D3.1.2 Study on market and value chain specificities of ESEE partnership countries

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Contents

Abstract

'D3.1.2' – Study on market and value chain specificities of ESEE partnership countries – is designed to enhance partnership knowledge of the Lithium-ion Battery (LIB) value chain in the ReLi-ion countries. It is a follow up deliverable of methodology D3.1.1, valorising the research conducted by project partners for the identification of LIB market specificities in their respective territories. Countries examined in this study are Slovenia, Greece, Czech Republic, Poland, Hungary, and Romania. This deliverable is a milestone for the successful completion of WP3, which aims to enable project industry partners engage in business synergies with relevant business and policy stakeholders.

Overall, D3.1.2 elaborates on territorial LIB collection systems, Nickel Manganese Cobalt (NMC) and (Lithium Iron Phosphate) LFP circulation, current processing and recycling facility technologies, as well as LIB market trends and barriers. Findings suggest that LIB markets in the ReLi-ion countries are gradually adopting more systematic and efficient production, collection and recycling processes. Market trends - the most important being the expansion of the e-mobility sector - are expected to boost the LIB industry exponentially in the future. A key recommendation coming from this study is that public authorities should establish more elaborate monitoring systems for LIB circulation, to enhance information flow among the LIB value chain actors.

Introduction

“D3.1.2 – Study on market and value chain specificities of ESEE partnership countries – aims to describe and analyse territorial (LIB) market value chain specificities, emphasizing on aspects and data relevant to LIB recycling. Key elements described in this deliverable relate to territorial LIB recycling waste supply (focusing on NMC and LFP batteries), collection systems, existing LIB recycling facilities and an overview of case-specific market trends and barriers. The data used in this report were provided by partners throughout the course of D3.1.1, which assisted consortium members in conducting market mapping research on domestic LIB value chain specificities. Countries of interest for both deliverables are: Slovenia, Greece, Czech Republic, Poland, Romania and Hungary. The last two were included, in order to get a better grasp of the LIB market in the ESEE region.

The purpose of this study is manifold. On the one hand, D3.1.2 aims to increase partnership knowledge of the primary ReLi-ion markets. An extended awareness of territorial market specificities will enhance the project viability potential and increase growth prospect the of the ReLi-ion technological approach. Furthermore, D3.1.2 will offer a comprehensive understanding of LIB market dynamics, opportunities, and challenges in the battery recycling industry. More importantly, the study will allow ReLi-ion partners designed tailor-made commercialization strategies for each target country, based on territorial LIB market particularities.

The following section is an outline of WP3 and activity D3.1.2. Section 3 elaborates on the study findings, examining case-by-case results. The last is a conclusion of the study’s main assumptions, followed by an Annex with all data collection forms, as submitted by partners.

Work Package 3

WP3- Mapping market specificities and liaising with value chain actors- is designed to lay the ground for the commercialization of the ReLi-ion technological approach in the target countries. Overall, this WP supports the completion of project goal 2, which refers to the development of an integrated LIB collection, treatment and recycling network across the ESEE region. Furthermore, WP3 aims to diffuse the ReLi-ion know-how across the partnership countries and effectively set the stage for the uptake of the project technological approach. To successfully realise these objectives, ReLi-ion participants will complete 3 activities and 5 deliverables.

Task	Deliverables
T3.1 – Elaboration of market and value chain specificities in ESEE partnership countries	D3.1.1 – Methodology to guide data collection
	Data collection
	D3.1.2 Study on market and value chain specificities
T3.2 – Liaising with waste suppliers, LIB manufacturers & RIS value chain actors	D3.2.1 Guidelines to partners
	Data collection
	D3.2.2 Mapping report
	D3.2.3 Inventory of actors mapped
T3.3 – Analysis of regulatory frameworks and waste management processes	D3.3.1 – Report on regulatory framework and waste management processes

WP3 deliverables will assist partners:

1. Conduct a comprehensive territorial assessment of the Li-ion battery waste, as well as CRM supply and the demand;
2. Identification and establish business synergies with relevant stakeholders active in the LIB recycling value chain;
3. Analyse and document the regulatory landscape concerning the handling of End Of Life (EOL) LIBs in the participating countries of the RIS region.

