



re-sourcing

Mobility Sector

Industry

**Roadmap for Responsible Sourcing of
Raw Materials until 2050**

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Abbreviations

ASM	Artisanal and small-scale mining
BEV	Battery electric vehicle
CSOs	Civil Society Organisations
DRC	Democratic Republic of Congo
EC	European Commission
EoL	End-of-life
EU	European Union
EU27	27 Member States of the European Union
EV	Electric vehicle
G7	Group of Seven (Canada, France, Germany, Italy, Japan, United Kingdom, United States)
GHG	Greenhouse gas
GRI	Global Reporting Initiative
GSSB	Global Sustainability Standards Board
ICE(V)	Internal combustion engine (vehicle)
ICMM	International Council on Mining and Metals
IFC	International Finance Cooperation
IRMA	Initiative for Responsible Mining Assurance
LCA	Life cycle assessment
LIB	Lithium-ion batteries
NGO	Non-governmental Organisation
OECD	Organisation for Economic Co-operation and Development
OEM	Original equipment manufacturer
RS	Responsible Sourcing
SDGs	Sustainable Development Goals
SLO	Social licence to operate
SME	Small and medium-sized enterprise

Executive Summary

The transformation of the mobility sector is essential in order to meet the Paris Agreement's goals. A 90% reduction in transport-related emissions by 2050 is needed to achieve climate neutrality. To achieve this, a major contribution will come from new technologies: the battery electric vehicle technology is the most promising technology today. The roadmap for the mobility sector therefore focuses on lithium-ion batteries (LIBs). While the global market for this technology is growing rapidly, production and end-of-life are linked to major environmental and social impact concerns. To ensure a just transition, it is crucial to implement high social and environmental standards in production and sourcing along the entire supply chain including end-of-life.

Following the [State of Play and Roadmap Concepts for the Mobility Sector](#) – a stock-taking report of the current sustainability challenges in the mobility sector – this report by the RE-SOURCING project focuses on the road towards achieving a sustainable mobility transition by 2050. The roadmap addresses four relevant raw materials used in LIBs (lithium, cobalt, nickel and graphite) and three supply chain stages (mining, cell manufacturing and OEMs, and recycling). Recommendations for EU policy makers, international industry (cell and battery producers, OEMs, recyclers, etc.) and Civil Society Organisations (CSOs) were developed to achieve the identified three main targets needed for a sustainable mobility sector (see figure below):

- **Circular Economy & Decreased Resource Consumption**
- **Responsible Procurement**
- **Level Playing Field**

For the development of the [Roadmap](#), the RE-SOURCING project relies primarily on bringing together existing knowledge from key stakeholder groups and regions. A series of six webinars during October 2021 and June 2022, supplemented by additional expert consultations, were used to elaborate the recommendations presented in this report. It is obvious, that **we need to act now** without any further delay to ensure changes in these long-lasting processes of a life cycle of a mine, production facilities and recycling strategies. This is why there is a very high number of recommendations up to 2030. These actions are the basis for achieving milestones for 2040 and 2050.

The key issues for all three targets are **communication** between all stakeholder groups and along the whole value chain as well as **transparency** to provide the basis for changes. In addition, the **rethinking of transport** in general as well as **thinking about the end of a material or production from the very start** (e.g., design for recycling) are essential for a sustainable mobility sector.

In this document, the recommendations for industry are presented, with corresponding milestones and required actions for short- (2025), medium- (2030 and 2040) and long-term (2050) time frames. The numbering of the targets does not imply any priority. All three targets are interlinked and must be pursued simultaneously to achieve the vision developed in the State of Play report for the mobility sector.

Target 1 'Circular Economy & Decreased Resource Consumption' addresses the need for changes in behaviour and the economic system to stay within planetary boundaries. A transition to a mobility sector without direct CO₂ emissions will not be possible or not be enough to mitigate all negative impacts from the mobility sector without improvements in energy efficiency and decreased demand. Additionally, end-of-life LIBs need to be seen as a strategic source of raw materials, with improved collection and recycling systems.

Milestones and recommendations in **Target 2 ‘Responsible Procurement’** focus more on the organisations themselves, considering the entire supply chain. Recommendations include transparency as a prerequisite for supply chain due diligence, support for sustainable development, the fair distribution of benefits and burdens, stakeholder engagement, and finding a European and worldwide common understanding of a sustainable product.

Finally, **Target 3 ‘Level Playing Field’** aims at harmonising requirements for companies operating and trading across the value chain in and with the EU. Raw materials or products that are produced with lower standards should be disadvantaged in the future or no longer allowed. However, creating a level playing field also implies supporting companies, regions and countries in improving their practices and achieving the required standards.

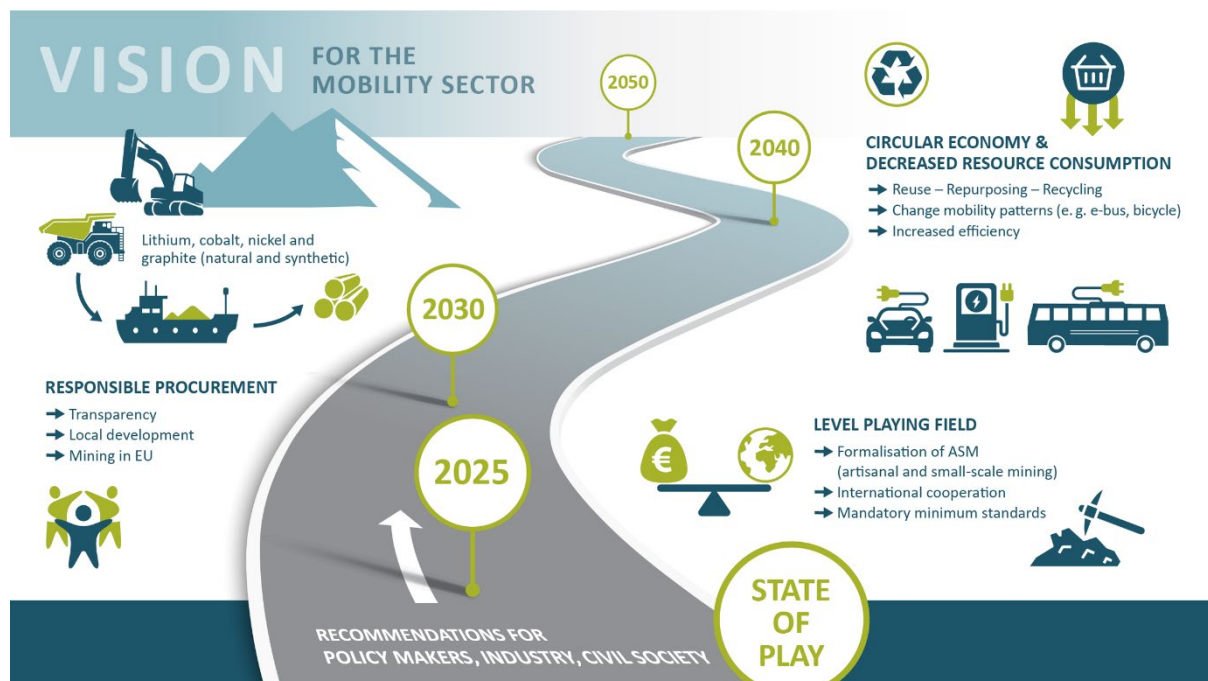


Figure: Roadmap for the mobility sector up to 2050

Keywords:

Mobility Sector, Lithium-Ion Batteries, Responsible Sourcing, Sustainability, Circular Economy

1 Introduction

1.1 The Mobility Sector

Work on the mobility sector started with the [State of Play report](#) which was published in April 2021. The aim of this report was to investigate the current state of the mobility sector with the focus on the lithium-ion battery (LIB) as the key component of electric vehicles. (Betz et al. 2021)

The mobility sector plays an important role in worldwide efforts to achieve the goals of the Paris Agreement. The legally binding international treaty on climate change was adopted in 2015 and entered into force in 2016. Its goal is to ‘strengthen the global response to the threat of climate change’ (Art. 2), among others by limiting the increase in the global average temperature to well below 2 °C, preferably below 1.5 °C, compared to pre-industrial levels. In order to achieve the temperature goal, ‘Parties aim to reach global peaking of greenhouse gas emissions as soon as possible’ (Art. 4). (UNFCC 2015)

In December 2019 the European Commission (EC) presented the European Green Deal with the aim of making ‘Europe the first climate-neutral continent by 2050’ (European Commission 12/11/2019). The European Green Deal requires a 90% reduction of emissions from transport by 2050 to achieve climate neutrality. However, this must be achieved without creating negative impacts in other environmental fields. To reach these targets, the EC proposes a 55% reduction of emissions from passenger cars by 2030 and emission-free new cars by 2035 (European Commission 2022).

In 2019, the mobility sector accounted for 31% of total EU greenhouse gas (GHG) emissions, as can be seen in Figure 1 below. Road transportation is of highest relevance, with more than 70% of the GHG emissions from this transportation sector (aviation, navigation and railways play a minor role).

