developed and rendered more efficient, and how to meet the demand for raw materials to supply, for example, climate-efficient and renewable energy systems for which demand is rapidly increasing. This is well reflected in the set of action points, although SEI's analysis of the positive aspects is fairly brief, and the industry's important role in this context could be brought more clearly to the fore in the discussion. In this context, it is also important to raise a couple of key issues for the successful transition to climate-efficient production systems and products. An important issue is access to fossil-free electricity and bio-based energy – something which unfortunately the industry's own resourcefulness cannot guarantee.

Another point of view expressed in the set of action points is the increasing significance of circular systems and recycling, and further extraction of metals and minerals from mined materials. Within the foreseeable future, both primary mining and recycling and extraction will be needed to cover the increased demand for raw materials in society. Below are Svemin's more detailed comments on the set of action points that SEI chose to discuss in more detail.

Supply chain traceability as a means to drive sustainability in commodity markets

SEI highlights “traceability and supply chain transparency” as one key outcome of the process that is worth pursuing. We fully support this conclusion. Making it possible to put an “eco-label” on metals has for decades been on the wish list of mining companies with high environmental standards. One reason this has not happened is the way metals are traded as a commodity on the global metal market. SEI rightly identifies this as a challenge. However, we are more optimistic than SEI about the possibilities. In the last few years, things have begun to change. Certification initiatives are being taken by governments, NGOs, mining companies and others. Legislation on “conflict minerals” has led to the development of new chain-of-custody models. The development of block-chain technology has provided new potential tools for tracking goods and information.

The need for metals and minerals will grow substantially because of a growing world population, rising living standards and, not least, the transition to a climate-neutral society. In this context, certification of metals and minerals could contribute to meeting the sustainability challenges of increased resource use. SEI rightly points to recent studies that conclude that there is limited interest among end-consumers in “sustainable materials”. We believe this is partly explained by knowledge gaps: such materials are not “visible” in the products consumers buy, so they do not make the link between, for example, a cell phone and mining. This is a challenge that could be overcome.

The Swedish mining and metals sector welcomes further development of markets that favour responsible producers and sustainable production. In 2018, Svemin initiated a study on metals traceability.⁶ In April 2019, Tillväxtanalys also issued a report on the topic initiated by the Swedish Government (Tillväxtanalys, 2019).

The Swedish mining sector’s responsibility regarding human rights and Indigenous rights

Extraction of minerals can only take place where there are mineral deposits, and geographical conditions are the determining factor. A large amount of Sweden’s known and potential mineral deposits are located in areas considered to be protected by reindeer herding rights under the Reindeer Husbandry Act.⁷ Reindeer herding is a civil right and a culture that is to be protected under the constitution. It is a significant or even crucial activity for the rights of Sami as an Indigenous people. Both reindeer herding and mineral extraction have been documented since prehistoric times. Access to land is crucial for both mining and reindeer herding.

All mining companies operating in Sweden must comply with Swedish laws. The principle of Free Prior and Informed Consent (FPIC) has not been enacted into Swedish law. Of course, that does not, as SEI points out in its analysis, prevent the Swedish mining industry from applying the principle on a voluntary basis. Such application is, however, not without complications. There is no clear legal definition of FPIC and the interpretations vary among different industries, as do the interpretations in different parts of the world. Application of FPIC may therefore in practice manifest itself in different ways. In Sweden, companies in the mining industry and Sami communities need to find their own way of living up to the principle if it is to be applied.

Svemin’s opinion is that applying FPIC requires a clear process for its application to work well. All those involved must understand their role, their responsibility and how the dialogue should progress. To develop such a process requires mutual participation and the will to do so by the parties involved. It should also be determined whether the process should be applied to other actors competing for land, not just the mining industry. This would however require a broader approach, with more parties involved in the issue of how FPIC should be applied in Sweden. Svemin has expressed a positive view towards a bill on a consultation procedure on land assessment. The bill⁸ has not yet resulted in legislation.

Svemin and several of the mining companies that are prospecting and mining are taking active steps to find a respectful and effective way forward on the issue of access to and shared use of land. In the case of companies, there are many examples of effective initiatives and forms of cooperation with the Sami communities in question. Svemin was therefore somewhat disappointed to read SEI’s analysis on this point which, through sweeping statements, minimizes the importance of the initiatives that have been taken in

⁶ See: www.svemin.se/sparbara-metaller-for-en-hallbar-framtid

⁷ See: www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/rennaringslag-1971437_sfs-1971-437 and www.sametinget.se/10175

⁸ See: Konsultation i frågor som rör det samiska folket. Ds 2017:43. www.regeringen.se/rattsliga-dokument/departementsserien-och-promemorior/2017/09/ds-201743

the mining industry. Several mining companies do not share the view described here of how the dialogue is progressing today, and Svemin believes that failure to comment on the perspective of these companies in this context contributes to an unnecessary lack of nuance in the discussion.

One example of a statement that results in an unbalanced discussion is SEI's claim that (only) 41% of Svemin's members have a policy of or commitment to respecting human rights and that only 31% report on human rights in their annual reports. In order for this information to be relevant in the context, it should also be indicated whether these companies are conducting prospecting and/or mining operations in the Sapmi region or not. Many of Svemin's member companies, such as machinery or technology suppliers, subcontractors and consulting companies in the industry, which make up a considerable percentage of Svemin's membership, have no operations that involve using land under the Minerals Act. There are also member companies that operate outside the Sapmi region. Svemin therefore believes that it is unclear whether all companies should be included in the comparison. Voluntary undertakings with respect to Indigenous rights involve complex and to some extent complicated issues, and companies do not have sole control over the solutions. Svemin welcomes an open and constructive dialogue between the actors involved.

With that said, and in summary, Svemin would like to clearly state that we and the industry have a positive view of SEI raising the issues of competition for land use and Indigenous rights. However, it is obvious that challenges around land-use competition are wider than the important question of Indigenous rights that SEI has chosen to highlight. The challenges for the mining industry cover many different land-use purposes, some of them also in competition with Sami interests, and they all need to be analysed and paid respect.

Moonshot projects

In its analysis, SEI recommends that the industry work with "moonshot projects". This is a challenge that we view as both exciting and constructive. The current strategic research and innovation agenda – where the focus is on sustainability – would be a relevant basis for this. One suggestion could be to highlight clear evidence of restoration of land and waterways after mining operations are shut down, and also what individual companies are doing to create new ecological and social value. Another suggestion could be to have a more obvious connection between future development projects focusing on managing land conflicts and Indigenous rights and the industry's vision.

The research and development activities that are under way today in the industry are to a large extent influenced by the earlier project Smart Mine of The Future.⁹ This project provided examples of research and technical solutions to create "the invisible mine" with technology that today is found in mines in automation, digitalization and autonomous solutions and in efforts to minimize residual products and the footprint of mining operations. Smart Mine of The Future was also the basis for the national research and innovation agenda that was first published in 2013 (within the framework of SIP STRIM)¹⁰ where the vision of a sustainable, competitive industry with safe and productive mines – that do not negatively impact the environment – is connected to research and innovation needs.

The industry has in this way already staked out a path towards mines of the future. Ongoing projects that link directly to the vision in the national research and innovation agenda and to Smart Mine of The Future are the European/Swedish-led SIMS project,¹¹ LKAB's SUM (sustainable underground mining) project,¹² and Boliden's various electrification, automation and G5 projects.¹³ All of these have links mainly to Swedish system and equipment suppliers whose solutions are among the very best in the world.

There are also no fewer than one hundred innovation projects within the framework of SIP STRIM, all supporting the national research and innovation agenda and therefore the goal of a sustainable industry. There is a need to highlight these initiatives and developments that are leading to increased sustainability

9 See: rocktechcentre.se/wp-content/uploads/2013/04/MIFU_final_report_WP7_101112_red.pdf

10 The strategic innovation programme STRIM (Strategic Innovation Programme for the Swedish Mining and Metal Producing Industry) is part of a joint investment in strategic innovation areas (SIP) by Vinnova, Formas and the Swedish Energy Agency. See: www.sipstrim.se/sv/hem

11 A research and development project financed by EU Horizon 2020 which focuses on tomorrow's mining technology. See: www.simsmining.eu

12 See: sustainableundergroundmining.com/index-en

13 See e.g. the Boliden pilot project for electrification of transport at its mine in Aitik, Sweden: www.boliden.com/news/el-trolley-aitik#

and a “zero-impact mine”, i.e. zero environmental impact, zero humans in the production area, minimized footprint and minimized waste. The initiatives could be communicated and described more clearly and a number of moonshot projects – both ongoing and new ones – identified.

The industry needs to constantly consider its competitors and create effective and smart solutions that will consistently improve competitiveness. In this context, it is important to recognize that the industry can, to some extent, drive this development, but also that it needs help carrying the cost of advanced technical development. Access to investments such as SIP, Industrilivet¹⁴, and similar funding instruments are therefore essential for success.

One exciting prospect is the potential for development in the communities where the mines are located. New opportunities will be created for other sectors owing to adoption of cutting-edge technologies developed within the mining industry. Working in cooperation with SEI on this project has enabled us to gain further insights and the inspiration to create new and unexpected solutions.

This is how we will proceed

The industry is already working actively on several of the items raised in the set of action points, or on ones we believe we can address immediately, while there are other aspects that must first be studied and further developed. The industry is already tackling some of the issues itself, while others require commitment and effort by other actors. All in all, the work now being planned can be seen as the starting gun for new industry-wide initiatives.

- This is of great importance for future efforts to develop the way Sweden’s mining industry manages friction around land access and land-use issues, including the matter of Indigenous rights, and it should preferably be put in a broader context. We look forward to a constructive and respectful dialogue in order to balance the competing interests. Svemin would like this project to be implemented in cooperation with SEI.
- Svemin will continue to work on the issue of traceability from mine to product and how this can be connected to sustainability certification of metals and minerals.
- Svemin also believes that there is important work to be done for an even more clearly defined connection than today between the national research and innovation agenda and the work being done within the framework of this project, but also with the companies’ own ongoing sustainability work and initiatives.

