re-sourcing

RE-SOURCING
Briefing document No. 12
june 2022
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Identifying Challenges & Required Actions for Responsible Sourcing in the e-Mobility Sector

Abstract:

Within the road transportation sector, the lithium-ion battery vehicles are playing an important role in the global effort to achieve the targets set under the Paris Agreement. This briefing document summarises the State-of-play and roadmap concept of the mobility sector, including the identification of the main actors in and outside the EU and the challenges within the battery value chain for the mining, production and recycling stages. The findings indicate that the mining of the relevant materials is associated with negative social impacts like human rights violations, conflicts with local communities as well as environmental issues such as water & energy consumption, including the occurrence of toxic materials. Recycling is crucial for lithium-ion batteries at the end of their life cycle, among other things because the risk of thermal runaway is high.

The **RE-SOURCING Project** aims to build a global stakeholder platform for responsible sourcing. The project addresses the challenges facing businesses, NGOs, and policymakers in a rapidly evolving ecological, social, business and regulatory world; through a collective, consultative, and industry & civil society driven approach. RE-SOURCING is funded by the European Commission's Horizon 2020 programme and runs from 1 November 2019 to 31 October 2023.

1. Introduction

Meeting the Paris Agreement's goals requires the transformation of the mobility sector, with 90% reduction in transport-related emissions by 2050 necessary to achieve climate neutrality. 2019, the mobility sector was responsible for the highest share of EU greenhouse gas (GHG) emissions with 31% of total EU GHG[1]. In this sector, road transportation is of high relevance with more than 70% of GHG emissions resulting from the sector. Battery electric vehicle technology today offers a promising opportunity to achieve the necessary changes to GHG emissions and transform the sector. The core component of the electric vehicles is the lithium-ion battery (LIB) containing strategic materials lithium, cobalt, nickel, and graphite.

This briefing document summarises the findings from the State of Play And Roadmap Concept: Mobility Sector report (RE-SOURCING, 2021) as well as main aspects developed during the Roadmap Workshop (October,2021). This document summarises the challenges, gaps and a vision for the mobility sector being developed under the RE-SOURCING project, addressing three nodes of the lithium-ion battery value chain: mining, cell manufacturing and recycling.

2. A vision for Responsible Sourcing in the Mobility Sector in 2050

The State of Play Report of the Mobility Sector (RE-SOURCING project) identified the current achievements and what needs to be done in the future, to achieve a level playing field in implementing responsible practices in the sector. A future vision of the mobility sector was developed within the project to be achieved in 2050[2]. The Vision is based on the concepts of planetary boundaries and strong sustainability, providing essential guidelines regarding the preservation of natural capital. The major relevant actions are as follows:

- The time to act is now, the issues are urgent
- Communication between all stakeholder groups and along the whole value chain is necessary (communities, production, recycling, etc.).
- Transparency through the whole value chain is key
- Reduction of energy consumption and using renewable energy is essential
- A fair value chain needs to be developed
- We need to think about the end of a material or product from the beginning (circular economy, desing for recycling)
- Transport must be rethought and reduced

The remainder of this document outlines the challenges and gaps that need to be addressed in short, medium and long term to meet this Vision.

1 European Commission (2021): EU transport in figures- Statistical pocketbook 2020; Part 3: Energy and environment
2 The vision is described in the State of Play report

3. Mining

The relevant materials for a lithium-ion battery (LIB) are lithium, cobalt, nickel and graphite. Lithium extraction is undertaken as large-scale mining (LSM) from hard rock and brines. Today, there is no significant lithium production in the EU. Cobalt mining mainly takes place in the DRC. Cobalt is mainly extracted as a by-product of LSM of copper and nickel production. A significant portion of around 25% of the DRC cobalt production is extracted by ASM (Artisanal and small scale mining)[3].

Today, batteries account for more than 50% of cobalt demand. Other applications include nickel-based alloys, tool materials, pigments, catalysts and magnets[4]. Nickel production is distributed worldwide (Indonesia, Philippines, Russia, New Caledonia, Canada, etc) and extracted in LSM from sulphide and lateritic deposits. However, batteries are responsible for most of the growth in demand, and the share of demand is expected to increase strongly. Graphite for LIB anode material can be produced from natural graphite in open pit or underground mines as well as synthetically using a carbon-based feedstock. Natural graphite is mainly mined in China, the synthetic graphite market is also dominated by China with around 50% of the global synthetic graphite production[5].