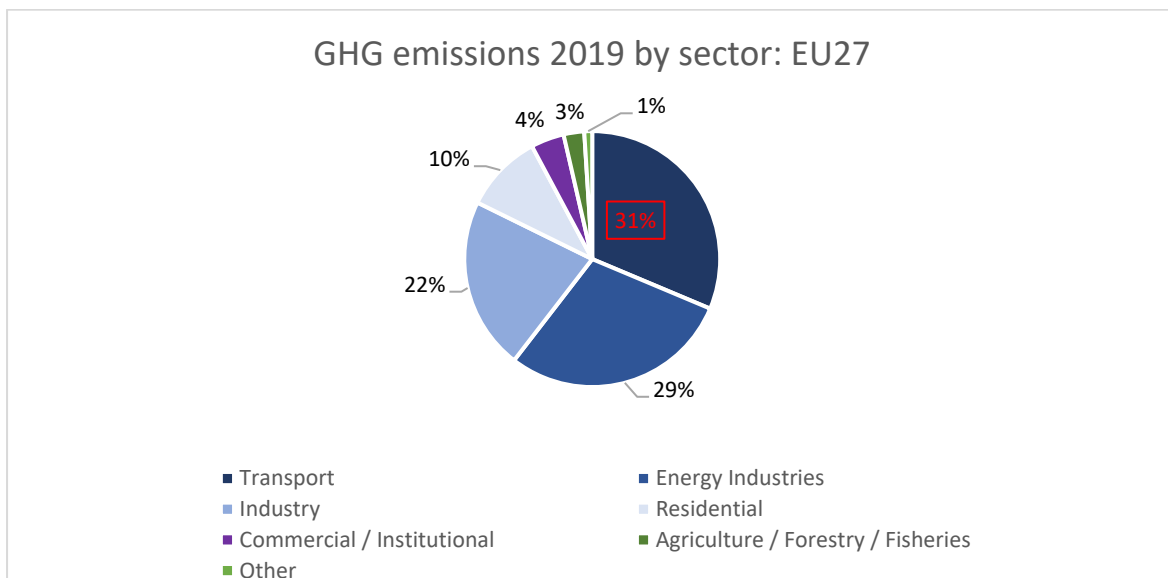


Figure 1: Greenhouse gas emissions 2019 by sector in the European Union (EU27) (data source: European Commission 2021)

This project focuses on road transportation due to its significant contribution to overall GHG emissions. The project’s focus on the mobility sector value chain therefore concentrates on a future technology in road transportation – electric vehicles – as this is seen as key for a transition to

transportation with lower GHG emissions. In 2050, it is predicted that 80% of all newly registered passenger vehicles worldwide could be equipped with alternative drive systems (Oeko-Institut 2019). Figure 2 shows the significantly lower GHG emissions of battery electric vehicles (BEVs) compared to internal combustion engine vehicles (ICE(V)s), even in countries with a high share of coal-based electricity.

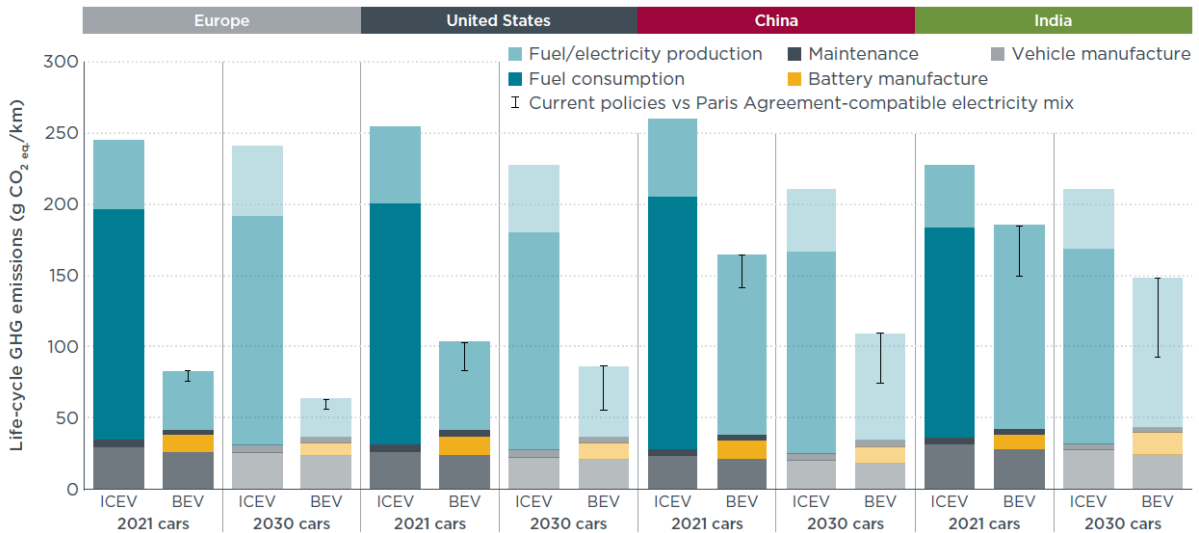


Figure 2: Life-cycle GHG emissions of average medium-size gasoline ICEVs and BEVs (Bieker 2021)

As a result, batteries are currently the main source of propulsion for cars to help achieve the Paris climate targets. The supply chain stages that are assessed in more detail in this roadmap are mining of the relevant minerals and the manufacturing of battery cells and their recycling.

In addition to the issues focussing on individual steps, there are also several overarching steps towards further minimising the carbon footprint of BEVs. Fewer and smaller cars on the roads reduce the energy and material consumption. Another important factor is increasing the share of renewable energy used for all steps in the entire value chain of a LIB. Life cycle assessments (LCA) and GHG accounting and reporting systems help to identify where emissions and energy use can be reduced. However, strong standards¹ and effective regulations for recycling are also important to reduce resource consumption and thus GHG emissions. The aim should be to achieve net zero GHG emissions.

The following paragraphs provide a brief overview of the main challenges presented in the State of Play report. For details see: [State of Play and roadmap concepts: Mobility Sector](#). (Betz et al 2021)

Mining faces a wide range of challenges that are raw material- and site-specific. Overarching challenges in hard rock or ore mining (for the selected materials lithium, cobalt, nickel and graphite) include heavy metal pollution, acid mine drainage, energy intensive processing, habitat fragmentation, disturbance of land areas and dust pollution. For lithium from brines, water scarcity and associated social tensions as well as dust emissions are major challenges. Social dimensions related to cobalt mining are an additional issue already in the public debate. The main cobalt-producing country, the Democratic Republic of Congo (DRC), has a relatively high share (10-20% of production from DRC) of artisanal and small-scale mining (ASM). ASM is the income basis of thousands

¹ See explanation and criteria on a strong standard in Degreif et al. 2022

of families in the DRC. But the often informal ASM sector is connected to child labour, forced labour, inadequate health and safety conditions and funding of armed conflicts.

Battery cell manufacturing is a very energy-intensive process and associated with high GHG emissions. The toxic substances in the battery cell also require proper handling. Additionally, high susceptibility to production errors for battery cells leads to high scrap rates in production. Resource efficiency is a relevant lever to reduce the negative impacts in primary extraction. There is a need for the decoupling of economic growth from resource consumption, especially when considering the rapidly increasing demand for raw materials in the growing market of electric vehicles.

At the end-of-life (EoL) of LIBs, **recycling** is indispensable because of the high risk of ‘thermal runaway’ from overheating batteries leading to fires. Adequate collection, storage, transport and treatment of used LIBs are therefore essential.

This project also analysed various regulations, standards, initiatives and guidelines promoting sustainable practices in the mining sector. The availability of standards and frameworks for the battery cell manufacturing and recycling steps are rather limited while other value chain steps are covered by numerous initiatives. A gap analysis was conducted to assess whether the standards and initiatives cover the challenges that exist in the supply chains. In the mining sector, one gap identified is the large number of guidelines that often lead to confusion when it comes to compliance. An international framework that provides mutual recognition of standards is, therefore, very important. Such a framework should define terms and provide guidance for companies on which standards to apply. For customers, knowing which standards and corporate qualities are relevant is also challenging. These issues in identifying best standards are also applicable to battery cell manufacturing and the collection and recycling of EoL LIBs. There are no international guidelines addressing the whole supply chain. The proposal for an EU Regulation on (waste) batteries could offer an important step to integrating crucial elements of the supply chain in a regulation (supply chain due diligence, product carbon footprint, material specific recycling targets, recycled content, etc.).

1.2 Vision

The horizon considered for the roadmap of the RE-SOURCING project is 2050. The vision for the mobility sector (Figure 3) was developed based on the underlying concepts of the Paris Agreement², planetary boundaries³ and strong sustainability⁴ and will be incorporated in the definition of responsible sourcing that is developed towards the end of the project. Further information on the RE-SOURCING project's vision for the mobility sector can be found in the [State of Play report of the mobility sector](#).

The remainder of this report outlines three key target areas for achieving the RE-SOURCING Vision 2050 (Mobility Sector):

- Circular Economy & Decreased Resource Consumption
- Responsible Procurement
- Level Playing Field

The discussion of each area considers targets and milestones, followed by specific recommendations for three key stakeholder groups: policy makers, industry and civil society. This document only includes recommendations for industry (for the other stakeholder groups see [here](#)).

² For further information on the Paris Agreement, please refer to the [UNFCCC](#) and the [legislation](#).

³ For further information on planetary boundaries, please refer to Rockström et al. 2009 and Steffen et al. 2015.

⁴ An explanation of the strong sustainability concept is provided by Ekins et al. 2003 and Dedeurwaerdere 2014.