In conclusion, this joint project has provided important input for future development of the sustainability work in Sweden’s mining industry. We hope to see the set of action points being further developed so that, in combination with Svemin’s vision and other roadmaps¹⁵ within the industry, a Sustainable Strategic Roadmap can be created.

¹⁴ See e.g. www.energimyndigheten.se/utlysningar/industrilivet--forsknings--och-innovationsprojekt-for-minskning-av-processindustrins-utslapp-av-vaxthusgaser

¹⁵ See e.g. svemin.se/mineralbidraget

8 Conclusions

The starting point for this project is the complicated role of the mining sector in the context of global sustainability transitions. On the one hand, the on-the-ground efforts necessary to realize the aims of the Paris Agreement and Agenda 2030 are likely to require an increased supply of minerals. On the other hand, mining operations are often associated with significant environmental and socio-economic impacts, some of which are very difficult to mitigate. The latter especially concerns conflicts with other forms of land use.

This project has used innovative approaches to advance the discussion on mining and sustainability. The use of exploratory scenarios in developing the draft sustainability roadmap has helped broaden the discussion. The draft sustainability roadmap includes a wide array of interesting action points that the Swedish mining sector can draw on as it continues to develop its sustainability ambitions.

As the SEI analysis and Svemin's response to it show, there are subject areas where perspectives differ. It is important to emphasize that this is in itself not to be seen as a problem. On the contrary, it is crucial to view open and honest exchange of viewpoints and ideas as a highly valuable tool, to develop joint understanding on topics that are so fundamental yet so complicated.

It is clear that in the coming years there will need to be an increasing focus on sustainability in discussions on the future supply of materials. These discussions should happen at all levels of society, and include efforts to educate the public about the importance of sustainable material supply chains. But it is most important that such discussions happen at the highest political level.

Final comments from Svemin

The extraction of minerals and production of metals is essential for a modern society, which most of us would find it hard to imagine being without. In a sustainable society, with constant population growth and a goal of eradicating poverty, the need for metals and minerals in society is unavoidable. There is also a growing need for metals for technology development and the energy transition which is necessary to reach carbon neutrality and stop climate change. It is important, however, to find a balance between extraction and recycling, primary and secondary, and to increase efficiency and achieve operations that have a minimal environmental footprint. It is also important to have social acceptance and to present the positive economic benefits of mining in society.

Overall, it is Svemin's opinion that the project has been very valuable for the industry, particularly as it has provided us with an outside perspective on a number of issues:

- how the industry and the work it does are perceived
- whether the industry is contributing to sustainable societal development, and
- what is needed for this contribution to be even greater.

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Appendix 1: Full list of action points from workshop 2 (in Swedish)¹⁶

- Mer lågvärdiga förorenade malmer kräver ökad tillgång till (billig) CO2-fri energi, samt ökad vattenreningskapacitet/förmåga, vilket vi och andra branscher tillsammans med politiken behöver jobba för att få till
- Svemin bör bli mer av Worldmin
- Branschen måste med politikens och konsumenternas hjälp få till en mer cirkulär ekonomi för att säkra en hållbar materialförsörjning (när importen försvårats)
- Omdefiniering av branschen med hjälp av design och cirkularitet från gruv till mineralcentral, där branschen är drivande men behöver politikens och kundernas hjälp
- Branschen ska längs hela kedjan arbeta för ökad spårbarhet
- Bransch, kunder och politik verka för att kvalitetsstandarder får genomslag för att trygga "feed-in"-processen i cirkuleringsfasen
- Branscher och politik hitta regler och system som underlättar att göra om avfallsströmmar till produktflöden (speciellt för kritiska metaller)
- Staten upphandlar (och/eller skattestyr) nydesignutformade produkter för öka konsumtionens hållbarhet och cirkularitet
- Branschen bör ha ett gemensamt förhållningssätt till, och ansvar för, hela värdekedjans avfall
- Branschen bör tillsammans med forskningen utveckla högteknologi för landfill-(slag)-mining
- Branschen bör komplettera sin gruvverksamhet med materialåtervinningsfunktioner och bli materialleverantörsföretag
- Branschen/företagen bör med sina kunder skapa system för att återföra material direkt till "materialcentralen"
- Bolagen måste utveckla förbättrade återvinningstekniker/strategier (även om det är dyrt och ibland svårt, men det måste få kosta - att satsa på detta kommer att betala sig)
- Politiken och brancherna skaffa sig gemensamt mål för återvinning innefattande forskning och teknik- och regelutveckling, drivet minst lika mycket av omställningsbehov som kostnadsbesparingar
- Branschen och forskningen bör utarbeta mer flexibla materialframställningsprocesser som lättare kan blanda jungfruligt med återvunnet utan att det degraderar slutprodukten Återvinning - återvinning av material. Man måste kunna blanda jungfruliga och återvunna materialströmmar för att kunna klara detta, utan att det degraderar produkten. Utveckla materialframställningsmetoder - ger mer flexibilitet.
- Branschen bör (tillsammans med politiken) via t ex design göra det lättare för (slut)kunderna att konsumera återvinningsbart
- Politiken och näringslivet måste gemensamt skaffa sig ett stöd hos medborgarnas/konsumenterna för att samhällsplanera och produktutveckla utifrån ett helhetstagande hållbarhetsperspektiv - inte minst runt en mer cirkulär ekonomi med effektiva system för materialåtervinning.
- Branschen bör arbeta med märkta material och delar för att öka spårbarhet i leverantörskedjan och underlätta återvinning -kan använda digital teknik för detta.
- Utökad utvinning ur befintliga flöden för att minimera nybrytning
- Samordna funktioner med andra aktörer för att få skalfördelar och utveckling
- Med hjälp av omvärldsanalys och branschsamverkan och anammande och spridning av BAS (best available security) få en säkerhet av världsklass både här hemma och borta
- Stat, kommun och bolag måste skaffa en infrastruktur och "praxis" för både en (cirkulär hållbar "e-handels") mineralhantering med automatiserade/digitala inslag och distansarbetsmöjlighet, så att branschen blir mer platsoberoende (Skapa "Cyber"-fors/bruk, vilket ökar branschattraktiviteten)
- Branschen ska med politikens och andra aktörers hjälp ansvara för en förbättrad jämställdhets och mångfaldskultur, inte minst vid rekrytering, vilket kan gynna både bolagets varumärke och samhällets mål ppå dessa områden
- Företag och lokalsamhället bör arbeta gemensamt för individanpassade anställningsformer som ger synergier för alla inblandade
- Branschen (-erna) bör samverka längs värdekedjorna för att bättra tillvarata hållbara produktivitetsvinster (industriell symbios)
- Företag bör rikta in sig på vertikala samarbeten för att "äga kedjan tillsammans" som i Litium-Panasonic-Tesla och HYBRIT

¹⁶ These action points are reproduced verbatim from the workshop, in unedited form.

- Branscherna måste värda sin hemmahamn, för det är det unikt goda förutsättningarna och kunskapen härhemma som vi kan saluföra globalt
- Branschen måste tillsammans med samhället få till en mer holistisk gruvdesign (från etablering till återställning) för att säkerställa en hållbar gruvdrift som kan trygga samhällets materialförsörjning
- Branschen bör inrätta sig mer i kluster både på horisontellt och vertikalt längs värdekedjan som kan samverka mer dynamiskt kring logistik, anläggningsteknik (alla anläggningar behöver inte ha allt själva), men också tillståndsfrågor
- I en mer regionaliserad värld behöver branschen med politikens/samhällets stöd använda såväl gammalt och nytt gruvavfall och recirkulera mer (urban recirculation - inte bara urban&site mining) och också vara beredda att bryta mer, och då använda mer av det som bryts
- Branschen bör med forskningens och kund/partners hjälp produktutveckla mot högre kvalitet med hjälp av specialmaterial och högre tjänsteinnehåll och digital teknik
- Branschen bör med företag längs hela värdekedjan utveckla hela industrikluster (industrisymbios där man minimerar transporterna) och sedan också går över till miljöbättre (båt)transporter
- Branscherna och politiken bör ännu mer utveckla regionala konkurrensfördelar och satsa på det vi har mycket av, är bra på och andra har svårt att kopiera: el, underjordiska material, biomaterial, inkl "biokolstål, med kolet från bio-flöden.
- Utveckla det bästa i den svenska modellen - ledarskap, platta organisation, transparens, delaktighet, "kulturen" sitter i människorna (och kunder i andra delar av världen är avundsjuka på oss för detta)
- Produktifiera alla flöden! De mineraler som bryts ska gå till en säljbar produkt. Gråberget till ballast. Söka och finna nya användningsområden för alla mineral och metaller som bryts.
- Produktifiering för ökat resursutnyttjande och att undvika avfall.
- Branschen, samhället och politiken bör planera för att teknikrelaterade kostnader går ned (lärkurvor), medan sociala/miljökostnader går upp (tröskeleffekter och tröga processer om de gått tillräckligt "fel")
- Öka branschens och samhällets förmåga att implementera morgondagens lösningar/verktyg, eftersom det avgör hur konkurrenskraftiga vi är 2050
- Vårda, utveckla och utnyttja svenska konkurrensfördelar (svensk kärnkompetenser) som är svåra att kopiera - platt organisation, konstruktiva fack - den svenska modellen
- Branschen bör i dialog med samhället bygga in mervärden i produktionen, men också i produkterna, för att om möjligt göra om sociala & ekologiska mervärden till ekonomiskarans
- Branschen bör med politikens/samhällets hjälp själva utveckla och använda nya teknikplattformar och lämna befintliga och gamla till konkurrenter.
- Branschen bör tillvarata goda erfarenheter (BAT - best available technology/practice) och sprida den internt - tvinga ut den i organisationsationen
- Branscherna behöver med statens hjälp ha med urfolkens kunskaper om en hållbar utveckling och inkorporera denna i regleringsbrev, branschkode etc
- Alla intressenter bör tillsammans med bolagen/branschen arbeta för att hitta välfungerande samverkansformer och intressedialoger för att säkerställa MR-målsuppfyllnad
- Branschen bör uppmanra staten att skapa en mer jämlik/jämbärdig dialog/spelplan för att sedan på ett inkluderande sätt kunna uppdatera lagstiftning utifrån internationella överenskommelser om mänskliga rättigheter
- Branschen bör med politikens och andra finansierare ordna oberoende fondmedel för att aktörer med mindre resurser ska kunna ta fram resursunderlag till MKB och annat på samma villkor som alla andra
- Branschen och politiken behöver sätta upp kvalitetssäkrade standards för prospektering i samförstånd
- Politiken måste med branschens hjälp säkerställa samordna rättssäkra tillståndsprocesser (likhet inför lagen)
- Lokal förankring gällande brytningstillstånd inklusive översyn av regel- och incitamentsstruktur (leta efter Best Available Practice i andra länder)
- Regelverk och tillståndsprocesser som ser till hela värdekedjan
- Se över arbetsgången hos länsstyrelserna för snabbare, mer rättssäker hantering av tillståndsprocesser
- Bolagen bör i proaktivt ta fram mycket bättre konsekvensbeskrivningar (business cases) gällande allt som har negativ påverkan för att underlätta dialoger och tillståndsprocesser (företagsförslag!)
- Branschen tillsammans med lokala aktörer bygga samverkan och landsbygdssamförståndsöar före tillståndsprocesserna
- Staten/domstolarna/myndigheterna bör (med branschens och andras hjälp) se över hur man väger total (hållbar) samhällsnytta mot skadan av en verksamhet i tillståndsprocessen, (och enas om