2.1 Activity 3.2

This activity entails the exploration of territorial LIB value chain particularities, aiming to expand upon the market analysis carried out during the development phase of the proposal, focusing on the countries comprising the ReLi-ion consortium. Available data for conducting the D3.1.2 study was provided by partners (D31.1) who were asked to identify LIB waste streams volumes and collection methods, emerging market trends and developments in the industry, as well as potential factors that may influence battery cells EOL volumes, in the countries assigned to them. Therefore, this deliverable is the follow up market analysis, summarizing and presenting all territorial information given by partners in D3.1.1. PROMEA has developed and distributed both D3.1.1 and D3.1.2.

A thorough market analysis will help partners assess the demand and potential for LIB battery recycling services. It will also enable them to understand the size of the market, identify key market segments, and evaluate the ReLi-ion growth prospects. This information will be crucial for making informed decisions about the viability and profitability of the project, considering that the D3.1.2 findings will be utilized by partners at the commercialization phase of the project. Furthermore, having a detailed overview of existing technological capacities of the target countries allows for the examination and comparison of various options based on their performance characteristics, energy density, cycle life, safety features, cost, and other relevant parameters. Hence, partners will be able to better estimate the volume of LIBs that can by processed and recycled at each respective country and adapt the ReLi-ion business development plan accordingly. Market trends and barriers is another important parameter when investigating LIB market value chain characteristics. Monitoring trends and barriers relevant to the ReLi-ion project will enhance partnership knowledge on emerging LIB recycling business models, consumer preferences and innovative recycling methods. The following chapter will delve deeper into the territorial data provided by partners.

Data Analysis

3.1 Poland

Collection Systems

Currently in Poland there are designated collection points for municipal waste, where one can deposit among others one's electro-waste and used batteries free of charge. Regarding the selling of new products, retailers placing electrical, electronic equipment and all types of batteries on the market are obliged to collect the equivalent type of equipment in waste from the consumers. Hence, all retail shops (including wholesalers) are effectively collectors of WEEE. Companies and public entities in possession of large quantities of any type of battery waste can dispose them at WEEE collectors.

Volumes of LFP and NMC battery cells collected

In 2022, **567 tonnes of LFP and 1647 tonnes of NMC** batteries were collected through official channels in Poland. There is no information regarding unofficial collection volumes. The following table summarises the sources of NMC and LFP batteries collected.

Sources of LPF and NMC batteries collected (in tonnes)		
LFP	Electric Vehicles	28
	E-Bikes	7
	Power Tools	-
	Energy Storage	255
	Other	277
NMC	Electric Vehicles	169
	E-Bikes	3
	Power Tools	250
	Energy Storage	1140

	Other	85

Recycling and Technologies

LIB recycling in Poland is implemented by a number of facilities, combining multiple technological approaches in processing and recycling of LIB waste. The table below illustrates the state-of-play of LIB recycling in the country, focusing on the recycling capacity of each facility, the technology mix used, as well as types of batteries recycled. As shown by the data, some facilities specialize exclusively in LIB recycling, while others include all types of batteries in their process.

Facility	Recycling Capacity	Technology Mix	Comments
Sung Eel Hitech, Bukowice	20 000 t/year	dismantling, thermal treatment, crushing, hydrometallurgical process of leaching, filtration and extraction	Li-ion batteries and rechargeable batteries of electric cars, bicycles, IT equipment, tools
Eco Hybres, Głogów Małopolski	20 000 t/year: 10 000 t/year Li-ion batteries, 5 000 t/year ZnC batteries, 5 000 t/year thermal/plasma processing of batteries	transportation, collection, sorting, processing, metal foundry	Li-ion, ZnC batteries
Stena Recycling, Warszawa	10 000 t/year	dismantling, sorting, distribution of raw materials	LTO, LFP, LMO, NMC, LCO, NCA batteries IT equipment, small appliances, flat-panel displays, large-

			format, refrigeration equipment
Karat Recykling S.A., Lubicz		collection, disassembly, processing	all types of batteries
Wastes Service Group Sp. z o.o. Kiełczów		disassembly, grinding, segregation, processing	Li-ion batteries
Eneris Recupyl Sp. z o. o. Stanowice	4000 ton/year	collection, transportation, manual - mechanical sorting plants for mixed batteries, mechanical processing lines, distribution of raw materials,	all types of batteries
Remondis Electrorecykling		intermediary entity: organizing collection, processing, recycling and disposal of waste batteries and waste accumulators and proper management of waste batteries and waste accumulators	
Baterpol s.a. Battery Scrap Processing Plant in Swietochlowice and Lead Plant in Katowice.		acquisition and processing of battery scrap, production of refined lead and lead alloys	
Elemental Holding	under construction; the expected		Li-ion batteries; the plant will produce secondary metals

	completion date is between Q3 and Q4 of 2023		and other materials that can be reused as inputs in various industries, in accordance with the principles of the circular economy