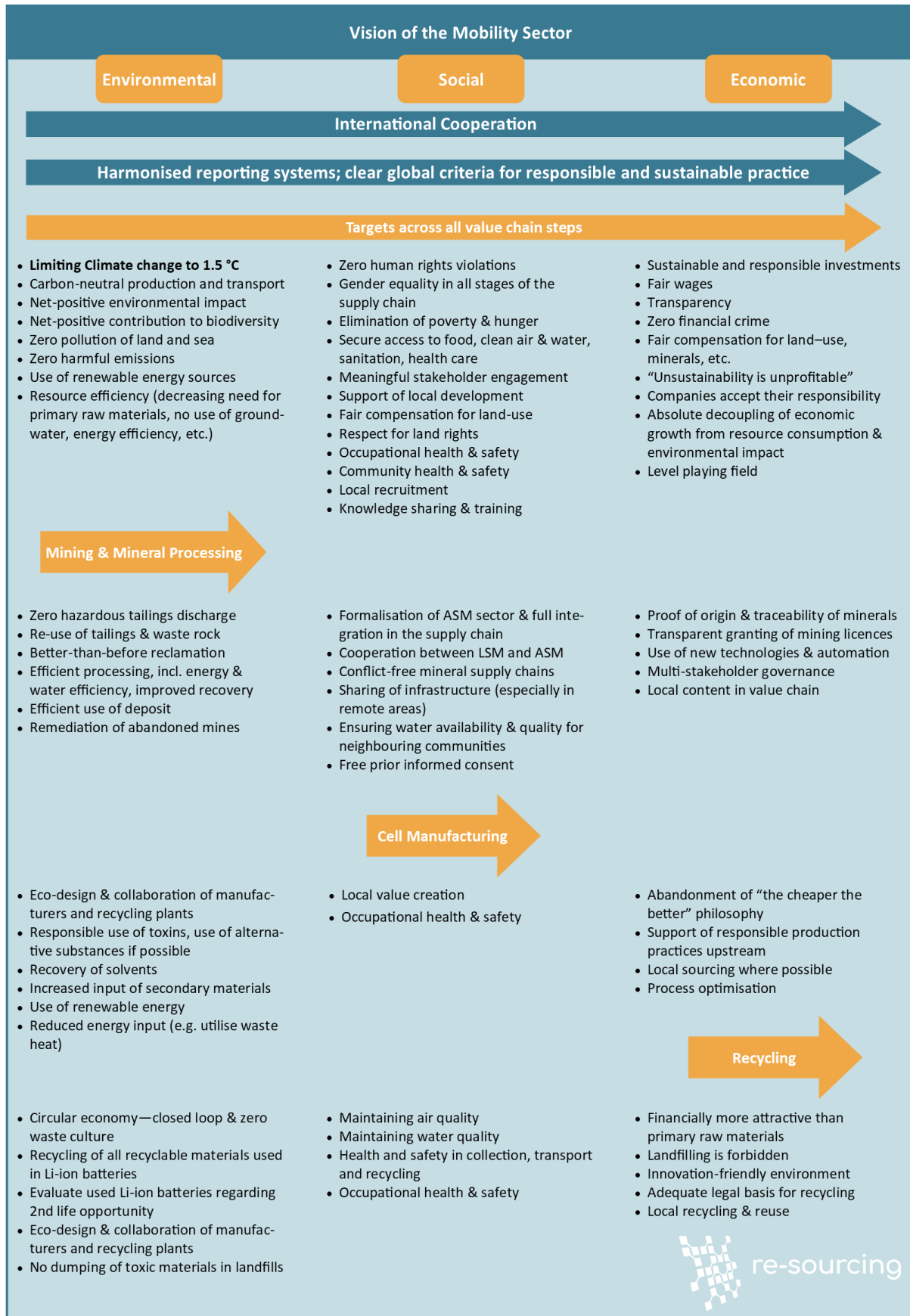


Figure 3: Vision for the mobility sector (Betz et al. 2021)

2 Pathway

The three overarching targets of the circular economy & decreased resource consumption, responsible procurement and level playing field are based on the concepts of the Paris Agreement, planetary boundaries and strong sustainability. Some approaches to reach these targets overlap each other as illustrated in Figure 4. There are therefore some cross-references between the target chapters.

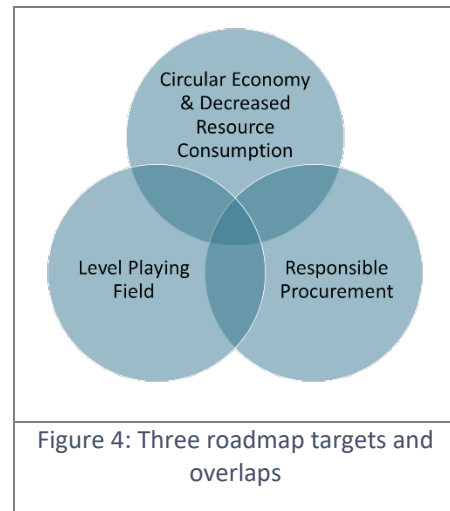
The following paragraphs explain the roadmap's scope, assumptions and limitations, and structure. In order to have a uniform project structure, these explanations are similar in the three sectors of the RE-SOURCING project.

Scope

The RE-SOURCING project provides a roadmap encompassing recommendations for actions for policy makers, industry and civil society. It does not propose new standards or guidelines for the mining step, nor does it attempt to 'reinvent the wheel'. For many areas, appropriate standards have already been developed and the first and most important step is to successfully implement these. Due to the existence of different standards and certification schemes, it is crucial to harmonise these standards. Alignment and mutual recognition are needed to avoid confusion for users and customers in the implementation. Implementation, alignment and mutual recognition of these standards is part of the roadmap's recommendations. It is important to have the foundation in place before thinking bigger. There is ample evidence of companies which, for example, do not respect basic human rights, or governments that fail to address the sustainability principles for protecting local communities.⁵

The State of Play report serves as a basis and baseline for the development of concrete recommendations for policy makers, industry and civil society for moving ahead from this baseline to the RE-SOURCING project's vision for 2050. The recommended actions for industry can be considered at a global level. The RE-SOURCING project recognises the important role of investors, insurance, logistics providers and other business service providers. However, they are out of scope for this roadmap as they are relevant for all three sectors (renewable energy, mobility, and electric and electronic equipment) included in the RE-SOURCING project.

As with the State of Play report, the roadmap focuses on the raw materials lithium, nickel, cobalt and graphite, the technology of the LIB and the supply chain stages mining, cell production and recycling. This scope was defined at the start of the project as part of the consultation. There are, of course, numerous other minerals and metals that are essential for the mobility sector, and many of the recommendations listed here can also be applied to other raw materials.



⁵ For further information on sustainability challenges in the mobility sector supply chains, as well as existing standards and initiatives, please refer to the [State of Play and Roadmap Concept report](#) for the mobility sector.

Assumptions and limitations

The RE-SOURCING project roadmap for the mobility sector assumes technological advances but does not specifically address this issue, apart from the continuation of these advances and the necessary support from the public and private sectors. More information on the technological aspects can be found in various reports, such as Fraunhofer ISI (2015; 2022) and Battery 2030+ (2020).

The roadmap assumes the continuance of wider development and governance issues that address improved governance and business environments in a number of EU partner countries. This would include efforts to address poverty and to raise income levels, creating education and employment opportunities, and addressing gender and human rights at the country, non-sectoral level. This is addressed through support provided by EU Member States development institutions (such as GIZ, SEDA) as well as international organisations (World Bank, UNEP, etc.). This roadmap should therefore be considered as part of the larger development landscape where the wide-ranging challenges for governance and development are being tackled through multiple avenues.

The conclusions from the consultation process indicate the difficulty in setting specific targets for the use of secondary raw materials, the circular economy, etc., as the necessary research has not been fully carried out at this stage by either this project or other external stakeholders. Nevertheless, this report attempts ambitious but realistic assumptions indicating the pathway to achieve the three targets. This aspect will be highlighted in the relevant sections of the report.

Structure

The roadmap differentiates between targets and milestones. **Targets** define the desired end points and are kept at a high and aggregated level. They can be medium- (2030 and 2040) or long-term (2050). Targets were developed during a consultation process with the project’s Platform Steering Committee and Advisory Board, as well as the Roadmap Workshop with participants from various stakeholder groups of the mobility supply chain. The targets consider all three pillars of sustainability: social, economic and environmental (Figure 5).

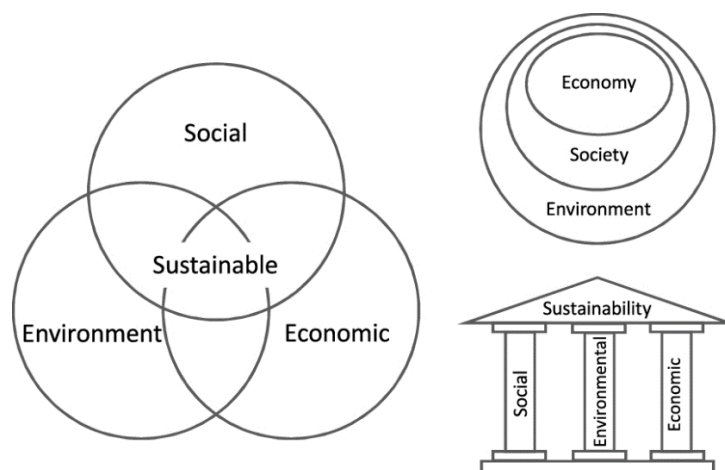


Figure 5: Depictions of the three sustainability pillars - social, environmental and economic (Purvis et al. 2019)⁶

⁶ Please refer to the report [The International Responsible Sourcing Agenda](#) for more information on sustainability and responsible sourcing approaches.




Milestones are points along the desired trajectory from baseline to target and are intended to help track progress. They can be short- (2025), medium- (2030 and 2040) or long-term (2050). While 2025 milestones may appear as short-term considerations, they refer to the achievement of commitments already made or set the direction for future goals. Wherever possible, milestones are specified according to desired quantity, quality and/or time (Capacity4dev Team 7/8/2016). Milestones also include existing and agreed goals, such as the Sustainable Development Goals (SDGs) of the United Nations (UN) and the Paris Agreement.

However, the RE-SOURCING mobility sector roadmap only focuses on targets and milestones that are relevant for and an issue in the focus of the mobility sector. Targets and milestones that are not mentioned here are therefore not considered irrelevant but are beyond the scope of this roadmap. Nevertheless, there are milestones that can be transferred to other sectors, such as the global mandatory supply chain due diligence for all international actors by 2040.⁷

The classification of the milestones and recommendations into categories is based on the authors' preference and should not be regarded as absolute. The time frame for the achievement of milestones and targets shows the latest deadline. However, earlier completion is strongly encouraged.

The term **'responsible sourcing'** is not considered as a simple supplier-manufacturer business transaction in the RE-SOURCING roadmap for the mobility sector. In this project, the term represents the idea that RS engages **all stages of the supply chain** and should be understood as a joint effort to make each stage sustainable. The recommended actions and milestones that follow therefore do not merely focus on procurement but on all stages of the supply chain, and touch upon sector-specific issues.

Recommendations were developed by the report team and discussed and further revised during the consultation process. The authors' aim is to set recommendations that are ambitious but also realistic, in order to achieve the milestones and targets. The recommendations were developed for policy makers, industry and civil society; however, this document focuses only on industry. The recommendations are also divided between the three steps of the mobility roadmap: mining, cell production and recycling. This differentiation represents the authors' view and is illustrated with the following icons in the text:

- Mining 
- Cell production and OEMs (Original equipment manufacturer) 
- Recycling 

⁷ See also the [Roadmap for the renewable energy sector](#).