(utveckla) hur en sådan samhällsbedömning ska se ut och gå till)

- Myndigheterna bör se över var kompetensen i naturresursfrågesammanhang finns och involvera dem i tillståndsprocessen (som kanske behöver ha tillgång till annan personal än bara den på länsstyrelserna)
- Tydliga rättssäkra tillståndsprocesser (vilka konsekvenser accepteras?)
- Branschen och politiken (samhällets alla aktörer) ska arbeta för att få till en samlad hållbarhetstillståndsprocess (a one-shop-stop), men det kommer bland annat kräva mycket bättre och bredare underlag från företagen för att fungera
- Öppna upp kunskapssynen så att alla kunskapsperspektiv representeras och kommer till användning, och där speciellt den regionalt utvecklade kunskapen ges utrymme
- Branschen, med utbildningssektorns hjälp, bör aktivt arbeta för ökat kvinnligt deltagande i branschens alla verksamheter
- Samordnad företagsbehovsstyrd kompetensförsörjning med tillhörande IT-infrastruktur - där kommun/skola, stat/högskola, och branscher gemensamt skapar regionala "utbildningscentraler"
- Utbildningsväsendet och arbetsmarknadens parter (bolagen och branschen) bör göra utbildnings- och fortbildningssatsningar inriktat på social välmående och alla dit hänförliga nationella policies och internationella regelverk
- Branschen, parterna och arbetsmarknadspolitiken bör preventivt säkra omskolningsvägar för yrken som det behövs folk i nu, men där de snart kan hotas av automatiseringen (t ex fordonschaufförer)
- Politikerna bör med parternas hjälp säkerställa en bred regionalt anpassad utbildnings- och arbetsmarknadspolitik som kan yrkesförsörja alla de funktioner som behövs för ett välfungerande lokalt näringsliv med alla privata och offentliga servicefunktioner som det drar med sig
- Omvärldskunskapfortbildning för alla grupper
- Branschen bör samverka med akademien för att få mer kunskap om framtidskraven i en långsiktigt hållbar värld
- Branschen bör tillsammans med akademien, och även utbildningsväsendet, verka för mycket mer flexibla utbildningssystem, där man kan byta ort, inriktning och kurser lättare
- Branschen bör tillsammans med akademien, och även utbildningsväsendet, säkerställa den långsiktiga kompetensförsörjningen i branschen
- Branschen bör samverka med alla lokala aktörer kring att öka den gemensamma kunskapsnivån, dvs alla ska hjälpa alla andra att både sprida och vara mottagliga för egen och andras kunskap
- Politiken bör med relevanta branscher fortsätta på MAX4-spåret och också inrätta ett "Cern" i Sverige
- Arbetsmarknads/regionalpolitiken bör tillsammans med branschen skola upp nyanlända med lämplig bakgrund för att säkra industribranschernas regionala kompetensförsörjning
- Branscherna (och parterna) bör medverka till att utbildningssystemet görs mer påbyggnadsbart -lättare att göra två mastersår senare, eller bygga ett 2+2+2-system där det sista steget kan vara MBA-lik, dvs kräva yrkeserfarenhet
- Företagen bör tillsammans med fack och myndigheter (arbetsmiljöverket och andra) öka kunskapen om värdet av en bättre social arbetsmiljö och hur en sådan byggs upp i en "maskinsystemspräglad" miljö - för fler branscher är på väg att automat-robot-digital-iseras
- Branschen (-erna) bör tillsammans med akademien (och politiken?) utveckla helhetstänkmodeller för mer balanserat beslutsfattande
- Branschen bör tillsammans med akademien (och politiken?) analysera sin "social/societal licence to operate", dvs öka kunskapen om vilka krav samhället kommer att ställa på dem framöver socialt och ekologiskt
- Branschen (-erna) behöver samverka globalt gällande kunskapsutbyte med alla sorts aktörer - själva bidra med kunskap och ta till sig andras
- Branschen bör tillsammans med "sina" utbildningsvägar kompetenssäkra branschen mycket bredare än som sker idag - morgondagens anställda behöver stå på bredare bas (t ex hållbarhetsmässigt)
- Branschen och det offentliga behöver göra gemensam satsning på tillämpad forskning kring hållbara lösningar för att möta alla morgondagens krav
- Tätare samarbete mellan branschen, universiteten, institutet och myndigheterna
- Bransch(erna) bör tillsammans med myndigheterna (och speciellt ute i regionerna där det råder brist på många kompetenser) utveckla sin syn på arbetskraft, och hur man själv kan hjälpa till att skola den: mer flexibelt arbetssätt, diversifiering (åldrar, etnicitet, kompetenser), öka inkluderingen
- Politiken/samhällena bör utveckla arbetsmarknaden och arbetsmarknadspolitiken (som har en delvis annan logik i regionerna än i storstäderna)

- Branscherna, bydgerna och politiken bör dra nytta av behovet av det svenska integrationsbehovet för att lösa regionernas demografiska utmaning där ålderspyramiderna är omvända - en lösning kan vara att ta vara på den arbetskraft som kommer
- Branschen bör internt utbilda om behovet av transparens, göra oss tillgängliga, att kommunicera utåt, och att fler anställda både kan och vill det, och det gäller både om den egna verksamheten, och dess roll i samhället, samhällsutvecklingen och den hållbara samhällsomställningen
- Ökad samverkan och mindre misstänksamhet mellan näringsliv och akademien - dra nytta av varandras forskning
- Näringslivet och andra aktörer hjälpa skolan att ta fram läromedel om hur saker tillverkas
- Få in det geologiska perspektivet mer i utbildningssammanhang.
- Branscherna tillsammans med samhället bör hjälpas åt att utforma jobb i en kunskapsintensiv industri för att vara attraktiva, med tanke på att globaliseringen gör kompetens allt mer flyttbar
- Företagen bör skapa en tydlig (allmänt accepterad) omställningskultur och lyfta omställningskompetens till en kärnkompetens
- Branscher tillsammans med utbildningsväsendet skapa medarbetare som har innovationskraft, vilket leder till att man blir mer attraktiva för kunder (och kan "byta anställda") - flexiblare arbetskraft till gagn för alla
- Branscher tillsammans med utbildningsväsendet skala omställningskraft bortom "best accepted technology" för att samhället verkligen ska kunna klara av att nå FN:s 17 hållbarhetsmål
- Företagen bör utnyttja viljan till innovation hos personalen till konkurrensfördel
- Uppmuntra mjuka kunskaper även i en hård-teknik(kunskaps)bransch - båggedera behövs i morgondagens affär och samhällsutveckling
- Offentliga och privata aktörer ska ta fram interna regelverk och rutiner för att kunna implementera och följa upp alla mål gällande hållbarhet, såväl gällande miljö och människors välmående och rättigheter
- Branschen bör verka för att politiken breddar miljöprövningar till samverkansinriktade hållbarhetsprövningar
- Branschen bör driva på globalt för gemensam lagstiftning och globala standarder
- Branschen bör skaffa sig gemensamma ekologiska och sociala standards och också standards för att "hantera" konkurrenter som lägger sig under dem
- Branscherna bör, kanske tillsammans med politiken, skapa certifikat för hållbara produkter inklusive spårbarhet
- Branschen bör driva på globala standard-arbetet, spårbarhet och märkning för att få stopp på konfliktmineralanvändning och sedan successivt städa underifrån till gagn för "most sustainable practice"
- Branscherna (företagen) behöver ha nolltolerans mot korruption och alla "genvägar" enligt Bamse-ledordet - är man stark måste man vara snäll
- Branschen, politiken och samhällets aktörer behöver skapa legitimitet för beslut, dvs följa internationella normer osv för att t ex hantera markkonflikter
- Tillsammans med andra aktörer hitta strategier för att motverka aktörer som utnyttjar svagare motparter och bryter mot regler och avtal och motverkar FN:s 17 hållbarhetsmål.
- Inrätta en hållbarhetsbalk som går att implementera (Vi har lagstiftning om prövning ur alla perspektiv, som inte följs. Länsstyrelsen har detta ansvar, men gör det inte. Behov av en hållbarhetsbalk (ekonomisk, social, ekologisk) som ersätter miljöbalken)
- Branschen behöver kunna visa spårbarhet och ansvarsbärande i tid och rum (där kan Sverige på sikt (för?) bli "bäst i test")
- (Branschen bör ligga på för att) Riksdagen bör lagstifta om en tydlig ansvarsfördelning mellan politiker och domstolar i tillståndsärenden för alla inblandades skull
- Alla hållbarhetsfrämjande aktörer bör arbeta för inrättandet av globala sanktionssystem mot dem som bryter mot (scenariets) regelbaserade värld.
- Branschen bör själva arbeta för ta fram gemensam industristandarder för transparens och "level playing-field", men också tillsammans med andra samhällsaktörer arbeta för att ta fram hållbarhetsstandarder som kan vara ett bra alternativ till lag om alla aktörer kan enas om den, även globalt.
- Politiken bör se över aktiebolagslagens innehåll så den bättre rimmar med samhällsutvecklingens nya bredare hållbarare mål och framgångsmått (ett bredare vinstbegrepp - om det nu ska vara ett aktiebolagslagsstadgat mål)
- Politiken bör (långsiktigt) hållbarhetsanpassa lagar och regler (och hålla sig till dem)