Trends and Barriers

A factor likely to affect the amount of EOL LFP and NMC batteries in Poland is the rapid expansion of both private and public entities responsible for increasing environmental awareness, especially in local communities. Actions also include social media and mass media educational campaigns. Furthermore, public/private cooperation aims to increase the number of collection sites for used portable batteries and battery accumulators, expanding the collection network near households. According to estimations, the amount of EOL LFP and NMC battery cells will increase by 61% by 2030. Also, actions target at improving the monitoring of battery products placed on the market, as well as of waste produced, collected and recycled.

3.2 Greece

Collection Systems

According to the stipulations of the EU Battery Directive, which is followed by the Greek authorities, scrap batteries are handed over to waste receivers who are responsible for direct or indirect recycling. For the moment, there are no LFP or NMC recycling plants in Greece, hence collected EOL or LFP/NMC LIB waste are exported to other countries for processing and recycling.

Volumes of LFP and NMC battery cells collected

Greece has no official data of LIB waste collection. Sunlight is the only LFP battery producer for traction and ESS applications in the country.

Recycling and Technologies

There are no processing or recycling facilities for LIBs in Greece, as confirmed by Sunlight.

Trends and Barriers

A trend that is expected to affect the amount of EOL LFP and NMC battery cells in Greece is the number of these types of LIBs exported. Currently, in absence of facilities for processing and recycling of Lithium-based batteries, all waste is transported to third countries for this purpose. Hence, the improvement of the collection system that clearly outlines processes and directions for LIBs would, as well as the establishment of processing and recycling facilities domestically, will likely increase the amount of EOL LFP and NMC battery cells in Greece. In addition, LIB appropriate facilities would attract the transportation of Lithium based EOL batteries in the Greek region. By 2030 project partner Sunlight expects to receive more than 2.5 ktn of EOL LFP batteries.

3.3 Czech Republic

Collection Systems

In Czech Republic there are two collection systems of spent LIB battery cells, operated by two EPR companies, namely ECOBAT and REMA. EPRs are responsible for collecting and distributing LIBs at the recycling facilities. Regarding the cost of the LIB lifecycle, according to the current EPR scheme, it is assigned to the producer.

Volumes of LFP and NMC battery cells collected

For 2022, which is the most recent measurement, **106 of LFP and 426 tonnes of NMC** were reported as collected through official collection channels. Regarding the sources of LIBs collected, there is no clear estimation. Evidence suggests that most LIBs come from power tools (and other portable devices), as the cells in other applications are used not long enough to be spent. Also, there is absence of data about unreported flows.

Recycling and Technologies

According to the research conducted by VŠCHT, there are no LIB recycling facilities in the Czech Republic.

Trends and Barriers

A factor expected to affect the demand of end-of-life LFP and NMC battery cells exponentially is the EU regulatory framework that limits the production and vending of combustion engine vehicles in Europe. It is expected that it will stimulate demand for EVs in the near future, boosting the need for vehicle LIBs. Currently there are no barriers in the collection of LIBs in

Czech Republic, however LIB recycling is not very developed, given the low supply of available LIBs. Furthermore, the process for constructing a recycling facility is extremely long, due to the bureaucratic obstacles set by the current regulatory framework. The growth of the EV sector, nevertheless, is expected to improve conditions for LIB recycling.

3.4 Slovenia

Collection Systems

In Slovenia LIBs are collected at dedicated collection points by authorized waste collectors. An EPR system has been established for all types of batteries, except for those used in cars.

Volumes of LFP and NMC battery cells collected

There is no available data on LIB waste collected. ReLi-ion partner ECOSIJ has estimated that **25 tonnes of LIB waste** have been collected in 2022. EV batteries are not included in this estimation, as car batteries are not collected by EPR organisations. Similar to other countries analysed in this report, there is no evidence regarding the source of waste collected. ECOSIJ estimates that most LIBs originate from power tools, laptops and phones. Lastly, there is no estimation or evidence pertaining to unreported flows of LIB waste in Slovenia.