2.1 Target 1: Circular Economy & Decreased Resource Consumption

A Circular Economy is a framework based on three principles:

- Eliminate waste and pollution
- Keep products and materials in use
- Regenerate natural systems

It therefore goes beyond recovering resources from waste through recycling by including sufficiency⁸, the intensified use of a product and the rehabilitation and secondary land-use of mine sites after production.

As described in the [Roadmap for the renewable energy sector](#), continuing with business-as-usual consumption patterns while using renewable energy can be described as a ‘low-carbon destruction of planetary resources’ (Swilling 2020, p. 101). New systems for both consumption and production are required to satisfy human needs and universal wellbeing while staying within planetary boundaries (Brand-Correa and Steinberger 2017; Raworth 2017; Swilling 2020).

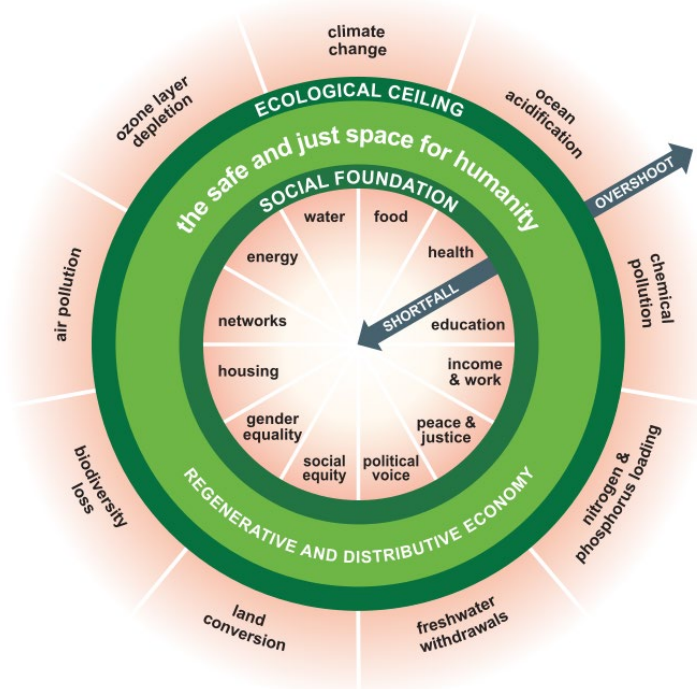


Figure 6: Doughnut Economics - combining social and planetary boundaries (DEAL 2021)

Absolute decoupling of economic growth, resource consumption and environmental impact is one of the proposed measures to tackle price shocks and resource scarcity and to halt environmental degradation (UNEP 2014). Decoupling relies on decreasing resource consumption by improving

⁸ For more information about sufficiency, see Thomas Princen’s book ‘The Logic of Sufficiency’ published in 2005, in which he argues that ‘seeking enough when more is possible is both intuitive and rational - personally, organizationally and ecologically. And under global ecological constraint, it is ethical.’ (Princen 2005)

resource efficiency through technological improvements, substitution of non-renewable by renewable resources, waste prevention through reuse and recycling, etc. The concept of decoupling also faces criticism as current research has not reached a consensus on whether absolute decoupling of economic growth, consumption and environmental impact is in fact possible (Parrique et al. 2019; Strand et al. 2021; Wiedmann et al. 2020). Similarly, 100% circularity of resources within an economy will not be possible, due to physical and economic constraints and in some cases will not be desirable due to the high negative environmental impacts of certain recycling processes driven to their limits (Moss 2019; UNEP 2013).

This roadmap follows a two-pronged approach for the mobility sector: (i) increasing resource efficiency, recycling and reuse rates is a prerequisite for achieving the transition away from fossil fuels and meeting the growing demand from a growing population and (ii) reengineering the current economic system with a focus on changing existing consumption patterns. These considerations are addressed by the Doughnut Economics Principles of Practice: ‘Think in systems’ – aim for continuous improvements; ‘be regenerative’ – the 6Rs of sustainability (reduce, reuse, recycle, repair, rethink and refuse); and ‘aim to thrive rather than grow’ (DEAL 2021).

Following this approach, the project came up with several milestones to be achieved over the coming decades. To achieve these milestones, a set of recommendations for actions are outlined. As mentioned earlier, the recommendations presented here are aimed internationally operating companies.

This report does not directly address research and academic institutions but does include some recommendations for these stakeholders to support a circular economy. They have a primary role in developing new technologies and advancing existing ones to reduce both the resources and the energy used in their production. It is also important for them to pay attention to the subsequent reuse and recovery of materials when designing products (design for recycling). When developing new technologies in the future, attention must be paid to the raw materials used from the very beginning. Interdisciplinary cooperation should be significantly improved and expanded for this purpose. Direct cooperation with industry needs to be intensified to effectively develop viable new products. Interdisciplinary cooperation should be strengthened not only in the technical field in relation to the use of raw materials, but also between engineering, social sciences, ecology, sustainability research, etc. Environmental and social impacts have to be considered, for example in the form of (social and environmental) life-cycle assessments, and in product development from the start of a project.

Industry should follow four main sub-targets to reach the main target of a circular economy & decreased resource consumption:

- Push for and create a circular economy
- Transform the transport sector to only BEVs on the road
- Label and report LIBs with sustainability criteria
- Make LIB production more efficient

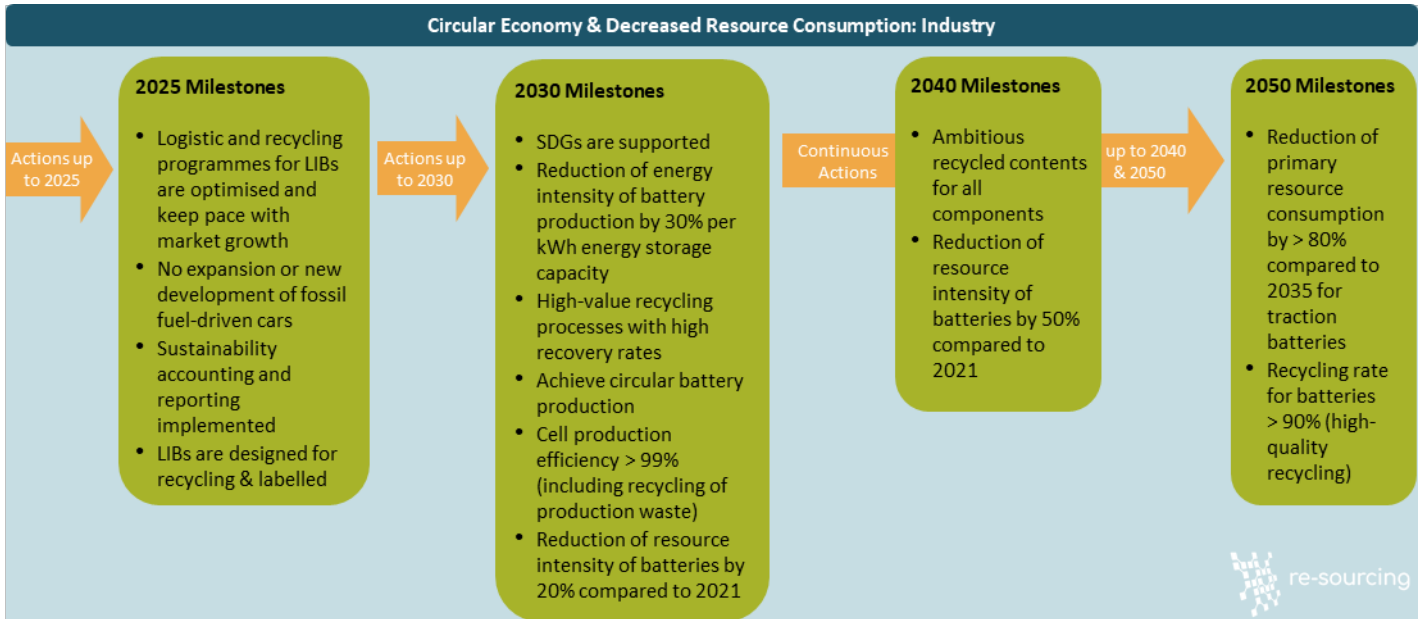



Figure 7: Milestones for industry towards a circular economy and decreased resource consumption by 2050

2.1.1 Milestones 2025

- **Logistic and recycling programmes for LIBs are optimised and keep pace with market growth**

 The LIB market is growing rapidly. As the batteries have a long lifetime, the waste stream of batteries is shifted by about 10 to 20 years (see Betz et al. 2021). To cope with the growing stream, the logistic and recycling programmes for LIBs have to be expanded as well to keep pace and recover the valuable resources. Fortunately, many companies have announced large recycling plants to be built and expanded in the near future.⁹


The collection of batteries also has to be increased. This could include re-buying of batteries or complete EVs as part of the product offering to customers. The return of products should also be an easy process for customers.

When looking at the recycling itself, the process not only has to be optimised to achieve high recovery rates, but the environment and health and safety issues related to the recycling process also have to be addressed.

Recommendations:

- Take responsibility for the batteries produced, keep in close contact with customers, provide funds for buybacks or implement a deposit system to get the battery back after each phase of use
- Expand, optimise, and support end-of-life logistic and recycling programmes for LIBs including second material refinement

- **No expansion or new development of fossil fuel-driven cars**

 To achieve a shift to electromobility as fast as possible, all efforts should go into the development and expansion of electric vehicles. Furthermore, more consumers will choose an electric car if no new fossil fuel-driven cars are developed. This supports the achievement of sustainable consumption patterns.

Recommendations:

- Support achievement of sustainable consumption patterns by not expanding or developing new fossil fuel-driven cars

⁹ <https://cen.acs.org/environment/recycling/Umicore-wants-build-worlds-largest/100/i23> (last checked 28.07.2022), <https://www.electrive.com/2022/07/05/battery-recycling-project-to-take-off-with-mercedes-in-germany/> (last checked 28.07.2022), <https://www.greencarcongress.com/2022/06/20220621-basf.html> (last checked 28.07.2022)

- **Sustainability accounting and reporting implemented**



To be able to get a benchmark and compare different companies, it is necessary for all companies to introduce a sustainability accounting and reporting system. This increases transparency and gives policy makers the chance to identify the state-of-the-art and best-available technology for new regulations. The sustainability accounting and reporting has to be done in a standardised way to be able to compare their achievements.