- Politiken bör säkerställa ett basbehov av grundläggande hållbarhetsskapande infrastruktur som fungerar i hela landet
- Politikerna ska vara aktiva och tydliga i att jobba för det generellt bästa och mot särintressen
- Politiken bör sätta upp en lokal basnivå för offentlig service (och kommersiellt tjänsteutbud) för att öka attraktiviteten att bo och verka i landsbygd
- Näringslivet bör och politiken bör arbeta för att ett nytt EU-direktorat för naturresurser, och ett nytt svensk naturresursdepartement, bildas, där markanvändningsfrågor (och konflikter) hanteras - det behövs bättre institutionella förutsättningar gällande markfrågor.
- Branschen måste tillsammans med alla svenska modell-aktörer (inkl akademien) på sitt sedvanliga icke-hierarkiska sätt utveckla det bästa i den svenska modellen för den är konkurrenskraftig
- Branschen, politiken och samhällena behöver ha/ta en ännu längre planeringshorisont än till 2050 pga de mycket långa tidsperspektiven i ledtider, investeringscykler osv för all sorts inblandat kapital (infrastruktur inte minst) Mycket långa ledtider för gruvproduktioner. Hur påverka produktionen för att anpassa till hållbarhetskrav. Hanterar idag system som byggdes för 50-70 år sedan. Hänsyn till malmreserv kontra mineraltillgång. 30-40 års perspektiv. Dvs omställning tar tid, 30-40 år.
- Definiera tillsammans med politiken och samhället vilka infrastrukturbehov ett hållbart närings- och samhällsliv behöver ha på plats till 2030-50 för att lyckas med Paris-avtalet/klimatlagen, Agenda 2030,
- När vi får bryta i bästa läget regionalt (som är sämre än bästa läget globalt) ger det mer komplicerad gruvbrytning, högre pris, kanske högre mervärde men också högre externkostnad - tillsammans behöver vi hitta samhällsacceptans och former för att hantera detta så hållbart som möjligt såväl ekologiskt, socialt och ekonomiskt
- Regeringsstrategier kring landsbygdsutveckling, materialbranschutveckling, utbildning, markanvändning bör samordnas och anpassas tillsammans med regionala aktörerna
- Alla aktörer behöver tillsammans hantera resurskampen (energi, mtrl, mark) mellan olika användares behov
- Samverkan stat, kommun, näringsliv, civilsamhälle för att ta ett samlat grepp om en hållbar landbygdsutvecklings behov av utbildning för den breda lokala arbetsmarknaden och allt som krävs runt omkring den
- Mer samverkan mellan kommun och bolag kring socio-ekonomisk "infrastruktur" - vad som krävs i en kommun/region för av social service
- Bygg upp lokala tillits- och framtidstros-skapande gemenskaper genom samverkan mellan alla lokala aktörer (bolag, kommun, föreningar)
- Företagen, lokala aktörer och kommunen ska gemensamt skapa bättre affärsmöjligheter/förutsättningar för att stärka lokalsamhällets livskraft (förtroendeskapande lokal förankring)
- Bolagen bör på orter de verkar tillsammans med lokala aktörer delta aktivt i kompletterande verksamheter för att öka den lokala "attraktiviteten"
- Politikens och andra (resurs)starka aktörer behöver skapa mer liknande förutställningar för alla medverkande intressenter i samverkanssammanhang (det kan gälla rättshjälp, utredningshjälp, tillgång till sakkunniga och jurister, ...)
- Bolagen och alla samverkansintressenter (inklusive politiken) bör skaffa sig en standard för intressentdialog
- Företag och sakägare får gemensamt identifiera kärnan i behoven/nyttan i samrådssammanhangen och hitta sätt att möta allas behov (ett sätt att få ILO att bli "överspelat" - givet att det fungerar)
- Sverige och branscherna måste iscensätta hållbarhetsskapande samarbeten med regioner där det redan bryts, eller kommer att brytas, strategiska mineraler
- Branschen ska tillsammans med politiken och samhället bygga en plattform för en kunskapsbaserad, rättvis dialog med (alla) aktörer där alla ska ha samma möjlighet och rättighet att delta
- Branschen bör i samarbete med alla andra aktörer hitta co-management/dialogformer och -metoder/verktyg för MKB och andra beslutsunderlag där man tillsammans arbetar fram underlagen
- Hitta politisk och lokal acceptans för "omvända naturreservat" där de material som samhället behöver, men annars inte kan få tag på, får brytas med så kontrollerade konsekvenser som är möjligt och då bara i ordnade former av aktörer som respekterar reglerna (statligt sanktionerad gruvverksamhet enligt konstens alla regler)
- Branschen bör tillsammans med politiken och andra samhällsaktörer verka för vattennyttjande strategier för att undvika vattenbrist (försämrad vattenkvalitet)
- Branschen bör samverka med miljövärderna för att utvinna begärliga material från "sänkor" där de för närvarande gör skada (fosfor på fel ställen) - entropimaskiner som då måste drivas av billig förnybar el

- Vattenfrågan en hållbarhetsutmaning både ur klimateffektperspektiv (idag är tillgången god) men än mer slutna processer behövs. Ökade utmaningar med vårflood, klimat, etc. Behövs också igen regionala bedömningar igen, lite tillbaka från de EU-gemensamma t ex fasta halter som idag är trenden att sätta (som inte gör en platsspecifik bedömning lika möjlig)
- Branschen ska tillsammans med forskningen ta fram en nollvisionsroadmap gällande all slags utsläpp
- Branschen bör med politikens hjälp börja arbeta med ekologisk kompensation när det kan vara en lösning, och det kan röra biotoper såväl som renskötsel frågor
- Gruvnäringen måste bli ärligare och öppnare om påverkan på andra näringar och miljön (skulle också leda till bättre/snabbare tillståndsärenden)
- Branschen ska agera för att bli försöksnäring för ekologisk kompensation - att kompensera för det lokala avtrycket ekologiskt genom åtgärder av minst lika stor "vikt" på annan minst lika viktig plats
- Branschen ska, tillsammans med politiken, öppna upp för mer anpassade livsstilslösningar för att locka kompetens - bygdelivet har både livsstils fördelar och nackdelar, så distansarbetslösningar etc som möjliggör att man delar sitt liv mellan stad och land skulle kunna locka mer folk till branchen/ landsbygden
- Företagen bör med lokalsamhällena, regionerna, och rikspolitiken verka för att man kan bo "urbant" på fler platser, och eller arbetspendla lättare, och/eller jobba lättare/mer "bortifrån"
- Branschen bör öppna för lokal vinståterföring som en dialogöppnare gällande lokal samhällsutveckling
- Branschen bör tillsammans med samhällena de verkar i marknadsföra attraktionskraften i att ha ett tekniskt avancerat välbetalt jobb som skapar global samhällsnytta, men är lokaliserat där boendet är billigt och en ren naturmiljö runt knuten, dvs livskvalitetsaspekterna
- Branschen ska verka för att bli en plattform för en mer inkluderande dialog för ett mångfacetterat inland där en hållbar gruvnäring är en bärande/närande del
- Stora företag bör ha en beredskap för att ta ett större ansvar i glesbygden om staten inte kan sitt "gamla" ansvar, och då behöver företagen jobba med lokala krafter kring allehanda servicefrågor för att minska/vända utflyttning
- Branschen behöver tillsammans med staten/politiken och alla lokalsamhällesaktörer diskutera förutsättningarna för samexistens - inklusive ersättningsfrågor - då de är varandras NIMBYs
- Företagen bör jobba internt, och på orterna där de verkar, för att öka medarbetarnas/medborgarnas inflytande för att motverka populism
- Branschen bör transparent tillsammans med politiken/lokalsamhället arbeta med revenue sharing
- Jobba med varumärket gruvor genom att sträva efter, och kommunicera, "best practice" och nyttan materialen och verksamheten ger (Skapa YIMBY!)
- Branschen måste kommunicera (och leverera) både lokal samhällsnytta (löner, skatter, varor) och exportera global samhällsnytta (specialkompetens/produkter som sprids över världen)
- Branschen behöver bygga varumärke kring hur den lyckas klara sina hållbarhetsutmaningar (utöver de politiska grundkraven)
- Branschen bör marknadsföra Nordic Mining som ett globalt hållbarhetsvarumärke (och leva upp till det) och bidra med kunskap, och material, till resten av världen
- Företagen och branschen (-erna) bör utveckla sin pedagogiska kommunikativa berättarförmåga som kommer att behövas i en allt högljuddare värld
- Branschen behöver identifiera och sedan kunna berätta materialframgångssagor (ändra den mediala bilden av gruvan som Mordor)
- Näringslivet måste tillsammans med politiken hitta sätt att berätta om hur, och geopolitiskt/regionalekonomiskt säkerställa att, samhällets råvarubehov av mat, vatten, virke, metaller och material tillgodoses av och är en del av samhällets (behov) markanvändning(sbehov) i ett hållbarhetssammanhang
- Branschen behöver utveckla sin trovärdig genom att bättre kommunicera produkters hållbarhetsbelastning till kunder, inkl. rättvisa, jämställdhet, etc, speciellt viktigt för business till consumer-företag, men alla bakomliggande led måste vara med
- Branschen måste tillsammans med sina kundföretag (och andra) kommunicera materialförsörjningens "väsen" och framtidens "rimliga" gemensamma kravprofil (all verksamhet leder till effekter)
- Branschen måste vara med och skapa en ny berättelse om sin roll i samhället, för den nuvarande gruvberättelsen är föråldrad - nu går branschen i bränschen för klimatomställningen...
- Företagen bör kampanja om att deras material finns i de flesta konsumentvarors värdekedja och i de flesta framtida hållbara teknikköslösningar
- Branschen behöver visa på hur den från att göra det mesta av en lokal malmkropp (och som cirkulär)