3.1 Challenges

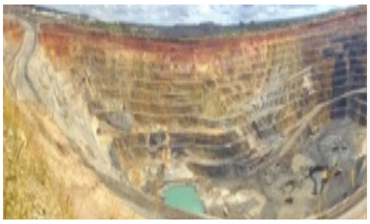
Lithium: Hard rock mining is mainly related to heavy metal pollution, acid mine drainage (AMD) potential and energy intensive production (see Box 1). The extraction from brines is associated with water consumption in arid regions and dust emissions leading to local conflicts. Lack of good governance in these regions is also noted as an issue. With new applications and the increase in lithium demand the pressure for further exploration and mining is high.

Figure 1: Challenges in Large Scale Mining

3 Mancini et al. (2020), https://op.europa.eu/de/publication-detail/-/publication/1c2bfa6d-ba77-11ea-811c-01aa75ed71a1/language-en

4 https://www.greencarcongress.com/2021/05/20210522-cobaltinstitute.html

5 DERA Rohstoffinformationen: Rohstoffrisikobewertung- Graphit November 2021, https://www.deutsche-rohstoffagentur.de/DE/Gemeinsames/Produkte/Downloads/DERA_Rohstoffinformationen/rohstoffinformationen-51.pdf?__blob=publicationFile&v=2



Cobalt: Cobalt production by ASM is mostly informal, which carries the risk of insufficient occupational safety, health problems for workers, and is often associated with child labour. Nonetheless, the sector is an important source of income and livelihood for the local community.

Nickel: Challenges in nickel mining are related to typical problems for LSM, especially AMD, high energy consumption, deep-sea disposal and biodiversity loss.

Graphite: The main challenges for natural graphite mining are dust generation and purification with acids. Main challenge in the synthetic graphite production is the high energy consumption during the production and the dependence on by-products of coal production or crude oil refinement.

For a detailed discussion on challenges, please see the State of Play report on the Mobility Sector.

3.2 Gaps

There are many standards, certification schemes and initiatives developed aiming to encourage responsible mining practices[6]. These schemes address a number of issues, but none address all relevant issues, under one approach. This results in many of the responsible sourcing (RS) challenges identified not being adequately addressed within the current responsible sourcing schemes or approaches. To achieve RS in the mobility sector, these gaps need to be addressed, not only within a particular node of the supply chain, but through collaboration across the entire value chain. Some of the more urgent issues that need to be addressed include:

Missing Level Playing Field

A level playing field is important to establish a sustainable global market, producers who do not act sustainably need to be brought in alignment with those who do. A level playing field requires globally binding, unified framework conditions for all operators. For example, a level playing field in recycling can be achieved by setting obligatory rates of recycled content in new products, as proposed for the revised EU regulation on batteries.

Many of today's issues in the value chain arise from asymmetries in regulation in different countries. High environmental and social standards can lead to an increase in production costs. For example, while one country might allow offshore disposal of tailings (e.g., discharge into rivers or submarine disposal), which brings a cost advantage, other countries prohibit this practice leading to higher costs for mining waste management or even to certain deposits being not extracted at all. The long-term aim should be to have globally negotiated and agreed standards, that are applied by all countries.

> Global effort and cooperation with mandatory standards are needed to achieve a level playing field.

Weak Global Due Diligence

A globally agreed due diligence approach across all sectors (mobility, renewable energy, electronics, energy, agriculture, jewellery, etc.) and value chain steps can

6 These are described in the State of play report and also listed in the existing approach side of re-sourcing website.

address the key challenges across all pillars of sustainability as one solution path. With a global approach, for example following the OECD Due Diligence Guidance, the negative impacts along the entire value chain can be identified and addressed at an early stage. Mandatory due diligence has already been introduced in the EU regulation on conflict minerals directly referring to the OECD guidelines. Moreover, the newly proposed EU Battery Regulation has also introduced the concept of a uniform due diligence requirement for certain raw materials in industrial and electric vehicle batteries.