In China, the Green Mining Framework includes technical specifications to be achieved by operations, a clear outline of how performance will be measured, and a benchmarking system that allows for the comparison of mines across minerals and regions, which could serve as a blueprint for other countries. (Degreif et al. 2022)

Recommendations:

- Implement reporting for sustainability in your company to account for environmental, social and governmental issues

- **LIBs are designed for recycling & labelled**



In battery recycling another major challenge is the large variation in cell and module structure between different types and manufacturers, creating problems in the extraction of components. Standardisation of modules would significantly increase recyclability (Tao et al. 2020).

When developing new products, eco-design considerations need to be included from the very beginning of the process. Cooperation with recycling facilities is required to improve the future recovery of raw materials, and existing products revised for this purpose.

To enable proper recycling of batteries, sufficient information about the battery should be provided to the recycler. This is possible by labelling the battery, e.g., with a QR code, to enable access to information about the battery's cell chemistry, material proportions, manufacturer, year of production, recycled content, etc.

Recommendations:

- Consider reuse/refurbishment/recycling from the beginning by cooperating with recyclers

2.1.2 Milestones 2030

- **SDGs are supported**



The SDGs relevant to the circular economy in the mobility sector and to LIBs are SDG 3, 6, 7, 8, 9, 11, 12, 13, 14, and 15. They are described in Chapter 2.1.1.2 of the [Roadmap for Responsible Sourcing - Mobility](#). Companies need to play their part to achieve these. For example, mining companies need to implement policies for improving efficiency and resource use in their operations,

e.g., based on IFC (International Finance Cooperation) Environmental and Social Performance Standards. These policies should include: (i) implementation of a management plan for sustainable use of the entire deposit; (ii) optimisation of the existing mining plan to take account of energy efficiency (incl. schedule, drilling and blasting, layout, etc.); and (iii) energy optimisation and increase of renewable energy use in processing.

In addition, mining companies should strengthen cooperation with research and academia to foster the development of new mining and processing technologies that increase raw material recovery and sustainable use of the deposit. This can also aid the management of tailings and waste heaps. Research projects with a focus on decreasing environmental impact and possible recovery with future technologies should be supported by mining companies.

Recommendations:

- Expand, optimise, and support end-of-life logistic and recycling programmes for LIBs including second material refinement
- Consider reuse/refurbishment/recycling from the beginning by cooperating with recyclers
- Implement circular and efficient battery production with renewables
- Support achievement of sustainable consumption patterns
- Support achievement of SDGs by greatly increasing efforts for a circular economy

- **Reduction of energy intensity of battery production by 30% per kWh energy storage capacity**



Battery production is very energy intensive and also directly related to GHG emissions when the energy is provided by fossil fuels. The reasons for this are the following:

- Dry room atmosphere for water sensitive processes
- Drying of electrodes after coating by convection drying
- Formation and aging of cells, including:
 - Temperature control
 - Charging/discharging

There are several measures possible to reduce the energy intensity of the battery production per kWh, including micro atmospheres instead of dry air for a large room, other means of drying electrodes or changing to dry coating processes, and innovative formation protocols using less time. Increasing the energy content of a battery or using a different cell chemistry can also improve the energy intensity per kWh energy storage capacity.

In addition to this, companies can consider further improving the batteries' carbon footprint by incorporating renewable energy in the production (and recycling) process and using more secondary materials. This, however, was not included in the 30% reduction milestone.

Recommendations:

- Make use of all possibilities and innovative production procedures to reduce energy consumption during production

- **High-value recycling processes with high recovery rates**



By collaboratively initiating common (minimum) standards and a systemic design for circularity, the industry can utilise synergetic potentials at different levels of action. Both individual actors (e.g., vehicle manufacturers, machine builders and recyclers) as well as industrial associations and standardisation groups can become active here, in particular at product level: this includes the modularisation of the traction battery, a circular design of the battery case, and a battery-friendly construction of the vehicles. The diversity of battery types, controls and applications should be taken into account and harmonised, where appropriate.

As described in CEID (2020), the development and implementation of basic knowledge, (initial) education, and (technical) training that will enable the scaling of the circular economy must be addressed in cooperation with politics and science. This includes:

- Technical training, in particular to ensure occupational health and safety in the handling of EoL batteries and the availability of trained personnel;
- The further development and opening of training occupations (e.g., production technologist) for the circular economy;
- The education of the population and specialist personnel on the basic principles of the circular economy (e.g., on resource conservation and climate protection as well as economic and business management qualifications).

For battery return and dismantling, broad deployment of digital technologies to locate traction batteries at decision points (change of ownership), especially EoL, and expand the necessary dismantling and logistics capabilities makes a lot of sense. Second life will continue to require technology and capacity building, especially for residual value analysis, remanufacturing, and recertification prior to being placed back on the market.

Recycling technologies need to be further developed with the aim of achieving optimal recovery rates and high quality throughout the process chain with optimized environmental impacts and costs. As mentioned, this also includes scaling up capacities in the EU. Economic actors - in particular vehicle manufacturers - should consider whether and how they can move to planning and making their business decisions across the value chain taking into account available resources and energy efficiency (entropy growth/residual exergy).

Recommendations:

- Achieve value recycling by design for recycling, improving technologies and high collection rates
- Develop and provide training sessions for circular economy of batteries

- **Achieve circular battery production**



High susceptibility to errors during battery production leads to high scrap rates. This needs to be optimised. At the beginning of production in particular, a scrap rate of up to 40% is common. This production waste has to be managed well, kept separately and recycled directly into new battery material.

Recommendations:

- Optimise waste management and recycling processes

- **Cell production efficiency > 99% (including recycling of production waste)**



The cell production efficiency of over 99% can be incentivised by policy makers (see Chapter 2.1.1.2 in the [Roadmap for Responsible Sourcing – Mobility](#)) but it has to be achieved by the industry itself. This target can be reached by reducing all waste streams and recycling the remaining waste to recover the resources. A switch to more resource efficient battery chemistries can also help.

Recommendations:

- Reduce waste streams and recycle the remaining waste
- Switch to resource efficient battery chemistries

- **Reduction of resource intensity of batteries by 20% compared to 2021**



The resource intensity is connected to the resources needed for the production of a battery with a certain energy content. It is defined in this case by the mass of primary material per specific energy in kWh. Several measures exist to reduce resource intensity:

- Use of recycled material
- Reduction of scrap rate
- Switch to resource efficient battery chemistries
- Increase of the specific energy content (more energy per mass means less mass and resource consumption)

The last-mentioned should not be at the expense of longevity, which is often the case.

Recommendations:

- Use as much recycled material as possible, also at higher costs
- Reduce scrap rate
- As mentioned before, switch to resource efficient battery chemistries

2.1.3 Milestones 2040

- **Ambitious recycled contents for all components**



Aiming for a higher recycled content means

- Collaborating with recyclers
- Getting the right specifications of secondary material for production of new cathode material equal to primary material
- Always favouring secondary material, taking higher prices into account (see also target 'responsible procurement' and milestone 'companies develop, implement and report on sustainability strategies')

Furthermore, industry should not lobby against mandatory recycled content, but try to be a front runner in demonstrating that higher quotas are no problem for them.

Recommendations:

- Collaborate with recyclers
- Get the right specifications of secondary material for production of new cathode material equal to primary material
- Always favour secondary material, taking higher prices into account

- **Reduction of resource intensity of batteries by 50% compared to 2021**



The efforts to increase the efficiency of resource consumption in the LIB production have to be continued.¹⁰ It is important to increase secondary material content further, reduce the scrap rate and increase the energy content of a battery, while keeping a similar battery cycle life (number of charge/discharge cycles). In addition, by 2040 the amount of recycled material available compared to the new battery production should have increased significantly, as the market in the EU for traction batteries should be decreasing by then and larger numbers of batteries will be collected for recycling.

To avoid additional recycling costs and secure access to secondary materials, manufacturers can collect back the batteries they produce and set up their own recycling facilities specialised for the specific battery type. A good example is KYBURZ, as they give their batteries a second and third life, before recycling them at the end (for more information on approach of KYBURZ please see [Guidance Document](#); Degreif et al. 2022).

Another important topic is the recovery of resources from tailings. This waste stream is produced during mining of primary material and often still contains amounts of raw materials, which have been discarded in the past due to a lack of recovery technology or for economic reasons.¹¹

Recommendations:

- Use the rising amount of recovered materials from batteries to drive a major increase in the recycled content.
- Recover resources from waste streams
- Follow all recommendations mentioned previously for a circular economy

¹⁰ According to the EC, 'resource efficiency means using the Earth's limited resources in a sustainable manner while minimising impacts on the environment' (https://ec.europa.eu/environment/resource_efficiency/)

¹¹ See for example Moca – development of production chain for rare earth elements from tailings of the ultramafic alkali-carbonatite complex Catalao/Goias on the site <https://www.bmbf-client.de/en/projects/moca>

2.1.4 Milestones 2050

- **Reduction of primary resource consumption by > 80% compared to 2035 for traction batteries**



The battery producers and OEMs have to achieve this by using secondary materials and choosing technologies which permit high amounts of secondary material content. The recycling industry, on the other hand, needs to develop further technologies to improve the recycling efficiency and recovery rate of > 90% (next milestone) in order to provide high quality secondary materials for car and battery material producers.

Recommendations:

- Collect and recover most materials from batteries and refine them to battery grade
- Follow all recommendations mentioned previously to provide enough secondary material and use this

- **Recycling rate for batteries > 90% (high-quality recycling)**



The recycling rate, as mentioned above, should be calculated from the ratio of the battery grade material resulting from the recycling process divided by the input weight of the battery. This means that only high-quality recycling counts, which is ambitious in terms of the large amount of organic materials that have to be recovered and recycled as well. This requires a technological advancement and a careful choice of battery materials to make this recycling rate possible.

