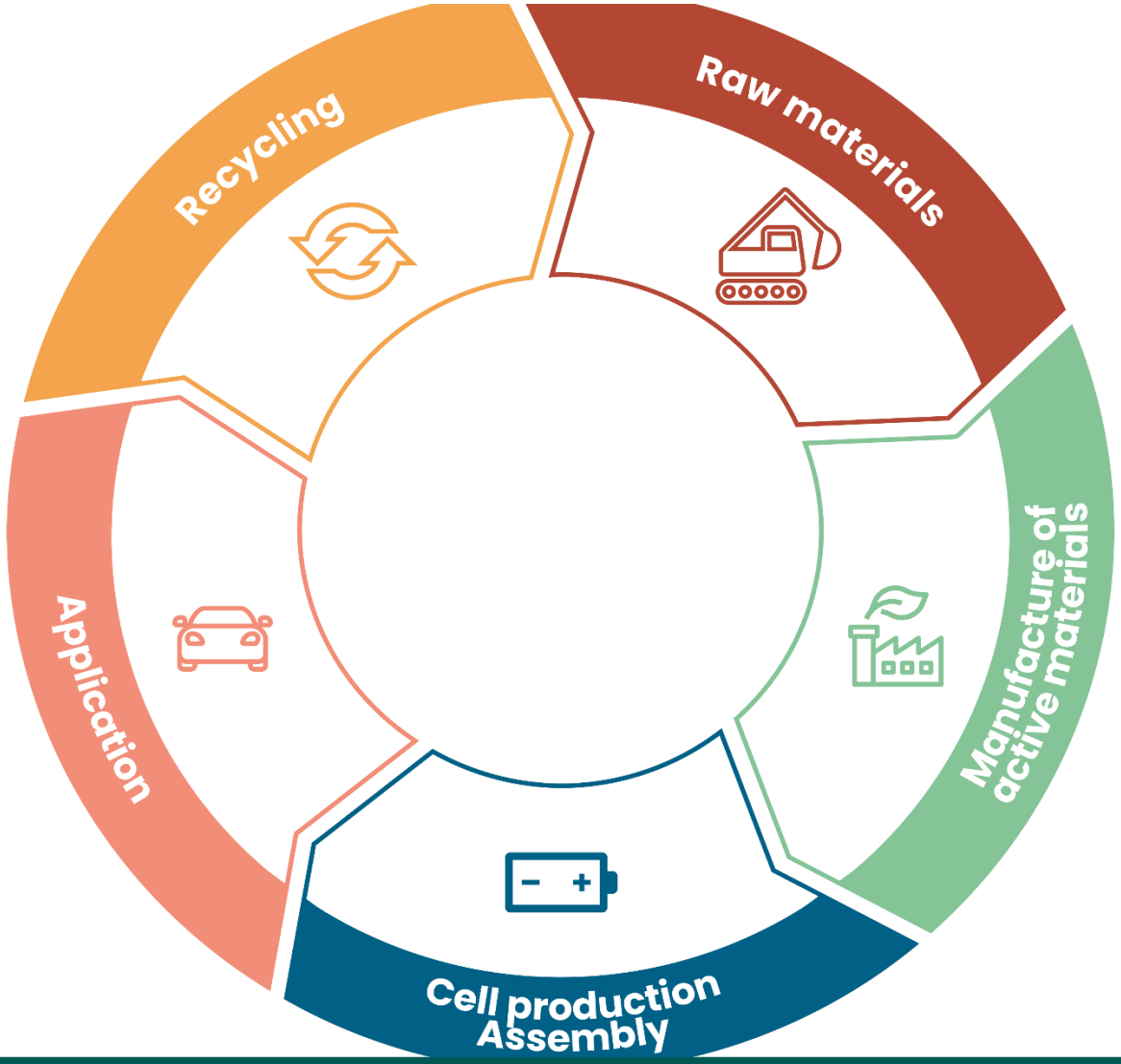

Environmental challenges of the battery value chain in the Nordic countries

Pre-study

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Sustainable battery value chain in the Barents region

2023-2025

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The background of the project

Demand and production of batteries is increasing and large investments to boost the green transition are ongoing in the Nordic Countries. This requires better understanding of the environmental challenges and risks in the battery value chain. The battery value chain covers different operations such as mining, metallurgy, battery chemicals production, assembly, the use of batteries as well as reuse and recycling. Batteries require raw materials (e.g., Nickel, Cobalt, Graphite, Copper, Iron, Aluminium) found and extracted in the Nordic countries. Large scale production of battery chemicals is a rather new and fast developing business in the Nordic and new facilities are being constructed.

Legislation and different strategies and programmes related to Green Transition have been developed both on EU and national level, such as the Battery Regulation[1] and Critical Raw Materials Act[2] (CRMA) and the revised Industrial Emissions Directive[3] (IED). These contain new policy instruments that steer the national objectives in Member States.

The EU battery regulation aims at more sustainable, circular and safe batteries. It regulates the entire life cycle of batteries: including extraction of raw materials, manufacturing, use and recycling of batteries. The battery regulation supports the implementation of the European Green Deal[4] and the Circular Economy Action Plan[5].