> A mandatory global due diligence could identify and prevent major negative impacts in all sustainability pillars across all stages of a product value chain.

Lack of Harmonization of Sustainability Requirements

IRMA
Initiative for Responsible Mining Assurance

An urgently needed step is the creation of a common framework for and harmonization of the sustainability requirements in the different standards and initiatives – especially in the mining sector. There are already some examples of harmonized international frameworks such as the ILO Conventions and recommendations that are widely accepted across countries and industries exist. The standards and initiatives related to battery cell manufacturing (e.g. the Battery Pass by the Global Battery Alliance or the proposal for an EU Battery Regulation of the European Commission) are comparatively few, localized and still under development. It remains to be seen how these approaches will develop and be harmonized in the face of rapid growth in cell production.

In the harmonization of sustainability requirements, the acceptance of a standard by all stakeholders within the value chains is also a relevant issue. The IRMA standard, involving all different stakeholder groups from industry to CSO with equal voting rights, demonstrated a way how to bring the actors together and find a common understanding of sustainability requirements.

3.3 Steps to Achieve Vision

There are many important aspects that need to be addressed for the extractive sector before responsible sourcing can be achieved across all players. Some of the most important issues are:

Short term:

- Sustainable supply chains including circular business models need to be developed and globally discussed. This includes concrete measures like legislation on design for circularity[7], designated end use for each mineral and information on how to subsidize more sustainable options (e.g., recycling) until they become economical.
- All large-scale mining companies should start the process of getting certified by strong standards, such as IRMA.
- To achieve a global level playing field, initiate a global accepted framework on "good enough" practices and also best practices, to provide information and examples of industry practice.
- The global policy discussion and negotiations on standards and frameworks needs to progress further. Independent auditors and reviewers from regions all over the world could ensure the broad acceptance through all stakeholder groups. An inter-

7 See RE-SOURCING Project Briefing Document N.10 on Designing for Responsible Sourcing- An Engineering Perspactive (March 2022)

national task force for the surveillance and standardization of reviewers could support the transparent and responsible review.

Medium term:

- Conflicts and negative impacts of extraction need to be resolved. The "resource curse" should be reversed to prevent resulting social problems. For this, the participation of the communities in the mining areas is essential. Good practice examples can help to support actions. Planning for closure and post-closure period is essential, to be initiated from the start of a project, enabling a fair social transition to closure.

- Responsible sourcing practices should be implemented in the ASM sector by this time.

- Transparent supply chains must be universally implemented by the medium term. This transparency should be supported by information and data need to be collected on practices, performances, etc. and validated.

- All environmental harm caused by mining must be mitigated and counterbalanced by active measures by all global actors.

Long term:

- Climate neutrality in the mining sector should have been achieved.

4. Manufacturing

Cell production is dominated by Asian countries, especially South Korea (LG, Samsung SDI), China (CATL) and Japan (Panasonic). In Europe, high investments in cell and battery production plants are being undertaken and the landscape of battery cell plants is changing quickly.