Recommendations:

- Improve the technology to enable a recycling rate of > 90% (no downcycling)

2.2 Target 2: Responsible Procurement

As described in the [roadmap for the renewable energy sector](#), responsible or sustainable procurement is defined as ‘the process of making purchasing decisions that meet an organisation’s needs for goods and services in a way that benefits not only the organisation but society as a whole, while minimising its impact on the environment’ (ISO 2017, p. 2). The authors understand this citation to mean that organisations need to consider not only their own impact – positive and negative – from production or procurement but also the **associated impacts along the whole supply chain**. Value should be created wherever possible along the chain, especially at the mining site. It is important to note that there are differences between adverse impacts caused by, contributed to by, or directly related to the company's activities, products or services through a business relationship.¹²

However, it should be mentioned that the authors do not recommend ending business relationships with suppliers or countries that do not adhere to the required social and environmental standards to achieve responsible sourcing. The vision is rather to engage with and support them in improving their performance. Wilful use of forced and child labour, environmental pollution and other irresponsible practices at any stage of their supply chain should not be accepted from companies that want to have business relations and do business in or with the EU.

The recommendation to introduce a global mandatory supply chain due diligence for all international actors by 2040 is not intended to undermine current efforts by countries to introduce such a law. The time frame proposed in this roadmap, as mentioned in the introduction of Chapter 2, is only the latest date by which these measures should be implemented. It is also intended to encourage countries that are not yet planning to implement such measures to do so and to provide recommendations on what to include.

The following milestones and recommendations for industry can be summarised into the following sub-targets:

- Develop and implement sustainability strategy including responsible procurement with, e.g., sustainability criteria for suppliers
- Support tracing and transparency
- Focus on local development
- Ensure SLO for mines, production and recycling sites (from the beginning to the end and beyond)

¹² For further information, see the OECD Due Diligence Guidance for Responsible Business Conduct (OECD 2018, page 70). Additional information is given in the OECD guidelines for Multinational Enterprises (OECD 2011) and OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas (OECD 2016).

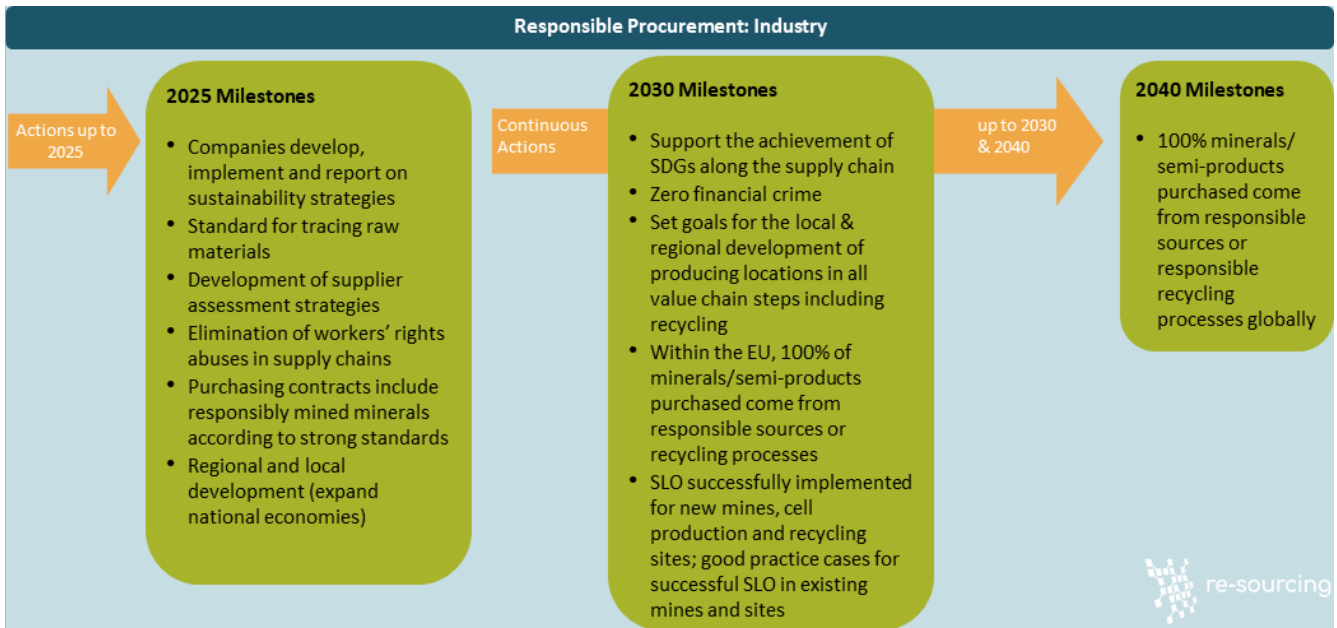


Figure 8: Milestones for industry towards a responsible procurement by 2050

2.2.1 Milestones 2025

- **Companies develop, implement and report on sustainability strategies**

Industry should not only follow political guidelines, but also show initiative in achieving sustainability for the whole company, including responsible sourcing. Some car manufacturers like Mercedes are already starting in developing a strategy (Mercedes 2022). Senior management support ensures the inclusion of sustainability requirements across the company. One aspect of the strategy needs to be responsible sourcing. One part of this is the inclusion of a binding request for certified material in the contracts and in the Supplier Sustainability Policy to ensure the use of responsibly sourced material. Responsibly recycled materials should be preferred. The employees of the different companies must be involved in the development of the strategy to ensure the subsequent implementation within the company. Large firms can also use their market power together to ensure compliance amongst suppliers (see also Degreif et al. 2022).

Companies should report on the sustainability strategy and measures implemented in a comparable manner so that they can be evaluated by policy makers and consumers.

Recommendations:

- Develop a company sustainability strategy involving the employees
- Sustainability strategy including binding requests for certified materials
- Sustainability strategy and measures with senior management support
- Report on sustainability strategy and measures

- **Standard for tracing raw materials**



While there are already strong standards for the operation of mines, these are still lacking for the tracing of raw materials. Industry needs to set these standards. Traceability should be adapted to the risk profile of the mineral supply chain, as this can be a significant barrier for engaging in due diligence. There is also sometimes confusion between due diligence and traceability, with companies focussing on the second rather than the first – which means using management systems (including traceability systems) to identify, mitigate and account for adverse impacts. Due diligence and traceability should be seen as two individual points to be met.

There needs to be target group certification / standard schemes to develop a discussion group on how to deal with and accept other standards. In this context, a standard for the reporting of raw materials tracing must also be created, as well as for smelting and recycling.

In addition, there needs to be standardised supply chain reporting on all minerals to uncover grievances and thus prevent negative impacts. The purchasing companies need to address the risks from the mining sector and put pressure on the mining companies to improve the situation. Reporting can be combined with an advertisement for the sustainability aspect when published, which in turn can bring a competitive advantage.

Recommendations:

- Target group certification / standard schemes: develop a discussion group on how to deal with and accept other standards
- Implementation of supply chain reporting on all minerals

- **Development of supplier assessment strategies**



In order to be able to select responsible suppliers, a rating scheme should be available. Industry therefore needs to develop a supplier assessment strategy by 2025. Implementation of the assessment needs to start afterwards. Companies need to exchange information with each other and make responsible sourcing known to the public. When following an agreed assessment strategy, the automobile market can use the power of the sector. To prevent negative impacts along the value chain, strong standards¹³ should be preferred with public reports and third-party audits.

Recommendations:

- Develop a supplier assessment strategy with other OEMs
- Use the power of the automobile market to strengthen responsible sourcing in the LIB supply chain

¹³ See explanation and criteria on a strong standard in Degreif et al. (2022)

- **Elimination of workers' rights abuses in supply chains**



Workers' rights abuses need to be eliminated along the supply chain. This needs to be ensured within the EU as a first step. In a further step, the rules for production within the EU should also be ensured for EU-based companies active abroad. Worker's rights should also be an element in the sustainability strategy as a criteria for responsible sourcing.

Recommendations:

- Ensure compliance with workers' rights

- **Purchasing contracts include responsibly mined minerals according to strong standards**



One aspect in the overall sustainability strategy of a company is responsible procurement. Even though secondary material should always be preferred to primary material, the purchase of primary raw material is necessary in a growing sector such as LIBs. Responsible procurement includes responsibly mined minerals. Companies should include a binding request for certified material in the suppliers' contracts. It is essential to clearly communicate these requirements with the suppliers from the beginning, so that they are aware of this development. How responsible procurement of minerals can be achieved through aligning with a strong responsible sourcing scheme is explained in Degreif et al. (2022). When developing the contracts, the amount of available certified material and potential alternatives, when the material is not available on the market, need to be considered. Definitions for responsibly mined minerals must be based on strong standards and should also include further aspects such as mining equipment, e.g., requiring BEVs.¹⁴

To ensure a decision based on the standard and criteria, a CSO representative should be involved in the decision-making process. The industry therefore needs to be open to discussions with NGOs. However, it must be kept in mind that CSOs do not always have enough capacity available.

Recommendations:

- Openness to discussion with NGOs; involve NGOs in decision-making process
- Start discussion with mid-stream companies about the requirements and push RS
- Target group certification / standard schemes: develop a discussion group on how to deal with and accept other standards
- Implementation of supply chain reporting for all minerals
- Exchange information with other companies and make responsible sourcing known to the public. Use the power of the automobile market

¹⁴ E.g., Glencore has ordered electric mine machinery from Epiroc for a nickel and copper mine in Canada, which is scheduled to come on stream in 2024 (Electrify 2022)

- **Regional and local development (expand national economies)**



Through the use of local content and local procurement policies, a contribution needs to be made to local and regional development (as well as the national economy), particularly for operations in developing countries. This includes local procurement, jobs creation, infrastructure and local content¹⁵.

However, industry should not only focus on minimising the negative impacts, but also strengthen the positive impacts of mining, production and recycling. A strengthened local procurement in producing regions supports local development. Awareness of the positive impacts of the production site such as jobs and building infrastructure (roads, hospital, schools etc.) can strengthen the SLO and the companies' reputations. However, there is no commonly accepted way of reporting this topic globally. Companies can measure and report e.g. on criteria from LPRM (Local Procurement Reporting Mechanism) created by the Mining Shared Value initiative of Engineers Without Borders Canada, the GRI 204 standard (Global Reporting Initiative) for local suppliers (GSSB 2018) or ICMM (International Council on Mining and Metals), with a new social and economic reporting framework from May 2022.