Recycling and Technologies

LIB waste processing and recycling facilities do not yet exist in Slovenia. All batteries including LIBs are exported abroad for processing. However, there is a start-up company active in the reuse of Li-ion cells, although the technology is not yet developed for industrial use.

Trends and Barriers

According to the annual growth in the quantities of NCM and LFP battery collection, it is expected that by 2030, the annual growth of EOL LIB cells collected will increase significantly at around **100 tonnes**. The estimation takes into consideration the rise in the demand for EVs, which will be significantly higher in the near future. Currently, the biggest obstacle in the Slovenian LIB processing and recycling market is the amount of time required to obtain permits. The usual time needed is almost a year, factor that impedes companies from engaging in the processing and recycling of LIBs.

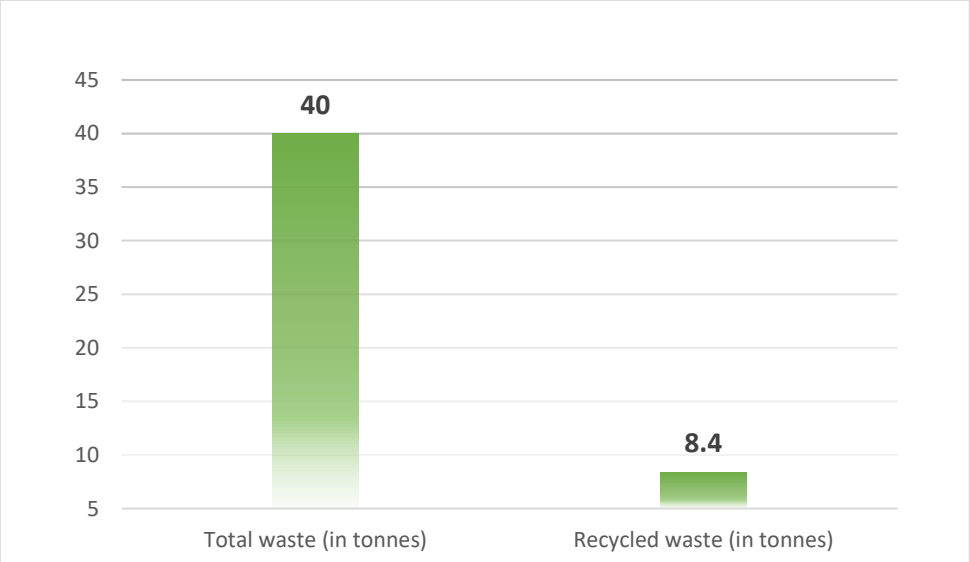
3.5 Romania

Collection Systems

In Romania there are some designated collection points where electronical waste, including used LFP and NMC batteries, are disposed. Retailers and distributors are key actors in the disposal process as they bear the cost of collecting and distributing Li-ion batteries at recycling companies. Furthermore, all retailers and distributors have in-store collection points installed, to ease the disposal of LIBs (among all WEEE). Furthermore, Romania has an EPR scheme, consisting of several organisations that are responsible for collecting, sorting and distributing WEEE at recycling facilities[1].

Volumes of LFP and NMC battery cells collected

There is no specific data regarding the types of batteries and their respective volume collected available. In 2020 Romania **generated 40 tons of waste of Lithium Batteries** according to Urban Mining Platform. Based on Eurostat[2] indexes **Romania recycles around 21%** of the generated waste, so an amount of 8,4 tons is estimated as the volume of the collected lithium batteries. The table bellow summarizes the amount of LIBs recycled in Romania in 2020.



[1] Rovinaru, F.I.; Rus, A.V. The Economic and Ecological Impacts of Dismantling End-of-Life Vehicles in Romania. Sustainability 2019, 11, 6446

[2] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Waste_statistics_-_recycling_of_batteries_and_accumulators

Recycling and Technologies

Currently, there are four recycling facilities for LIB recycling in Romania. In addition, there is rapid progress in the LIB recycle sector, which is actively supported by the National Recovery and Resilience Plan (PNRR). The Plan is estimated to grant domestic value chain actors a EUR 1.2 billion budget to improve the management of all types of waste by 2026. It also includes the establishment of 565 collection centers for voluminous or hazardous waste, such as batteries and construction packaging litter. The new centers will be installed in small communities with up to 50,000 inhabitants[2].