materialleverantör kan bidra till alla 17 SDG-erna. (Välfärdsstaten tas för given, vad driver den, exportindustrin 70%, låg kunskap, få anställda i basindustrin. Är motor lokalt-regionalt. Urbaniseringen går snabbt. Gruvan är där den är, pga geologin. Förståelsen brister. 2050 förstår vi detta. Nationalismen suboptimerar.)

- Branschen bör sprida kunskap för att öka förståelsen hos allmänheten om vad faktiskt materialhanteringsindustrin är idag och var den är på väg och på så sätt skapa "social acceptance".
- "Macho"-branscherna bör tillsammans med utbildningsaktörer verka för ökad jämställdhet och jämlikhet genom utbildnings- och andra insatser
- Branschen bör utveckla egna normer för forskning: jämställdhet, rättvisa, etc och bygga in det i verksamheten, inte minst för att öka attraktionskraften som arbetsgivare
- Branschen behöver jobba med jämställdhet för att öka attraktiviteten att jobba i branschen
- Branschen behöver förbereda sig för vad ett ökad genomslag av digital teknik kommer att betyda - färre anställda som behöver kunna andra saker än idag i gruvdelen, men kanske fler människor anställda i cirkulära delen - och vad ska vi ställa för kravprofil på dem - och vad kommer de att kräva av oss/arbetsgivaren
- Branchen bör tillsammans med andra nytta digitaliseringens alla möjligheter gällande säkrare och mer flexibla arbeten (där man kan jobba längre upp i åren om man vill) , och på så sätt också skapa nya arbetssätt och arbetsformer, och därmed möjligheter för ökad integration med resten av landet/samhället
- Branschen bör tillsammans med politiken säkerställa utbyggnad av 5G-internet för att det behövs för både näringslivs och offentlig verksamhet - utbildning hälsovård och välfärd
- Politiken/samhället/branschen måste fundera över vem som ska äga - och då kanske kunna sälja - din (allas) data - IP-frågor
- Branschen, akademien och politiken/myndigheterna måste skapa (officiellt definierade) mått för att mäta hållbarhet,
- Alla relevanta aktörer behöver skriva hållbarhetskontrakt för den lokala/regionala verksamheten (sustainability policy commitments som det sedan behövs operativa rutiner för att uppfylla)
- Aktörer samfällt verka för regler kring att mineralimport endast ska ske från ackrediterade (hållbarhetsgodkända) företag
- Politiken behöver med aktörernas hjälp föra en möjliggörande samordnad politik för att Sverige (och branscherna) samlat ska kunna fungera som SDG-motorer både lokalt och globalt
- Politiker (lokalt och nationellt och internationellt) bör sätta upp tydliga samordnade hållbarhetsregler för alla nivåer
- Politiken (FN med hjälp av medlemsstater och "major groups" jobba för ett gemensamt globalt hållbarhetscertifieringssystem
- Politiken, experter och branscherna bör jobba fram hållbarhetsstandarder (ISO) för certifiering, där det övergripande som ska vara är globalt, men där det finns särlösningar gällande annat regional/lokalt för att gällande annat är hållbarhet just en lokal/regional anpassningsfråga
- Rättvisemärkning som sträcker sig längs hela värdekedjan, gjord av oberoende aktör
- Industrin och politiken bör gemensamt arbeta fram tydliga sätt att mäta alla hållbarhetsdimensioner för ökad transparens
- Branschen bör, tillsammans med andra branscher, använda digital teknik för att synliggöra materials/varors fotavtryck (CO2 och annat) för kunderna, och på så sätt också ta ut prispremie för bra värden
- Branschen (-erna) behöver bli proaktiva i globala hållbarhetsfora (FN/OECD/...) för att visa hur de kan bidra till samhällsnytta (hållbarhetslösningar) snarare än att utgöra ett socialt och ekologiskt problem
- Branscherna och akademien (och politiken?) bör räkna fram olika hållbara scenariers materialåtgång och sprida den kunskapen
- Branschen måste våga och orka tänka långsiktigt hållbarhetsmässigt för med tiden förlorar de företag som inte fortsätter den denna inslagna väg andras "acceptans"
- Näringslivet/branschen bör med politikens hjälp (och troligen då påhejrat av samhället) bredda syftet med företagande från vinst till samhällsnytta
- Branschen bör stödja utvecklandet av hållbarhetsmätmetoder
- Branschen bör spårbarhets/hållbarhetsredovisa (gentemot konsumenter och intressenter) med tredjepartsgranskning
- Näringslivet behöver planera för en hållbar omställning som eventuellt inte inkluderar fortsatt konsumtionsvarutillväxt eller ens ekonomisk tillväxt, och vilka behov/produkter/material som det då kan behövas mer eller mindre av, och hur verksamheten då behöver ses över

- Alla aktörer behöver tillsammans verka för ett globalt system för internalisering av alla hållbarhets-/miljökostnader.
- Samhället i stort och branschen behöver gemensamt bedöma (definiera och kalkylera) vilka behov av metaller det kommer att finnas från de 10 miljarderna människor.
- Branschen och samhället behöver analysera behoven post-Paris när det inte längre finns några fossila bränslen att ersätta. Utveckla andra hållbarhets-miljöfördelar
- Utveckla märkningsinitiativ tillsammans - miljömärkning, fairmärkning/MR/urfolk osv (gärna sammantaget för hållbarhet)
- Öka spårbarheten och därmed medvetande hos allmänheten om varifrån alla produkter kommer (inkl konsekvenser av det)
- Satsa på fair-produkter/tjänster och den samhälleliga (hållbart definierade) vinster, och omdefiniera därmed dagens "avkastningskrav"
- Politiken, samhället och näringslivet verka för "Hållbarhetstillstånd", villkor kopplade till de 17 hållbarhetsmålen.
- Branschen, politiken och samhället bör leta efter synergier mellan SDG8s delmål om jobb och alla andra mål, dvs skapa sysselsättning med syfte att möta målen
- Branschen bör verka för att materialursprungsmärkningar
- Branschen bör bygga globala hållbarhetsbaserade varumärken med hjälp av spårbarhetens alla landvinningar
- Branscherna ska med politikens (och hållbarhetsaktiga måtts) hjälp göra rätt avvägningar vad som bäst produceras var
- Ökad utmaning att samsas om begränsade resurser, inte minst mark, kommer att kräva mer samverkansforum där alla aktörers perspektiv kan "brytas"
- Staten måste ansvara för att lösa markanvändningskonflikter enligt rättighetsavvägningar utifrån gällande rättsregler
- Branschen och politiken, bör med sina respektive först nordiska, sedan internationella, kontakter, få till samarbeten och en global grand plan för bästa resursutnyttjande både i Sverige och globalt
- Politiken behöver tillsammans med alla samhällsintressen hitta nya sätt att göra nationella markanvändningavvägningar (kanske "kampanjvis") utifrån den stora breda nyttan.
- Samplanera för småskalig gruvdrift med gemensamma anläggningar där så passar - och därmed stoldriftsfördelar vid tillståndsprocesser
- Samhället i stort och branschen behöver enas om "Best available location" – BAL, var ska produktion ske i ett globalt perspektiv.
- Samhällelig dialog kring var och hur etablering eventuellt kan/ska ske - företagsekonomiska bedömningar måste underordnas hållbarhetsinriktade samhällsekonomiska bedömningar
- Branschen ska driva på för en mer global materialförsörjningsdiskussion - gruvnationalism hållbarhetssuboptimerar ofta, och mer av global transparens och en mer global hantering av tillståndsfrågan skulle gynna svensk industri
- Branschen, och samhället, bör förbereda sig för alternativa sätt att bedriva, och finansiera, materialförsörjning- och materialhandel, om (LME) London Metal Exchange av olika skäl inte fungerar (Skellefte ME med riksbankens metallreservfinansieringsfond som uppbackare)
- Politiken bör med relevanta parter hitta system för vinstdelning som automatiseringen lär föra med sig, både för att vinna acceptans för teknikutvecklingen och finansiera utbildningsvägar som kan de som förlorar jobbet framtidstro
- Det behövs ett nytt kommunalt utjämningssystem, inkl vinståterföring till där värdekedjornas naturresursersuttag sker för att trygga dessa orters/bygders (och värdekedjornas första länks) fortsatta attraktivitet
- Bolagen med politikens hjälp införa "Vinståterbäringssystem till lokalsamhället"
- Politiken (nationellt och kommunalt) bör arbeta mer aktivt mot ojämlikhet (slå ihop skatteutjämning ovan)
- Politikens ska stöjda en "industrialisering av cirkulär ekonomi" (spin-off-bolag) för att underlätta mineralåtervinning
- Branschen ska tillsammans med finansbranschen guida den senare så den lättare kan hitta hållbarhetslösningsföretag i materialvarukedjan
- Branschen bör, tillsammans med politiken, arbeta för verktyg där sådant som inte är cirkulerbart kan kompenseras för genom att bidra till att något nytt önskvärt tillkommer (intern jungfruliga-materials-avgift/skatteväxling som stödjer cirkularitet/hållbarhet)