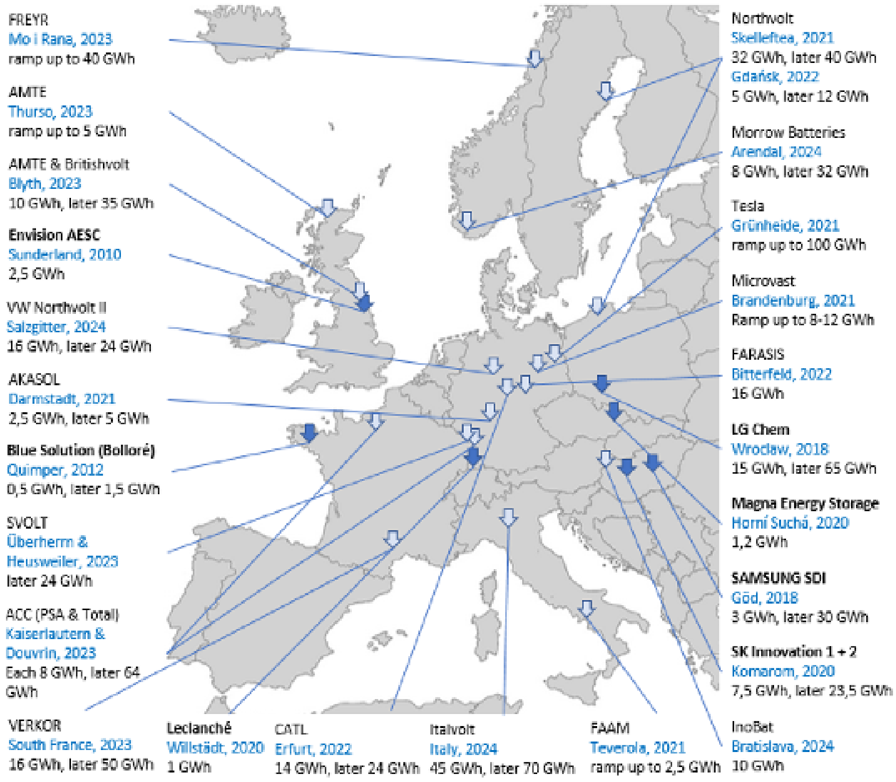


Figure 2: Overview of battery cell plants announced in Europe (own compilation according to T&E 2021; Zenn 2021)

4.1 Challenges

Environmental Challenges: A specific environmental challenge lies in the high energy consumption of cell production. Depending on the source of energy production, GHG emissions are significant[8]. The battery production process is highly material intensive, resulting in large waste streams, as a result of a high scrap rate given that the production itself is highly susceptible to errors. Especially at the start of operations, scrap rates can be in the higher double digits. The production is dependent on material flows from all over the world. Cell manufacturers must monitor their extensive supply chain for the origin of their mineral resources and the social and environmental conditions under which they were extracted. This requires stringent due diligence exercises.

Health and Safety Challenges: Lithium-ion batteries pose a danger for themselves. Defective or damaged cells during production could pose a safety risk, especially due to the possibility of a thermal runaway. Lithium-ion batteries contain many toxic substances that must be managed to reduce impacts on health of workers and the broader community. Even if the material itself is inert, such as graphite, inhaling the powder of the material can be dangerous for workers who come into contact with it[9].

> Cell production can influence the entire upstream chain by creating a demand for sustainable materials and thus increasing their procuring.

4.2 Gaps

Currently, there are no standards or initiatives adequately address responsible cell production. However, the proposal for the new EU Battery Regulation include some of these issues, including energy consumption during the production process.

Weak Responsible Procurement Requirements

The link between the individual stages of the supply chain is created by procurement practices of the companies. Global or national initiatives addressing procurement often focus only on public procurement (e.g. Sustainable Procurement Guidelines of the Australian government). Some international companies have internal regulations on how procurement is managed in a sustainable and responsible manner (e.g. Umicore).

There are other non-sector specific standards, such as those provided by ISO20400:2017 or UNEP Sustainable Procurement Guidelines, but guidance specifically addressing lithium-ion batteries needs to be developed. Procurement guidelines can have an impact on sustainability programmes at the mobility sector level, as they set requirements that operators must place on their suppliers. This means that procurement guidelines could also benefit from harmonization with sector-specific standards. Otherwise, they add to the multitude of already existing standards and partially overlapping guidelines.

4.3 Steps to Achieve Vision

To overcome existing challenges, the following issues are the most important to be addressed:

8 Larcher, D; Tarascon, J.M. (2015): Towards greener and more sustainable batteries for electrical energy storage. *Nature chemistry.* 7(1), pp.19-29

9 The State of Play report on the Mobility sector describes in detail the challenges as well as the landscape of actors.

Short term:

- A standard must be set for the mapping of the supply chain. Recognized and trained auditors, fully knowledgeable of minerals supply chains, have to be available for reviewing certain companies. These auditors need to be trained in all regions.
- Benefit sharing across all actors in the supply chain must be ensured ("value equity"), especially aiming at local procurement. This includes that more value chain steps should taking place in developing and emerging countries.
- Keeping recycling as an important consideration, closed loop cell production needs to take place. This includes the recycling of all waste streams from the production step.
- A reduction of electricity and material demand per cell unit should be achieved.