Facilities
Eco Electronic collect
Green WEEE
CNREE
Eco one

Trends & Barriers

According to recent studies, the quantities of EEE products, including LIBs is growth in Romania. Currently, the Romanian government subsidizes collection and treatment of WEEE including LFP and NMC batteries, given the increased demand for EVs[3]. At the same time, there has been an increase in the purchase of electric and hybrid vehicles, partly affected by the tax increase imposed by Romanian authorities on vehicles of 15 years of age and more. Overall, the growth of the EV industry is expected to stimulate demand for a more advanced LIB value chain for in the country[4].

However, there are still barriers for the collection and recycling of LIBs in Romania. First of all, the current EPR scheme does not implement modern practices for collection and treatment of LIB waste. An improved EPR scheme would increase the reuse and recyclability of LIBs, decreasing energy demand for LIB waste processing. Secondly, Romanian authorities have not yet adequately incentivized the shift from fossil fuel to electric vehicle technology. Such actions would boost Li-ion battery production market, as well as the need for better collection, processing and recycling practices.

3.6 Hungary

Collection Systems

Prior to 2012, the regulatory framework pertaining to packaging encompassed two distinct collection methods. First, the responsibility for planning the lifespan of both the packaged product and its packaging rested with the manufacturer (in the case of packaging waste), necessitating provisions for waste collection and recycling. Secondly, the entity responsible for the packaging was obliged to pay a fee resembling a tax, unless they achieved a satisfactory recovery rate for the emitted packaging waste. This recovery rate was incrementally raised annually.

With the introduction of new Waste Disposal Act[3], the system previously administered by Extended Producer Responsibility (EPR) schemes was discontinued, and the management of recyclable waste (including Lithium batteries) was transferred to the state. The Waste Act dictates that the environmental obligations and recycling targets imposed on the producers, distributors and retailers of any electronic product could no longer be fulfilled on an EPR basis.

In accordance with the legislation, the National Waste Management Agency was established by the state to assume responsibility for coordinating the collection recycling of WEEE from January 1, 2012.

Volumes of LFP and NMC battery cells collected

Hungary has generated 24 metric tonnes of LIB waste in 2020. Considering that the cumulative recycling rate of batteries is 46%, the collection volume of LIBs should be at around **11 metric tonnes per year**[4]. There is no available data regarding the sources of LIBs collected nor information about unreported flows. The graph bellow summarises the estimated amount of LIBs recycled in 2020, according to the available data.

[3] https://www.europarl.europa.eu/doceo/document/E-7-2013-007807_EN.html

[4] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Waste_statistics_-_recycling_of_batteries_and_accumulators&stable=0

Recycling and Technologies

Currently, there are three recycling facilities for LIB recycling in Hungary, however market trends indicate an increased activity in the EV manufacturing sector. Furthermore, the government actively promotes the expansion of Lithium battery manufacturing and processing, in conjunction with the rapid development of enterprises focusing on e-mobility[5]. There is no available information about the recycling capacity or any technology specific information regarding the facilities mentioned bellow.

Facility
JWH Kft.
SungEel HiTech
NIO Power

[5] https://source.benchmarkminerals.com/article/hungary-set-to-be-europes-leading-tier-1-battery-producer-this-decade

Trends and Barriers

Hungary has committed to a zero-emissions strategy by 2050, adhering to the milestones set by the European Green Deal. Hence, the LIB battery sector is seen by public officials as key industry for achieving climate neutrality within the given timeframe. The most recent Battery Strategy[6] outlines an ambitious action plan involving all aspects of the LIB value chain (production, collection, recycling). Primary objective is to make Hungary a 'Battery Hub', emphasizing on the LIB market. Furthermore, the government has signed agreements with several Asian companies, which are considered 'key players' in the LIB production and recycling sector, to expand their business activities in the country. The rapid expansion of the EV industry in Hungary further increases demand for processing of LIBs and Raw Material recovery. In addition, public transport systems are incentivised to transition to electrification, growing the need for LIBs specifically developed for electric fleets. Government plans also pinpoint the incorporation of VG1 (smart charging) and VG2 (grid balancing) technologies, to better capture the market surge of e-mobility.