- Branschen bör samverka med finanssektorn för att få metallbörsen (LME) att anamma hållbarhetsstrategier
- Branschen bör föreslå, och medverka i, en ny social skatte(växlings)reform, då robotar kanske slår igenom mest först i materialbranscherna där då mest jobb riskerar att försvinna (eller ändra karaktär/krav-spec)
- Branscherna måste hjälpa finansmarknaderna att ändra innebörden i "en god investering" så den blir mer långsiktigt samhällsnyttig (hållbarhetsskapande)
- Branschen/politiken bör kompensera med mer avkastning till lokalsamhället, inte minst eftersom Automatisering leder till färre anställda,
- Branschen/politiken bör jobba för att återföra en del av det värde som skapas lokalt i glest befolkade regioner, men redovisas i Sthlm.
- Näringslivet (och kunden som ju nästan alltid till slut får betala) och politiken bör inrätta ett globalt system för hållbarhetsersättningar - det lär kosta slutkunden lite, men kan göra stor skillnad i långa varukedjor där merkostnaden i ett led är stort men för slutkonsumenten knappast ens märks.
- Branschen bör tillsammans med andra energibehövande aktörer (och forskningen och politiken) göra allt för att få fram billig förnybar energi som är nyckeln till en hållbar utveckling
- Näringslivet och övriga samhället behöver ligga på politikerna för en strategisk regionalt utvecklad hållbar energipolitiken, för materialbranschen ska den stötta hållbar materialåtervinning och materialutvinning.
- Branschen ska tillsammans med andra elproducerande och elintensiva branscher och staten (svenska kraftnät) arbeta dels för ökad elektrifiering, dels för ökad elproduktion och förbättrad distribution (bygga bort falskhalsar i nätet)
- Branschen bör satsa på elektrifiering och samarbeta med "elektrifierings-partners"
- Näringslivet bör samarbeta med politiken i energi(tillgångs)frågan .
- Hur ska politiken, samhället och branschen gemensamt se till att en hållbar energiförsörjning blir verklighet, inte minst gällande bästa lokalisering kontra ett hållbart transportsystem.
- Branscherna måste hjälpa (och informera) kunderna (kanske mha politiken) att efterfråga så att det ekologiskt hållbara blir ekonomiskt lönsamt
- Branschen måste informera kunden om mervärdet av att varor kommer från "hållbarare leverantörskedjor" och kunna få dem att betala för detta
- Branschen bör med sina kunder, och politikens hjälp, arbeta för teknisk innovation på hållbarhetsstrategiska områden som automation, batteridrift, cirkulär återvinning 3D-printning
- Stötta en pro-sustainable-market-utveckling (inte pro-business företagsstöd) för att stödja en hållbar samhällstransformation
- Branschen bör börja lease ut dyrbara material
- Branschen (-erna) bör integrera värdekedjorna och sälja funktion snarare än produkt till slutkund/ användare
- Branschen bör utveckla trendspaning för att kunna hantera innovationsbehov i de allt snabba förändringar som sker
- Branschen bör förbereda sig för hur den ska hantera att den får konkurrens av fossilfria kolmaterial - vidareutveckla framför allt det som är unika egenskaper i den egna branschens material!
- Branschen och företagen bör samarbeta mer med politiken kring samhällsnyttiga lösningar/ innovationer, inkl de regelverk som kan underlätta/förhindra dem
- Svenskt gruv- och materialkunnande ska exporteras och användas mer utomlands - låt vårt kunnande sköta deras verksamhet (där/om vi är bäst - lease the know-how)
- Branschen bör verka för att kunna utvinna framtidsmetaller (hållbarhetslösningssmetaller) - REE:s och Litium etc - och samverka med alla aktörer för att få tillstånd för detta
- Branscherna och Sverige som land bör dels investera utomlands, dels exportera hållbarhetskapande (SDG-solutions)
- Branscherna måste vara med och skapa sin efterfrågan (och då på sådant som ger dem hållbarhets-"cred") och inte vara invänta vilken efterfrågan som helst
- Företagen måste skaffa nya affärsidéer - allt måste säljas, inte bara den primära metallen.
- Bolagen och samhället bör planera (redan nu) för att råvaror kommer att få alltmer strategisk betydelse - materialtillgången behöver bli en strategisk planfråga
- Staten och branscherna i hela mineralvärdekedjan ska tillsammans få till en klimatmärkning av bulkmetaller och cement, bl.a med hjälp av spårning från gruva till smältverk
- Branschen måste hitta affärsmodeller som fördelar risk längs hela värdekedjan (som Kina gör)

- Branchen och politiken behöver få till en social märkning av kritiska metaller - kobolt litium grafit - med spårbarhet i centrum, och där båda aktörer sedan driver på: t ex via smältverkskrav och via offentliga upphandlingar
- Svemin bör ta fram en ursprungsmärkning med tredjepartsgranskning
- Bredda verksamhet (via samarbeten) mot att bli teknikleverantör för att säkra lönsamhet när skalfördelar försvinner - och börja tänka/agera mer lokalt/regionalt redan nu
- Branschen bör utveckla premiumteknologier för utvinning av premiummaterial - vara bäst i märkningsammanhang och kunna ta betalt för det
- Branscherna bör tillsammans med politiken få fram långsiktiga regler kring materialanvändning i infrastruktur/byggnationssektorn med krav på återvinningsbarhet
- Branschen bör med politikens hjälp göra hållbarhet till ett tydligare affärsintresse.
- Industrin bör med andra aktörers hjälp börja rikta in sig på att leverera mer av tjänster och funktioner, mindre av prylar (delningsekonomi)
- Branschen bör hjälpa politiken med dess (hållbara) naturresursförsörjningsambitioner
- Samverkan mellan varukedjans aktörer och politiken för att skapa efterfrågan och drivkraft för hållbar utveckling genom policys, t ex fossilfri energi, beskattning,
- Branchen/varukedjan behöver bedöma vad som är det mest "lönsamma" i ett globalt perspektiv, speciellt som det lär finnas ett annat tänk hos människor 2050, som inte sätter dagens ekonomiska motiv främst. Normerna har ändrats m h t hållbarhetsaspekter.
- Samverka mellan företag och policymakers för att skapa efterfrågan på de hållbara materialen.
- Integrera affärerna så branschen kommer närmare slutkunder, och då behöver man tänka mer funktion och gemensam kunskapsutveckling (utveckla samsyn snarare än att sälja en standardiserad produkt)
- Satsa på spetsprodukter till marknader som är på väg att växa och/eller ställa om (large deployment potential)
- Hitta strategiska sätt att fundera kring nya produkter som är två generationer framåt teknikplattformsmässigt. Beslutsprocesser styrs av dagens teknikplattformar. Ex SUM-programmet (sustainable under ground mining)
- Branschen ska med andra intressenter (noga och försiktigt!) leta nya fyndigheter av Rare Earth Metals, gärna som biprodukter
- Branschen ska tillsammans med andra öka intresset för hållbar materialförsörjning i t ex offentlig upphandling, och då blir spårbarhet viktigt
- Företagen måste hela tiden hitta sätt att sälja sitt kunskapsförsprång - produktifiera det.
- Företagen måste lära sig hantera mer algoritmstyrda konsumenter (som köper det Googles/Amazons sökningar visar upp för dem)

Appendix 2: Full scenario descriptions¹⁷

Scenario 1: Mining for a globalized sustainable world

In this scenario the Swedish economy is helped by a supportive global economy, in which UN-treaties are both agreed upon and followed, for example concerning combating climate change. The Swedish public sector has invested heavily in a sustainable infrastructure which benefit both companies and citizens in their attempts to lower their ecological footprints. Recycled materials are benefited from political instruments. Industrial infrastructure has also been partly financed by government research funds. The steel industry uses hydrogen made from renewable electricity. Hydrogen production has thus become a way of balancing the electrical system when the well-developed wind and solar power produces for full sunny and windy days. Electric cars and electric roads dominate the densely populated regions.

Internationally, most countries have signed the UN's renewed global sustainability agreement, Agenda 2060, which extends over the years 2030-2060. With this, the ecological and social sustainability dimensions have increasingly become sales arguments that attract more and more customers around the world, which benefits Swedish industries, as Sweden is known for their high quality natural resources and technically advanced production methods. In addition, Swedish companies are known for delivering functional solutions promoting system thinking with associated service plans carefully tailored to customer needs and wishes.

Not only Sweden, by more and more countries get access to decentralized and jointly distributed fossil-free energy. Globally harmonized licensing and accounting rules are not also decided, but actually followed by almost all industry actors. These new global frameworks also include issues like human rights, social development and environmental externalities. UN also allocate innovation-critical metals to all member countries that cooperate in the UN spirit. In this increasingly democratic globalized market economy, the major global material-extracting companies compete to cooperate with those who own the local commodities.

More processing takes place regionally, and more manufacturing uses 3D printing, which leads to that there are local 3D-printing facilities in also rather small towns. Despite taxes on virgin raw materials, which accelerated a more circularly designed material and product supply, the total amount of transportation ton-kilometres increases as the world population rises, along with living standards in general. However, concerning many pollutants there is absolute decoupling, and not only relative decoupling as for transportation work. Bio-fuelled aircrafts and electric vehicles for all modes of transport, have made that possible. The sharing economy has also been an important part of making better use of what is already produced, not only concerning the vehicle stock, but also the stock of buildings.