Medium term:

- For full transparency from extraction to recycling, technologies and first successfully implemented practice examples have to be developed and published. An extensive labelling of cells is one step in this approach.
- Over 80% of energy used in manufacturing process has to come from renewable sources by then.
- Circular product supply chains must become the standard. The development of a comprehensive communication strategy between actors in the whole value chain from the beginning is required.
- Shift to less individual and more public transport, which leads to less vehicles needed and less resource consumption.

Long term:

- Only renewable energy sources should be used for the manufacturing process.
- Investment in public transport to reduce further the number of cars driving on EU roads.
- Fair distribution of costs and benefits along the value chain has to be achieved by then.

5. Recycling

The RE-SOURCING project focuses on the recycling of lithium-ion batteries for electric vehicles. This includes the collection, transport and treatment of end-of-life (EoL) batteries.

5.1 Challenges

Health and Safety: Among the greatest challenges during storage, transport and recycling of EoL LIBs is the avoidance of a thermal runaway (TR), in which the battery heats up. Given the internal reactions this heat can increase massively, leading to fires or explosions. Another hazard lies in the hazardous substances contained in an LIB, such as the electrolyte and other toxic metals, that must be properly handled and recovered.

Lack of information: The lack of information about the battery cells' conditions, such as the cell chemistry and performance parameters, make it difficult to give used LIBs a second life and prevent fire hazards. Also, information about quality of recovered materials is important to enhance cooperation between all the actors of the value-chain and recirculate materials (e.g. link between recyclers and manufacturers).

Design: Common designs for LIBs do not always provide the possibility to disassemble cells or modules from battery packs, which would facilitate recycling. In fact, the trend appears to be moving in the opposite direction. A modular structure is no longer used, and the cells are directly connected with glue to form a pack to save weight, volume and material. However, this makes disassembly or repair almost impossible[10]. In addition, production waste, like punching waste or defective elements is not always kept separate. This would be needed to reduce waste and ensure a more efficient or direct recycling.

Environment: Recycling processes of LIBs can lead to direct or indirect GHG emissions or other emissions. The direct emissions come from the combustion of organic parts (including fluorine-containing organic compounds) of the battery cell during heat treatment. Indirect emissions come from the energy used to heat and recover the materials, depending on the energy source used. Hazardous substances are another challenge if they are not properly handled and contained.

Economy: Although most LIBs used in electric vehicles contain valuable materials like copper, cobalt, or nickel, it is difficult to profit from the recycling process. The most important factor is the cost intensive logistics, which are related to safety risks as described earlier. However, at the same time, the battery chemistry changes constantly. Changing to cathodes with less cobalt and sometimes even to cathode materials which hold no material value, like LFP (lithium iron phosphate), impacts the profitability of the recycling market. To achieve a circular economy, the less valuable materials need to be recovered as well.

Recycling Capacities: Recycling capacities for EoL LIB need to be increased, as it is already becoming apparent that the recycling capacities will no longer be sufficient to meet market demands[11].

> Proper recycling of LIB at their end-of-life is crucial as there is no alternative for safe battery disposal.

5.2 Gaps

Currently, there are no specific standards or initiatives aiming for responsible battery recycling (see also the State of play report Mobility Sector). But the proposal for the new EU Battery Regulation has included the recycling topic in general with collection, recycling und recycled content targets.

Missing Recycling Specific Standards and Design for Recycling

The broad aim of circular economy is to reduce the negative impacts of primary raw material sourcing and the dependency of raw material imports. As recycling of lithium-ion batteries from the mobility sector is a comparatively young technology, improvements of recycling processes are expected. The recycling technologies must be significantly scaled up. This includes, on the one hand, a more efficient recycling process itself, which requires further technological development and research. On the other hand, the entire process of

10 The challenges of the mobility sector are further described in the State of Play report.
11 See above

collecting end-of-life batteries, as well as transport and storage, must also be considered.