Furthermore, to ensure regional and local development and to have a sustainable view from the highest level, CSOs should be on the company boards. This requires the companies to be open for the CSO's view and vice versa, and CSO capacities need to be built (with the financial support of policy).

This includes support for diversifying the manufacturing sites, both in the EU and in other continents/countries, with a focus on sustainable manufacturing and local value creation.

Recommendations:

- Strengthened local procurement in producing regions
- Report on local development
- CSO as a voice on the company board

¹⁵ The local content is the proportion of materials, labour, etc. used in the production of a product that originates in the area where the product is produced and is not imported.

2.2.2 Milestones 2030

- **Support the achievement of SDGs along the supply chain**



The SDGs are global goals to be achieved by 2030. The SDGs to be achieved in order to reach responsible procurement in the mobility sector are mainly SDG 1, 2, 3, 5, 6, 8, 10, 12, 14, 15, 16 and 17. For more information, see the Renewable Energy Sector Roadmap (Kügerl 2021).

Recommendations:

- Support achieving SDGs, especially SDGs 1-3, 5, 6, 8, 10 and 14-17

- **Zero financial crime**



Financial crime such as corruption, fraud, money laundering and financing terrorism leads to several problems in the supply chain, such as poor and unequal pay and environmental pollution. Financial crime exists among policy makers as well as in industry and needs to be eliminated. Industry, like policy makers, can refer to corruption risk indicators. When possible, they should not establish sites in areas where financial crime has been proven to occur or ensure through contracts that it is prevented. With regard to traceability, see the milestone 'standard for tracing raw materials' (Chapter 2.2.1).

Recommendations:

- Ask for audit reports of suppliers
- Check contracts for corruption risk indicators

- **Set goals for the local & regional development of producing locations in all value chain steps including recycling**




As a continuation of the 2025 milestone, industry needs to set goals for the local and regional development of producing locations in all value chain steps. Recycling needs to be included. These goals should also be part of the overarching sustainability strategy of the company with short-term, mid-term and long-term goals. The company should monitor and report on the criteria on a yearly base and review the long-term targets every five years.

Recommendations:

- Set long-term goals for local and regional development in the sustainability strategy and review the goals every five years.
- Monitor and report the criteria yearly


- **Within the EU, 100% of minerals/semi-products purchased come from responsible sources or recycling processes**

 From 2030 within the EU, all minerals and semi-products should come from 100% responsible sources. This ensures that the companies also meet the conflict-free mineral supply chain requirements. Manufacturing companies should therefore always favour sustainable or sustainably recycled material for production and purchased semi-products, irrespective of the price. The additional recommendations mentioned previously should also be followed.

Recommendations:

- Target group certification / standard schemes: develop a discussion group on how to deal with and accept other standards
- Implementation of supply chain reporting on all minerals
- Exchange information with other companies and make responsible sourcing known to the public. Use the power of the automobile market
- Start discussion with mid-stream on their requirements and push for responsible sourcing
- Always favour sustainable or sustainably recycled material for production and purchased semi-products (irrespective of price)

- **SLO successfully implemented for new mines, cell production and recycling sites; good practice cases for successful SLO in existing mines and sites**


 Companies involved with LIB supply chain have to implement SLO for all new mines, cell production and recycling sites. Producers and suppliers of raw materials can achieve this by making it mandatory for purchasing contracts. The milestone is supported by legislation. However, operators should ensure that the SLO continues in further operation until post-closure, as well as for existing mines and sites.

Recommendations:

- Make SLO for new mines and cell production and recycling sites mandatory for purchasing contracts

2.2.3 Milestones 2040

- **100% minerals/semi-products purchased come from responsible sources or responsible recycling processes globally**

 By 2040, 100% of the minerals and semi-products purchased need to come from responsible sources or responsible recycling processes globally. This can be achieved by strengthening the demand for sustainable and recycled products together with other automobile industries and all preceding recommendations.

Recommendations:

- Strengthen the demand for sustainable and recycled products together with other automobile companies
- Follow all previous recommendations

2.3 Target 3: Level Playing Field

The consultation process showed that the development of a level playing field (not only) for the mobility sector needs to be one of the major targets in a roadmap for responsible sourcing in the mobility sector. The current system focuses on producing the cheapest product, mostly ignoring the way in which the products are produced and their quality or durability. This system encourages companies to locate production in countries with low social and environmental standards and is based on a ‘throwaway society’.

With globalisation, supply chains do not end at EU borders, so the RE-SOURCING project supports the idea of a joint effort to reach more responsible supply chains globally. The roadmap not only encourages the introduction of requirements for social and environmental standards for doing business in the EU but puts forward milestones and recommendations that include cooperation with and support for companies, organisations and governments that currently do not fulfil those requirements globally.

A level playing field should achieve a fair distribution of costs and benefits along the supply chain.

In the discussion about a level playing field, seven main issues are of relevance:

- Quality over Price
- International cooperation
- Producer Responsibility
- Polluter Pays and Border-Tax Adjustment
- Harmonisation of mining and production policies
- Harmonisation of sustainability and reporting criteria
- Formalisation of artisanal and small-scale mining (ASM)
- Mandatory minimum standards

In the beginning of each chapter, figures provide an overview of the milestones for supporting the target of level playing field identified in the project. To achieve these milestones, a set of recommendations for actions are outlined. In the following sub-chapters, the milestones and recommendations are developed for the different stakeholder groups: EU policy makers, internationally operating companies and CSOs.

In the sub-chapters, the milestones are given as bulleted lists in bold type. The explanations and their recommendations follow each milestone. For quick access to the recommendations for action, these are summarised in the coloured boxes at the end of each milestone.

For industry the following sub-targets are essential to achieve a level playing field:

- Find a common understanding of sustainability criteria and responsible standards (first in the EU, then globally)
- Build transparency along the supply chain
- Support the formalisation of ASM and projects on the ground

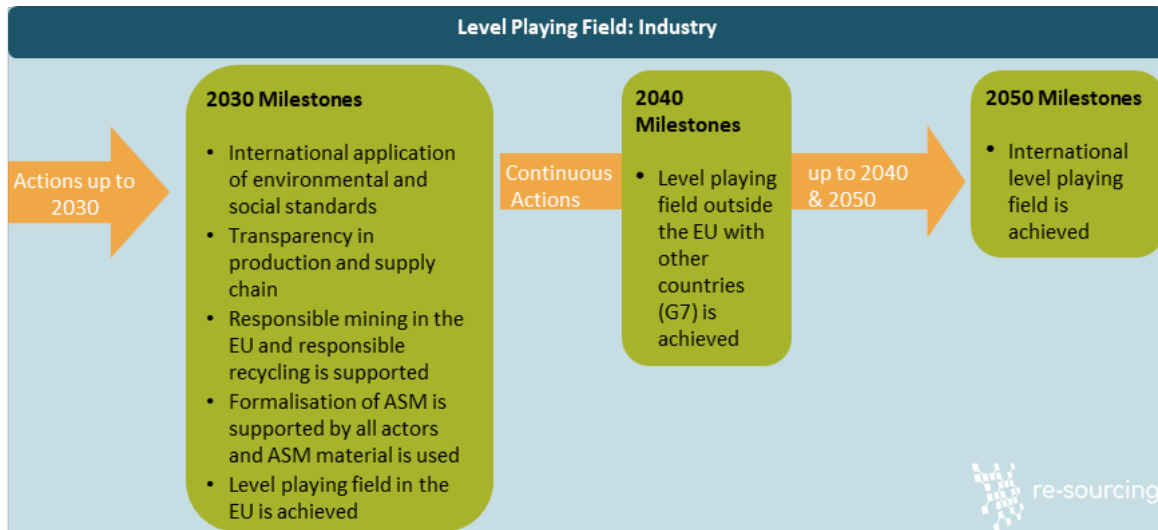


Figure 9: Milestones for industry towards a level playing field by 2050

2.3.1 Milestones 2030

- **International application of environmental and social standards**



Industry actors in mining, cell production and recycling need to apply environmental and social standards – not only within the EU but also maintain the same high standards abroad. For the mining sector, strong standards have already been developed.¹⁶ The proposal for the EU Battery Regulation has sustainability criteria in place for the production step in order to achieve a level playing field. For recycling an appropriate standard needs to be developed. These standards need to be applied globally. As sustainability issues are becoming more and more relevant to the public, companies can try to be frontrunners and achieve a competitive advantage. Institutions like the Global Battery Alliance can also implement overarching criteria on sustainability from the beginning to broaden the network outside the EU.

It is not only the highest standards that need to be developed and promoted. Minimum standards also need to be agreed globally, with the aim of improving to the highest level within a given time frame.

Through compliance or non-compliance with these sustainability standards, taxes can be lower or higher, depending on the level of sustainability fulfilment.

Recommendations:

- Common understanding of minimum and high-level standards with improvements over time
- Taxes depending on compliance / non-compliance with standards

¹⁶ The definition of a strong standard is provided in the good guidance document on the mobility sector (see Degreif et al 2022)

- **Transparency in production and supply chain**



Transparency is key to understanding the status of production and the associated value chain. This refers to mining, cell production and recycling. Transparency in the supply chain is only achievable when all actors in the supply chain participate. An OEM needs to receive information from the supplier on their chain to have an overview of the complete supply chain of the LIB. Transparency in the supply chain as well as transparency in sustainability information for production is included in this milestone.

For producing companies, it is important to make the suppliers aware of the transparency approach and to encourage other companies in the supply chain and also the producing companies to follow suit. With the transparency approach, an open exchange with NGOs/CSOs and policy about information expresses a willingness to work transparently and to discuss the information. This can lead to building trust between industry, policy and NGOs/CSOs, as industry not only discloses information when asked but is proactive in publishing data.