Major advances in digitization and AI have helped the decoupling processes in most areas, especially concerning resource-efficiency and traceability. Customers want to know exactly what they are buying, which increases demands on sustainable products and forces all producers to fulfil at least hygiene-requirements concerning ecological and social sustainability issues. Taxation and other policy instruments have promoted this development.

With close to 10 billion people globally, and no remaining unused land areas, a lot of people in less developed or less resourceful areas still have to struggle to support themselves. Increasing income gaps between the more fortunate and the less so, leads to conflicts and also an ever-increasing migration pressure, which, however, a stronger and peace-creating UN is rather successful in handling. Altogether, the world development strives towards meeting the new Agenda 2060 sustainability goals, that the UN has also managed to agree upon.

In Sweden, and most of countries Swedish companies export products to, the customers expect the globally best knowledge content, but they are happy to share the product with others, to get the most resource-efficient and environmentally friendly solution. Thus, durability and warranties are good sales-arguments. Customers also want life-cycle-positive-products, that is not only non-emitting ones, but there the entire supply chain cause minimum social and ecological harm, and rather produces positive externalities along the way. Especially important are human rights, including indigenous people, and to

¹⁷ These scenario texts are reproduced verbatim from the workshops.

make provisions to make progress in the local development wherever that is. Certification showing the origin and life-cycle effects of the product is a hygiene factor, and producers which can prove that they are fully circular with closed loops and where the origin comes from mining below ground with the highest environmental standards can charge premium prices and sign long-term favourable contracts.

Digitization has meant that all major players in the metal and mineral business can offer traceability, which increases the competition for the highest sustainability standards. The best actors with the best practices and sustainability programs can not only sell at premium prices, but also sell their know-how. Material-innovation, and knowledge concerning materials, is at the forefront also of industrial innovation, especially concerning transformative technological solutions which can help society make sustainability progress. That development has helped to recruit students to materials-oriented universities, which in turn has helped the materials-oriented industries to find the right people. Also governmental agencies have understood that they need to hire and hire people which understand both the industrial logic and all sustainability dimension. On the other hand, industry also wants to hire people with such broad know-how. As women do better at universities, the gender balance within heavy industry is improving quickly.

The fast-moving technological frontiers and the UN-led global development have despite the rather successful overall outcome put new strains on society. A lot of people have trouble adopting to an increasingly faster moving more globalized world, and the many people feel a growing power-divide. To secure access to safe data, and artificial intelligence-application, is a struggle in these fast-moving technological times. Companies are concerned about security and espionage, and the political liberal establishment is worried about fake news.

Other problems also need handling. Better traceability of material and products, is contrasted with worse traceability concerning how decisions are made at the top in both the business world and the political arena, it seems to most people. There are also pockets of resistance of the current UN-led sustainability transformation agenda among the last remaining fossil-fuelled industries, or for other reasons have a hard time to transform. Thus, there is an urgent need for progressive sustainability-driven companies to communicate to the whole society what one does as a company, and why, and to involve the employees and the local community in the progress made, and the decisions taken. In places there the democratic and social divide has grown too wide, protectionism, fact resistance, right-wing-movements and even riots, seem to become more common. Progressive parties have started to realize that technological investments are not enough to ensure a sustainable development, and that social investments will also be needed.

Scenario 2: New solutions in the wake of re-regionalization

In this scenario, material efficiency and longer life of products have become important due to limited trading opportunities. Local and regional business can get a boost when some of the globalization competition is falling apart into more regional trading patterns. The export industry's markets are equally limited. A lot of import substitution - not least for food - are developing, also concerning parts of the mineral- and metal-supply chains which we can no longer import, but which we have (re)built the capacity to produce domestically.

Globalization has broken up in a regionalization. World trade has more or less ceased and is replaced with trade mainly within the regional power blocks that have replaced the world order. The decline of globalization has resulted in various degrees of economic stagnation. The new situation has also forced the necessary structural changes when previous imports need to be provided at home or in the immediate area. However, as some former export customers have come out of reach, a lot of resources have been released and at best found other uses. Price levels may differ widely between the different power blocks depending on what the regional supply looks like.

EU is no longer growing in member states, but has begun to shrink, but there still is a core EU with more northern-European focus, of which Sweden is participating. It has grown increasingly important for a country to be part of the right alliance. Trade routes are changing according to also-changing geopolitical conditions. It is especially important to secure raw material deliveries, market access and not to end up "off-side". Economic growth has slumped overall globally, but even worse is that it is also even greater spread between regions, countries, regions and groups, i.e. all are doing worse in general, but some are

doing much worse than others. This gloomy development has increased the conflict-proneness at all levels, especially in the areas where populism has gained ground. How to politically handle social issues is a priority in all liberal democracies, and also actually in less liberal and less democratic states.

Laws, rules and ownership have been reviewed to suit the new reality. A globally increasing population, combined with the absence of global climate policy and functioning world trade, has made it necessary to use the natural resources available. Fossil fuels have thus still been used in many ways. In practice, all Norway and Britain's recoverable oil has now pumped up, even though higher prices in our region encouraged more test drilling. Russia has a lot of oil and gas left but only cooperates "on its terms", which makes the imports negligible. The trade routes for the oil and, above all, gas that a few other countries still have is usually "closed" up to the region Sweden belongs to. The coal in Poland is one last option for those in our immediate area who have not yet fully managed to re-adjust their energy system. Countries' transformation efforts have been hampered by the current poorer economic situation where previous global technology spread and much of the cooperation has ceased.

Climate change and other environmental impact have been significant despite a stagnant global economic development. The world is heading for four degrees of warming. The effects of environmental problems, regional overexploitation and a hotter climate have been increasingly recognized in terms of reduced productivity in ecosystems. Many of the world's forest, agricultural and fishing areas work worse from human point of view than they did a few decades ago. For the economy, this implies increasing supply uncertainties, but also rising costs for healthcare and reconstruction

Global companies have started to try to set up sub-companies and sub-brands to keep their market-shares even if borders are closing. Each local division try to find the local unique touch to be able to sell in its new domestic area. Products are branded with local names - like Kiruna-iron and Lule-steel, at least in their home-regions.

The quality requirements for materials built into durable products are increasing as what one has previously been able to buy cheaply, and throw away then some part did not work properly, is perhaps not as easily available anymore. Shortages do occur and repairing, and recycling, have become increasingly important with regard to things that can no longer be easily imported. However, import restrictions also drive innovation, especially concerning industrial symbioses, especially how to make use of resources which have previously been classified as waste.

What is important geopolitically get politically prioritized. Demographic issues are also more in focus, as the age groups which are supposed to work and support the rest of society is shrinking in Sweden and especially in rural areas, while in other parts of the world it is the rapid population growth which seems threatening as it might drive resource and land conflicts.

Even in Sweden, there are increasing conflicts about land, and land-use, as natural resource issues are considered increasingly important. The global environmental and resource concerns get less attention, while the local ones are still a priority. However, if the resource issue is important enough nationally or even geopolitically, it often overrides the environmental concerns, or for that matter social concerns, even if that is less of a problem in Sweden than in other less developed countries.

The resource focus in society also drives some re-ruralisation to areas where people sometimes have an easier time supporting themselves, than in the urban areas which have been losing out in the more stressful economic development. Thus, the dynamics between urban and rural, and what is the centre and the periphery, have partly been overturned when new power centres have arisen due to changed trade flows and relative prices. Domestic or even local energy supply is becoming increasingly important, and Sweden has good conditions that we can utilize and export in the immediate area. Different parts of the world have to solve their energy-supply situation in the way that works for them regionally.

How to mine the minerals and metals which society needs for its (sustainable) development in a "safe and attractive" way for all actors concerned, is a sensitive issue and a political priority to solve. SGU has become one of Sweden's most important governmental agencies. Another national priority is the Department of Industry securing that the strategic Swedish resources - raw materials, energy, industrial

expertise and holistic solutions – are used wisely to promote our trading opportunities. The government also struggle with how to be able to distribute the benefits of the high commodity price stemming from regional “resource monopolies”, which trickle down unevenly throughout the country. As the state own some of these mineral and metal companies, it can use the dividends, but there is also the question of how to tax what can be considered excess profits for some private owned companies at times. To prevent to much state interference large companies have voluntarily starting to take more responsibility for the local development, which is also much needed as the state has gotten increasingly weakened financial muscles due to the sluggish global economic development, which has hurt a formerly open economy as the Swedish quite hard.

However, there are also positive economic signs like re-industrialization in the wake of a slow-down, or even partly a shut-down, of globalisation. People can’t live without their technological devices, and most of them has a mineral “heart”. Minerals being the heart of our material needs, which we cannot live without, is the metal- and minerals industry’s communication mantra.

Scenario 3: A business-driven revival of the 2030 Agenda

In this scenario, technological advances have been used to increase energy efficiency and secure production optimization using for example sensors and robotic identification. Economically and partly also socially the world did well throughout the 2020-ies, even if the profits were not shared especially equally. However, the compounded economic growth, demanding increasing volumes of natural resources has led to escalating environmental and climate problems, which together with the increased inequality, started to curb also the economic progress in the mid 2030-ies. A high demand for “the cheapest” concerning natural resources also led to increasing shortages and that resources have recently becoming more and more expensive. Thus, the supply of inputs to production was hampered due to environmental degradation and resource depletion, and demand slacked as the purchasing power was too unevenly divided. Therefore, citizens, politicians but also the business-leaders are now prioritizing not only technological advances in general, but radical transformative technological advances directed specifically towards resource-efficiency, renewable energy, low-or-no-emission technology in order to, in the very last minute, kick-start the development towards a fully sustainable society, prioritizing the ecological but also the social dimensions. This urgent need of much more, and harder, environmental considerations has led to that politicians, with the support from the business community, have laid many restrictions on all economic actors to force them to act sustainably.