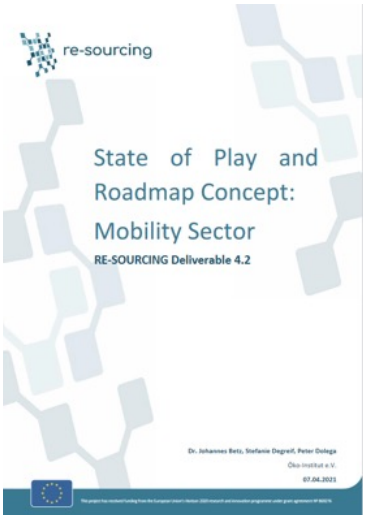
Furthermore, standards and regulations for recycling need to be developed and considered as there are no international standards for recycling Li-ion batteries. The EU, however, has several regulations in place that mention recyclers. The Battery Directive, which is essential for battery recycling, is currently under review, with a new proposal for a regulation containing detailed and ambitious targets of revisions recently submitted by the European Commission[12]. Additionally, the EU's ELV Directive is also relevant for waste management of LIBs from passenger cars and currently under revision.

Recycling can be supported by setting guidelines and standards already for the design phase of a product (design for recycling). Furthermore, possibilities to standardise batteries should be investigated, along with digitisation concepts to provide information about the battery cell chemistry and its construction. An overarching approach for a recycling LIB scheme is essential for several reasons:

- the high risk of fire and explosion of used or damaged LIBs
- the valuable resources contained in batteries
- sustainabilituy benefits of secondary materials
- the fact that cars are often exported to other countries and continents, allowing these materials to leave the strongly regulated EU market.

5.3 Steps to Achieve Vision

For sustainability across the lifecycle of lithium-ion batteries the following aspects in the recycling step are of great importance: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State of Play and Roadmap Concept: Mobility Sector

RE-SOURCING Deliverable 4.2

Short term:

- A broad understanding and acceptance of the necessity of LIB recycling is necessary to meet the projected resource demand and cope with the emerging waste stream of batteries. The export of used batteries from the EU must be prevented at all costs if recycling cannot be ensured in the importing country, as EoL batteries can be a huge environmental hazard.
- Globally accepted standards for responsible lithium-ion battery recycling should be in place.
- Recycled material must have a competitive price on the global market. This can be achieved by mandatory recycling content quotas, which can in turn create a market for secondary resources, independent of highly fluctuating primary material prices.
- Actors along the whole value chain must discuss products from the beginning to the end in regard to sustainability. This includes for example design for disassembly, design for recycling, material efficiency and the general principle of waste as a resource, as well as more information about battery's status and cell chemistry.

Medium term:

- Global recycling infrastructure has to be put in place and further adapted and expanded. This includes a more efficient recycling process itself, which requires further technological development and research. Additionally, the entire process of collecting

12 Proposal for the new EU Battery Regulation

EoL batteries, as well as transport and storage, must also be considered.

- Continuous reduction of emissions in the recycling process must be ensured.

Long term:

- There should be enough secondary material available, leading to independency from primary sourced material.

With the input from the state-of-play consultations and the first brainstorming roadmap workshop in 2021 and the discussion on good practice examples – so called flagship cases – in the mobility sector in February / March 2022, the next steps of the roadmap development in the RE-SOURCING project are:

- Producing a good guidance document on mobility by June 2022
- Incorporating the above-mentioned findings in the roadmap development until June 2022

In summer 2022, the RE-SOURCING roadmap on mobility will be finalized and published.