For mining companies, the decision to follow a strong standard with a high level of transparency like IRMA is associated with a mandatory detailed public report and engagement with local stakeholders such as workers and local communities.¹⁷

Recommendations:

- Start transparency approach in your supply chain
- Be transparent at your own production site

¹⁷ For further descriptions on a strong standard, please see the good practice guidance document on mobility on the RE-SOURCING website (<https://re-sourcing.eu/reports/d53-guidelines-for-mobility-sector-final-20220629-final-style-guide/>)

- **Responsible mining in the EU and responsible recycling is supported**



The current geopolitical situation in Europe forces a discussion about mining on EU territory. The broad attitude of ‘not in my backyard’ is a challenge for mining in the EU. There is often a lack of awareness of what materials are needed not only for LIBs but also for buildings, cars, bikes, electronics, energy infrastructure, etc. An exchange and discussion between industry, policy and CSOs/NGOs (including local communities) on a level footing within the EU is necessary to exchange points of view and discuss the arguments. There is a need not only for an awareness of the necessity of raw material production, but also the mining activities need to change to become responsible/sustainable¹⁸. Before opening new mines, there should be a focus on the responsible secondary raw material supply and a support for this from policy. The supply of responsibly sourced secondary raw materials from the EU should be supported and favoured compared to virgin material (see also target 1).

Recommendations:

- Open exchange and discussion on an equal footing between industry, policy and CSOs/NGOs on mining in Europe and why it is needed in a responsible/sustainable way.
- Open exchange and discussion between actors on responsible recycled material, their acceptance, supply and demand

- **Formalisation of ASM is supported by all actors and ASM material is used**



There should be no ban on ASM material, as it is crucial for the livelihood of thousands of families. To support the formalisation of ASM, producing companies can be active and support the formalisation of ASM on the ground via pilot projects such as those by BMW (2020), Hanrui (2020) and Huayou (2022). In addition, the pilot projects on ASM material should have easy access to the market and ideally be used in the companies’ production as at BMW. Industry support for ASM formalisation on the ground should be in close cooperation with local governments and of course with the local ASM sector and CSOs. A common minimum standard on ASM formalisation and high-level targets should be agreed upon jointly with industry, policy and NGOs/CSOs. High standards such as Fairmined are not manageable for all ASM actors, as the implementation and application involve a lot of administration.

Recommendations:

- Pilot projects on formalisation of ASM on the ground
- Minimum standard for ASM formalisation and target of ASM formalisation

¹⁸ For further details about sustainable management in extractive industries in Europe please see the information and a framework on the SUMEX projects website <https://www.sumexproject.eu/>

- **Level playing field in the EU is achieved**



With the above-mentioned milestones and recommendations, the level playing field in the EU should be achieved in 2030 in the steps mining, production and recycling. Companies have recognised their responsibility and apply the same high standards to social and environmental aspects in all the countries where they operate.

2.3.2 Milestones 2040

- **Level playing field outside the EU with other countries (G7) is achieved**



In France, Germany, and Italy, the level playing field should already be achieved in 2030. The involvement of the other G7 Member States is already included in the milestone ‘Supply Chain Due Diligence is included in all Trade Agreements within G7 for all materials and kept at highest priority’ in the target responsible procurement and serves as a basis for a level playing field.

With the agreements mentioned in the policy makers recommendations above, EU industry players should always have in mind and strengthen the level playing field approaches in their contracts with the G7 members (G7 members outside EU: Canada, Japan, the United Kingdom and the United States).

Recommendations:

- Continuous discussion and exchange on level playing field standards in contracts with G7 member states

2.3.3 Milestones 2050

- **International level playing field is achieved**



By 2050, a global level playing field should be achieved in mining, cell production and recycling. Based on the EU-wide and G7 agreements, international application of equal environmental and social standards is reached. A globally accepted framework on ‘good enough’ practices and also best practices provides information and examples from industry.

Recommendations:

- Follow the recommendations above on sustainability criteria, transparency, ASM formalisation and communication

2.3.4 Role of International Organisations (UN/OECD/IFC)

The LIB supply chain is very complex and has a globally interlinked structure. This applies not only to the LIB sector but also to renewable energy and electronics.¹⁹ It is therefore important that international organisations, such as the United Nations and OECD, are strengthened. These organisations can make an important contribution to a level playing field and to harmonising requirements for companies globally. To make it easier to hold internationally active companies accountable for financial crimes as well as crimes against the environment and humanity, the role of the UN's international justice system should also be extended to companies.

The UN, OECD and IFC already provide important templates for responsible behaviour by international companies in general. In addition, there are specific guidelines for mining, manufacturing, and responsible sourcing of raw materials, all either specific to or applicable to the commodities under consideration. These guidelines need to be implemented by member states on a mandatory basis and without delay, thereby also supporting an international level playing field.

¹⁹ See also the [roadmap on renewable energies](#) and the [state-of play report on electronics](#).

3 Conclusion of the overall Roadmap

Even though the roadmap has a time frame until 2050, it is clear that there is no time to waste - we **need to act now!** Changes are needed and cannot be postponed to the next generation or next legislation period. All targets need to be addressed simultaneously and all with the same importance and power from the stakeholder groups. The targets are also interrelated, e.g., to make procurement sustainable by obtaining only responsibly recycled materials, the latter is needed on the market.

One of the key findings of the roadmap and the consultations is the importance of **communication and cooperation between stakeholders along the whole value chain** for all three targets: none of the targets can be resolved by only one stakeholder group. Challenges must be tackled together without ending relationships when problems arise.

A **change in thinking** is needed for all actors – policy makers (e.g., by setting overarching regulations with concrete criteria), industry (e.g., by implementing quality over price), civil society (e.g., by promoting good practice cases) and also the general public (e.g., a change in transport behaviour) – who need to understand, support and embrace the new way of thinking.

A **shared goal** must be pursued. This must be addressed through joint actions with the different stakeholder groups (policy, industry and civil society). The decisions that are taken need to follow this common target to build trust between the stakeholder groups and among the general public. This is also the basis for a change in behaviour. Frontrunners and role models are needed in all stakeholder groups where others can follow.

This roadmap supplies only very few specific details on actual data for increases or decreases. Further **research** is needed to set ambitious but realistic targets and be as precise as possible to define the necessary measures.

A variety of recommendations are developed for all stakeholder groups. Some are specifically for the project's focus on lithium-ion batteries (LIBs) with the materials lithium, cobalt, nickel and graphite. However, recommendations are identified that are valid for other raw materials and other sectors and technologies. This underlines the complexity of raw material supply chains and the interlinkages between the different sectors.

The overview of the three main targets is illustrated in the roadmap figure (see Figure 10). **Target 1 'circular economy & decreased resource consumption'** needs fundamental changes in transport behaviour and also systemic changes for the recycling and use of secondary raw material. By 2040 the circular economy needs to be implemented for LIBs in the EU. In addition, the resource intensity of batteries should be reduced by more than 50% compared to 2021. By 2050 the primary resource consumption for traction batteries needs to be reduced by more than 80% in the EU compared to 2035 and ICEs should no longer be on the roads globally.

The recommendations for **Target 2 'responsible procurement'** and **Target 3 'level playing field'** need to be implemented as soon as possible in order to first reach a common understanding of a 'sustainable product' in the EU and abroad as a basis for implementing a fair distribution of benefits and burdens in the transition to e-vehicles. Responsible procurement in all EU firms (including SMEs) needs to be implemented by 2040, and globally by 2050 at the latest. A level playing field should be achieved within Europe in all three pillars of sustainability by 2030 and globally by 2050 at the latest.

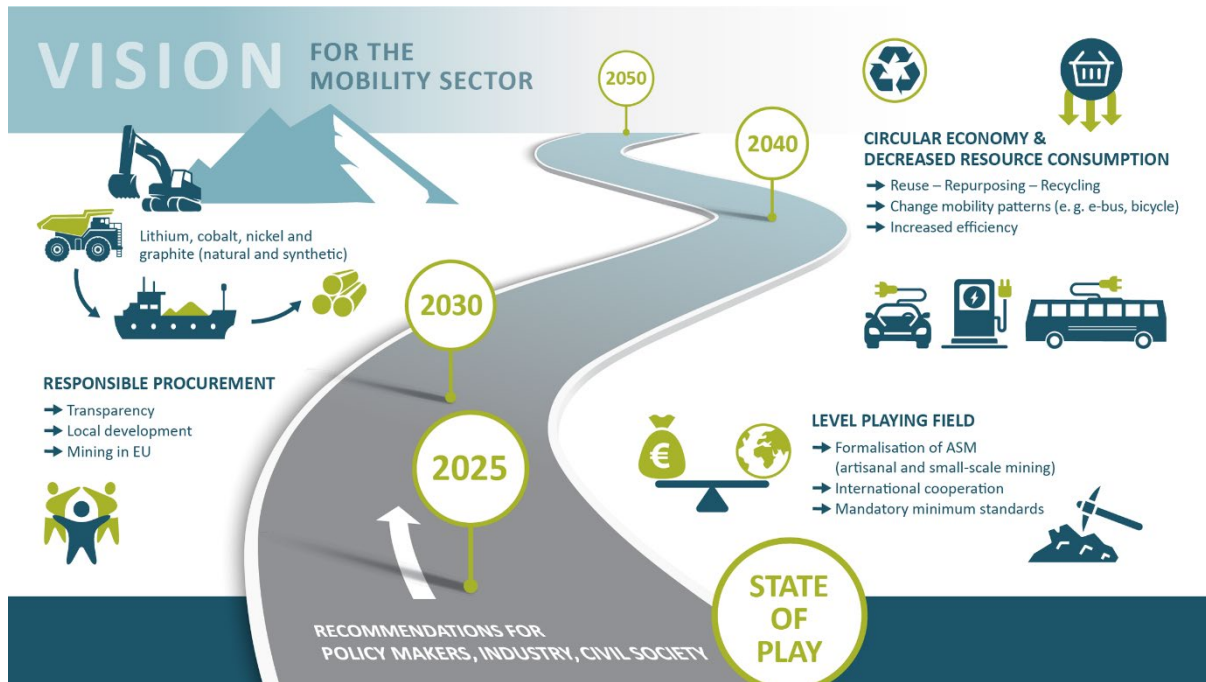


Figure 10: Roadmap for the mobility sector up to 2050

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