Some countries, including Sweden, have throughout the first half of the 21st century continued to politically put environmental and climate policies in place, which made them better prepared to act on the urgency of the degraded ecosystem health and to accommodate to temperatures which seem to be on a path of beyond four degrees of warming. Other countries have more recently starting to put policies in place in order to abide to what they agreed upon on UN summits, but the global organization never had the power to force the less-willing to act upon. In some countries where it was already difficult to support themselves, migrations are now taking place, and the domino effects are seen in all continents, leading to that most countries have prioritized up border-control. Globalization, which previously has driven development, can thus be threatened, but world trade is still going on, as the international business community is stronger than the national administrations in the developed countries. Swedish companies still have international foothold and focus, and in particular logistics in order to do business across the world

Demand for both input goods and high-tech products are still high and increasing, but less so now in the 2040-ies than in the earlier decades, and the striving for absolute decoupling might lead to shrinking volumes in the future. Income gaps between countries are also increasing based on their different progress in riding on the technological industrial development, but also within countries there are widening gaps between thriving cities and struggling country-sides, and between groups depending on how they have fared on the labor-market.

Out of almost ten billion people, almost eight live in cities, which means that the number of urban residents has doubled in 30 years. Those who have benefited from the economic achievements have met their materialistic needs, which means that more and more consumers, and most of all the increasing purchasing power, are now directed towards more non-material consumption, such as experiences and travel.

The very big resource demand has led to environmental problems, increased resource price levels due to relative scarcity, despite major efforts to through innovation promote resource-substitution, resource-efficiency and -circularity. These attempts have to be increased even much further, due to an awareness in the public opinion, and due to increasingly radical political reforms, and those businesses that want to keep their “licence to operate”, which now includes not only economic considerations but to an increasing degree also social sustainability issues, have to be on their toes. However, the mining companies also make more and more own more far-reaching commitments regarding human rights, indigenous peoples, local development and local democracy, to build good-will. On the positive side, the mining industry and its value chains for technological solutions are also increasingly recognized as sustainability facilitators.

The labor market is centralized to the urban areas, and it is becoming increasingly difficult to get a job, make a living, and get an economically functioning local community outside (all) major cities. However, a few rural hubs based on the extraction of natural resource, basically mines and bio-resource processing industries, are also thriving, in contrast to the rest of the countryside. Accessing the necessary new skills, and wanting them to settle down and stay in these resource-hub-rural-towns, is an ongoing struggle. The fact that Sweden is becoming a smaller and more distant actor in the fast-growing global economy turning more to Asia than the old OECD-countries is making recruiting even harder.

Furthermore, new disruptive business models such as material-leasing and functionality-selling put pressure on traditional commodity-selling companies, i.e. product-packaging and putting them on the market have become more difficult. However, there seem to be open business niches for companies with business models that support social justice and social development, and also ecologically sustainability-smart metals. There is also a global interest from the developing world about general sustainability knowledge, work-related health and security and risk management, especially in the possible next generation of resource extraction from the interior of the earth, below the seabed or even in space.

Knowledge in material-relevant areas is highly valued, and if it can be sold as a service, it is usually the most profitable business unit of a company. Areas like using non-toxic low foot-prints minerals for solar energy, in the energy-storage-capacity-solutions, for artificial photosynthesis, or to detoxify waste are high on the agenda as improving ecosystem health is a political priority as it has become apparent that it is essential to come to grips with securing the renewable natural resource supply and the food supply and resolving the ever-more frequent fresh water shortages. The costs of not handling these questions are enormous and related to human health, health, refugee flows, geopolitical conflict internationally, and rioting and populism domestically. Now all - individuals, businesses, public sector, capital owners - know that climate change, environmental impact and resource depletion cost. Sweden, having a reputation as a sustainability-leading country, can use its traditional comparative advantages, and its “green” trademark, to market its products, build alliances and position itself on the new global arena, where social issues, ecological concerns are upgraded in all kinds of deal-making.

The Nordic countries have also realized that the more unstable the world gets, the more interest there is from international companies of doing business with stable regions, which has made it a joint political and business priority to invest in both social and ecological sustainability projects. To secure the supply of public goods, customary and statutory rights, the idea of a welfare state which can help to handle the fast-changing job-skills-challenges in the wake of automation and robotization, are examples of such social focal areas, in which businesses have found it in their own interest to cooperate with the political sphere.

Overall, the last decade both public and private investment plans have been sustainability-redesigned, which hopefully at the last minute could succeed in transforming the former autobahn economy onto a (more) sustainable path. Automation and all other technology development will, as far as possible, not only increase production at lower cost but, primarily from now on serve as a sustainability tool. Swedish construction and process engineers have as a consequence more and more specialized on designing system solutions where a circular-oriented metal- and mineral-industry will be able to deliver products which can be sold with a sustainability glow.

Scenario 4: The “glocal” mine

The world has evolved towards an open network of regions where the hubs are urban centers, which are more virtual than physically linked. In the best-performing regions, it has been possible to create sustainable cities living in symbiosis with the surrounding rural areas. Local and regional values have meant that some of the possibilities of globalization have been rejected in favor of a development with a more local / regional distinctive character. Ideas and technology know-how spread rapidly across the world, but due to relatively high shipping costs significantly less tons and cubic meters cross borders.

With changing more regionalized trade patterns and a more service-oriented economy, the Swedish economic growth path and the current account surplus are slowly heading downwards. The increased elements of the sharing economy reinforce these tendencies and also erode traditional tax bases. Most people use the societal productivity gains not to increase income and consumption, but to work less and spend more time on leisure. Democracy has become small-scale and more decision-making is based more upon negotiating until there is a consensus. The economy has also received more small-scale elements with much local cooperation around industrial symbiosis - to use each other's residual products as inputs, in order to tackle society's requirement of increased material-circulation, but also the business challenges of more fragmented markets and lower possibilities to benefit from economies of scale.

The increased interest for sharing and performing economy means an upgrading of all kinds of durable and capital goods in order to increase both the utilization rate and the longevity. Local features add value but can be spiced up with a global touch if it is considered sustainable. Circular economy-based life-cycle products are supported by the citizens' values and thus a hygiene factor. Demand for Swedish produced goods is increasing here at home because it is local, and globally because it is “clean”. Circulated metals have become a brand, but in order to maintain it, increased environmental considerations have been required throughout the supply chain, especially upstream.

Prosperity and welfare have also diverged, partly because all areas or individuals have not fared equally well, but partly due to increasing differences in preferences, which make different cities and region diverge in architecture, policy-set-up and in several other dimensions. However, a common trait is that welfare is not structured as much about private property and material things as the beginning of the 2000s. The collaborative - collaborating and sharing premises and gadgets - characterizes life, which is most often lived in the highly efficient multi-family house and in the well-planned available-to-all green city-quarters. In the rural areas, the collaborative economy is a natural way of building community and achieving the same accessibility to the material good of life that urban residents have access to. The increased sharing and the prolonged longevity enable well-being to be decoupled from production volumes, as more people can benefit not only from this years products, but also from products produced long ago as they have been manufactured to hold and be easy to maintain.

Business models have been adapted to the new era, and increasingly the manufacturing companies retain the ownership of what they produced. Instead, consumers get paid for the services and solutions they actually want to use. Therefore, it is a matter of manufacturing with quality and to give priority to maintenance and repair. These kinds of business models have resulted in both overall societal sustainability improvements increased social and customer benefits.

The environmentally-conscious collaborative values have also led to the fact that it has been easy to gain profound investment in resource-efficient technology solutions, not least in well-developed environmentally friendly public transport. Many actors are also involved in producing their own renewable electricity. Altogether this has led to decreased environmental impact and resource-use, making it probable to keep global warming below a two degree increase.

Production takes place in all scales, from large plants where actual economies of scale make sense down to micro-installations that can be done at household level in rural areas and at quarterly levels in the city. Small-scale production of advanced products has gotten a break-through with additive manufacturing (3D printers).

The vast flow of information between regions is a much more important part of trade than physical flows. Functional solutions developed in Sweden are used on the other side of the earth. Swedish companies

are then well paid for system drawings, as well as software and code adapted for different regions, as well as some project management via link, but it is local workforce that, with local natural resources, gives the functional solution physical form using, for example, 3D printers. Overall, selling ready-made physical goods to individuals and households has become a shrinking business, while sharing, borrowing, renting and reuse has become more common. GDP is no longer used as often as a measure of prosperity, but different measurements of perceived well-being have instead come into focus. Many customers are willing to pay for goods and services with low or no negative social and environmental footprints, and even more if the seller can prove there are social and environmental benefits connected with the life-cycle of the product.

Locally, the metal- and mineral industry companies are often the driving force in the community, cooperating with other local actors, to ensure the licence to operate. Thus, the industry is not only an important transformative actor in the society's sustainability transition, but also in the local community and in keeping rural regions alive. This new broadened scope has also led to new professions, and academic specialisations, and people now graduate and work as sustainability inventors, eco-designers, ecosystem service compensation suppliers, industrial tourist guides etc. In line with this development Sweden has signed the follow up of ILO169 – its 2.0-version – bringing in all the local interest groups into the boardroom. The NIMBY (Not In My BackYard)-tendencies in society has been somewhat easier to handle for the business-community due to the fact that all interest groups are consulted in the decision-processes, which has also been a way to secure that the business logic goes more hand in hand with society's sustainability logic.

In spite of a social climate with a focus on collaboration, both within and between regional centers, there are some tensions that arise due to increasing gaps between regions as they develop on the basis of their particularities. Even in the same region, there may sometimes be some tensions because everyone is not able to thrive in collaborative settings, and the redistribution systems can look very different not only between regions but also between cities in the same region. The fact that the materialistic values have been downgraded often means that social ability determines how much an individual can benefit from the resources shared in different communities. Persons without so much social ability or interest in education risk to end up in exclusion.

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