The CRMA aims at ensuring a secure and sustainable supply of critical raw materials (CRMs) in EU and to increase the Union's capacity along strategic raw material value chains. It also entails lower dependencies and diversified imports of strategic raw materials and promotes circularity and resource efficiency. The aim of CRMA is also to have smoother permitting processes and to establish national programs to e.g., incentivize technological progress and resource efficiency and promote waste prevention and increase re-use and use of secondary CRMs.

The Industrial Emissions Directive was updated in 2024 and since then mines producing certain metals and production of batteries in gigafactories has been included in the scope of the IED. The process for developing the EU Best Available Technique Reference Documents for metal mines started in 2024 and in 2025 for production of batteries in gigafactories.

All these recent legislative processes concern all the Nordic countries and affect their administrative procedures, such as environmental permit process. Cross-border cooperation concerning battery value chain has been established under the umbrella of the Barents cooperation between the environmental authorities in Finland, Sweden and Norway. The Sustainable green transition in the Barents region (BAVIS) project utilised this network and exchanged experiences and knowledge between permitters, supervisors, environmental experts, Sámi right holders and researchers from the Nordic countries. The aim of the project was to identify the main environmental issues in the battery value chain and future study needs in the Nordic countries.

Main environmental issues in the battery value chain

The project held in total three workshops accompanied with site visits in Finland, Sweden and Norway to one mine with integrated battery chemical manufacturing, one battery gigafactory, one metal smelter and

[1] 2023/1542/EU
[2] 2024/1252/EU
[3] 2010/75 amended by 2024/1785
[4] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en
[5] https://environment.ec.europa.eu/topics/circular-economy-topics/first-circular-economy-action-plan_en

one battery recycling company in 2023-2024. The workshops addressed different battery value chain topics related to the site visits and were attended by experts from each country. Based on the site visits and workshop findings the project concluded that mining and battery manufacturing are the most significant phases of the value chain concerning environmental impacts. More specifically, the project identified the following issues as the main environmental challenges in the Nordic battery value chain: land use associated environmental and socio-cultural impacts, waste management, water use and management and chemical risks.

Land use issues are an important factor in assessing both environmental and socio-cultural impacts. Metals needed in battery production are mostly available in the norther parts of the Nordic countries, and mines producing these metals require extensive amounts of land. In contrast to other production plants, mines can't be relocated, which may lead to land use conflicts. At the same time, there is pressure to speed up environmental permit processes and other administrative procedures contributing to green transition. To facilitate safe, sustainable and fair green transition, both environmental and socio-cultural impacts of the planned operations should be carefully assessed and considered. This requires time and resources.

Special consideration should be put to waste and water management and on water use in different stages of the value chain. The mines use significant amounts of water and produce large quantities of waste, but also battery chemicals factories can produce remarkable amount of waste, including chemical waste, scrap metal, and plastic materials. Measures for mitigating the impacts on soil, groundwater and surface water in short and long-term are important throughout the value chain.

Other significant environmental issues identified by the project are impacts on climate and biodiversity. The biodiversity challenges in the battery value chain were considered the highest in the mining phase. Dust emissions from the mines were highlighted in the project workshop as significant environmental issue.

Measures such as reuse, remanufacturing or repurposing, can extend the useful life of batteries, and hence reduce the need for extraction of new raw materials as well as minimise life-cycle energy consumption and emissions. However, if the battery's capacity is significantly reduced, the damaged cells cannot be replaced or the battery chemistry is outdated, recycling is the final option to reclaim precious and scarce metals and reduce the pressure on natural resources. The EU Battery regulation aims at facilitating both measures extending the use life of batteries, and recycling of the battery raw materials. Technologies and systems for these are still under development and comprehensive assessments of the environmental, economic and social impacts of alternatives are required to find the most sustainable options and methods.

Battery chemical manufacturing operations may have various case-specific risks since the operations may differ significantly. Manufacture of battery chemicals requires various chemicals, and the chemical risks are a key challenge also for occupational health. Accidents, such as fires or contamination of soils from spills, often pose a larger threat to the environment compared to "regular" emissions to water or to air from battery chemical factories. Extreme weather events may cause more risks in the changing climate.

In addition to environmental issues, the socio-cultural impacts of battery value chain are important to consider in the administrative procedures. For example, environment permit processes could be faster and smoother if the planning policies would e.g., set realistic targets, have better communication and if stakeholders were involved at an early stage. Sustainability and social acceptance is a pre-requisite for increased battery value chain activities in the Nordic countries.

Future study needs

During the project the following topics requiring more research were identified:

1. Environmental impacts of different processes and stages of the battery value chain, including abatement techniques.
2. Recycling, reuse and repurposing practices of batteries and battery materials.
3. Management of chemical risks in different stages of the value chain.
4. Socio-cultural aspects related to just green transition and public participation in administrative procedures.
5. Harmonised implementation of EU legislation applicable to the different stages of the battery value chain.