There are, however, several market barriers inhibiting the undistorted growth of the LIB sector. First of all, infrastructure capacities are not yet adequate to support a large-scale collection and recycling of LIBs. Considering the EV sector boom in Hungary, it is important for collection and recycling facilities to adapt their technological capacities accordingly. Secondly, the workforce lacks capacities to staff facilities active in the production, treatment and recycling of Libs. Third, regulatory progress needs to be made to constitute the collection and recycling market more flexible and less bureaucratic. Lastly, the LIB sector is dominated by large-scale companies, resulting in an uneven market distribution. SMEs need to be actively supported by government officials, to prevent the creation of an oligopolistic market. Lastly, a more transparent documentation of LIB volumes circulated in the market (either for purchase or collected for processing/recycling) would motivate more actors actively engage in the domestic value chain. Currently the lack of information on LIB flow is a constraining factor.

3.7 Summary of key findings

In sum, Poland seems to have, so far, the most developed market for LIB battery and this involves all value chain aspects, from production to processing and recycling. There are a number of facilities active in LIB processing and recycling, while an extended EPR system ensures the undisrupted collection of LIB waste (among other e-waste). Similarly to the rest

[6] https://hungarianbatteryday.hu/wp-content/uploads/2021/10/Kaderjak-Peter_Hungarian_Battery_Day_Ministry-for-Innovation-and-Technology_Strategy.pdf

of the countries covered in this report, the EV market growth will improve market conditions for LIB recycling. Therefore, ReLi-ion could find a fertile ground for business synergies in Poland. The common trend among all participating countries is the rapid expansion of the EV market. Even if currently conditions for LIB recycling are not particularly developed, especially in countries such as Greece and Slovenia, market rends indicate a rising demand for Lithium-based products, due to the surging demand for EVs. Furthermore, public authorities in all ReLi-ion countries, including Hungary and Romania, have outlined elaborate strategies to support business development in the LIB industry, while simultaneously promote the gradual transition from fossil fuel-based to electric mobility.

A barrier evident in most countries is, nevertheless, the absence of sophisticated LIB recycling facilities and a well-educated workforce. Furthermore, even if LIB recycling facilities exist the practices implemented are outdated and fail to capture the full capacity of LIB recycling. ReLi-ion could effectively fill this gap, transferring the project's innovative technological approach among targeted countries. Overall, evidence suggests that in the short and medium term, the ReLi-ion technological approach has the potential to be successfully transferred and commercialized in these countries, considering the emerging trend for EV market development. The establishment, however, of LIB processing and recycling facilities would prohibit the export of LIBs in third countries and further accelerate the adoption of the ReLi-ion technology. Lastly, a regulatory development likely to affect the collection system of LIBs in the participating countries, is a recent update in the End-Of-Life Directive. This development aims to determine conditions for EOL EVs, including the lifecycle of the batteries. So far, no EU member state has transposed this update into national legislation, considering that it was adopted by EU officials in June 2023. The aim of the update is to establish EPR schemes for the collection and recycling of used EV batteries. If implemented by the ReLi-ion countries, this regulatory development will overcome a legislative 'gray area' that did not specifically account for EV LIBs, which was caused primarily by the fact the EV waste streams did not have a significant market share in 2013, when the Battery Directive was amended.

Conclusion

D3.1.2 –Study on market and value chain specificities of ESEE partnership countries – is a summary report describing the current state-of-play of the LIB markets in the ReLi-ion participating countries (including Romania and Hungary). The study has provided a detailed analysis of the territorial conditions for LIB collection, processing and recycling. In addition, D3.1.2 has described domestic LIB circulation volumes, where relevant data was available. More importantly, the deliverable effectively identified key trends and barriers in the project respective territories that could promote or inhibit the development of the ReLi-ion technological approach. Even though data availability was not in all cases abundant, information is certainly adequate to provide an overview of territorial LIB market specificities. In smaller countries such as Slovenia and Czech Republic, for instance, there is little or no knowledge about the current LIB volumes recycled on a yearly basis. However, based on the data provided by partners, it has become clear that the rapid development of the EV industry in the ESEE region is a common factor, likely to positively affect the commercial success of the ReLi-ion project. Overall, the expansion of e-mobility in these countries, along with the intense support the industry enjoys from domestic policy makers will accelerate demand for LIBs exponentially. Therefore, market conditions, as well as the anticipated market developments pertaining to the LIB value chain are seen as favourable for the commercial success of the project.