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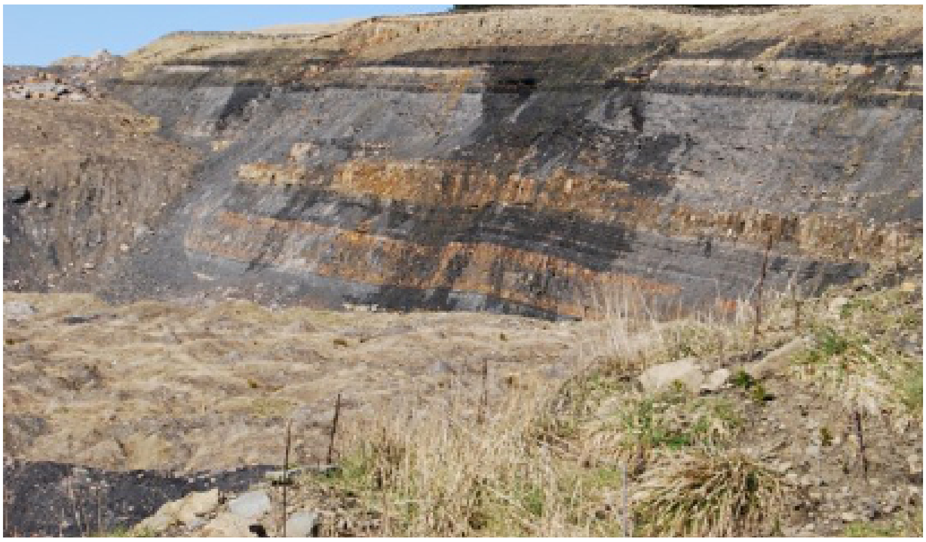

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Vision of the Mobility Sector

Environmental | **Social** | **Economic**

International Cooperation

Harmonised reporting systems; clear global criteria for responsible and sustainable practice

Targets across all value chain steps

Environmental
- **Limiting Climate change to 1.5°C**
- Carbon-neutral production and transport
- Net-positive environmental impact
- Net-positive contribution to biodiversity
- Zero pollution of land and sea
- Zero harmful emissions
- Use of renewable energy sources
- Resource efficiency (decreasing need for primary raw materials, no use of ground-water, energy efficiency, etc.)

Social
- Zero human rights violations
- Gender equality in all stages of the supply chain
- Elimination of poverty & hunger
- Secure access to food, clean air & water, sanitation, health care
- Meaningful stakeholder engagement
- Support of local development
- Fair compensation for land-use
- Respect for land rights
- Occupational health & safety
- Community health & safety
- Local recruitment
- Knowledge sharing & training

Economic
- Sustainable and responsible investments
- Fair wages
- Transparency
- Zero financial crime
- Fair compensation for land–use, minerals, etc.
- "Unsustainability is unprofitable"
- Companies accept their responsibility
- Absolute decoupling of economic growth from resource consumption & environmental impact
- Level playing field

Mining & Mineral Processing

Environmental
- Zero hazardous tailings discharge
- Re-use of tailings & waste rock
- Better-than-before reclamation
- Efficient processing, incl. energy & water efficiency, improved recovery
- Efficient use of deposit
- Remediation of abandoned mines

Social
- Formalisation of ASM sector & full integration in the supply chain
- Cooperation between LSM and ASM
- Conflict free mineral supply chains
- Sharing of infrastructure (especially in remote areas)
- Ensuring water availability & quality for neighbouring communities
- Free prior informed consent

Economic
- Proof of origin & traceability of minerals
- Transparent granting of mining licences
- Use of new technologies & automation
- Multi-stakeholder governance
- Local content in value chain

Cell Manufacturing

Environmental
- Eco-design & collaboration of manufacturers and recycling plants
- Responsible use of toxins, use of alternative substances if possible
- Recovery of solvents
- Increased input of secondary materials
- Use of renewable energy
- Reduced energy input (e.g. utilise waste heat)

Social
- Local value creation
- Occupational health & safety

Economic
- Abandonment of "the cheaper the better" philosophy
- Support of responsible production practices upstream
- Local sourcing where possible
- Process optimization

Recycling

Environmental
- Circular economy—closed loop & zero waste culture
- Recycling of all recyclable materials used in Li-ion batteries
- Evaluate used Li-ion batteries regarding 2nd life opportunity
- Eco-design & collaboration of manufacturers and recycling plants
- No dumping of toxic materials in landfills

Social
- Maintaining air quality
- Maintaining water quality
- Health and safety in collection, transport and recycling
- Occupational health & safety

Economic
- Financially more attractive than primary raw materials
- Landfilling is forbidden
- Innovation friendly environment
- Adequate legal basis for recycling
- Local recycling & reuse

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