CLUSTER HUB

PRODUCTION OF RAW MATERIALS FOR BATTERIES FROM EUROPEAN RESOURCES

CONSIDERATIONS FOR R&I PRIORITIES IN EUROPE'S BATTERY RAW MATERIALS CHAINS

Insights from EU-funded projects in the Cluster Hub "Materials for Batteries"

With contributions from:

BATRAW

LiCORNE

GR4FITE3

RELiEF

MaaSiveTwin

Horizon Europe projects working on mining, processing and recycling of battery raw materials

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List of acronyms

BEPA	Battery European Partnership Association
CRMA	Critical Raw Materials Act
ECA	European Court of Auditors
EIC	European Innovation Council
EOL	End-of-Life
ERDF	European Regional Development Fund
EU	European Union
EUSEW	European Sustainable Energy Week
EV	Electric vehicles
FOAK	Frst-of-a-Kind
IED	Industrial Emissions Directive
IP	Intellectual Property
IPCEI	Important Projects of Common European Interest
LFP	Lithium Iron Phosphate
Li	Lithium
LiB	Lithium-ion battery
LMFP	Lithium Manganese Iron Phosphate
NZIA	Net-Zero Industry Act
OEM	Original Equipment Manufacturer
R&I	Research and Innovation
RTO	Research and Technology Organisations
SET	Strategic Energy Technology
SME	Small and Medium Enterprises
SoH	State-of-Health
TRL	Technology Readiness Level
WFD	Water Framework Directive

Disclaimer

This discussion paper was prepared independently by the authors within the framework of the Cluster Hub for “Production of raw materials for batteries from European resources”. Throughout this document, the Cluster Hub may also be referred to as the “Materials for Batteries Hub” or simply the “hub”. It summarises insights collected through surveys and exchanges with EU-funded research and innovation projects, as well as with relevant stakeholders active in the field of raw materials for batteries.

The views, findings and recommendations presented in this paper are the authors’ interpretation of the contributions received. They should not be read as official positions of the contributing projects, their partners, the Cluster Hub, the European Union and its funding authorities. The authors alone are responsible for the analysis, conclusions, recommendations, and any errors or omissions contained in this paper.

Executive Summary

Europe's battery research and innovation (R&I) landscape is producing relevant technical progress, but too many results still encounter hurdles reaching industrial scale. Technologies work in research settings. The real question now is whether Europe has the conditions to test, demonstrate, finance and deploy them rapidly enough.

The main obstacles are practical:

- limited pilot and demonstration infrastructure;
- difficulties moving from laboratory scale to industrial scale and unsupported technology transfer mechanisms between research and industry;
- insufficient finance for first-of-a-kind (FOAK) plants and high upfront investments needed to operate at scale;
- fragmented and unaligned funding programmes;
- regulatory and permitting uncertainty across Member States;
- persistent vulnerabilities in raw material supply chains;
- limited demand for secondary materials.

This paper proposes alternatives to reduce the impact of these barriers and help Europe move faster from research outcomes to industrial deployment.

The analysis and recommendations presented in this paper reflect the experience of European stakeholders actively involved in R&I initiatives related to raw materials for batteries and early evidence from project implementation. They are intended as a contribution to dialogue between EU institutions, industrial actors and the research community, offering practical observations from a limited number of projects and stakeholders.

The paper is based on the reflections from a limited number of members of the Cluster Hub "Materials for Batteries"[1] related to observed challenges and opportunities in the battery R&I sector, collected through the following survey: Cluster Hub "Materials for batteries" - Battery R&I and Policy priorities. The survey findings were complemented by desk research on EU legislative and policy documents, open-access project material and stakeholder exchanges. The evidence base is limited, but it reflects direct experience from projects and stakeholders working across the battery value chain, from raw materials mining to recycling. The findings mirror broader concerns raised by policymakers and other influential speakers at Raw Materials Week 2025 and the EUSEW 2026 session "Competitive by design: strengthening Europe's battery value chain resilience". Delays in strategic projects, slow permitting for extraction and recycling facilities, as well as limited midstream processing capacity and supply chain exposure all impact Europe's ability to scale battery-related innovations.

[1] The Cluster Hub "Production of raw materials for Batteries from European resources", https://www.materialsforbatterieshub.eu/.

Introduction and context

Europe's battery value chain is developing amid geopolitical and economic conditions that have grown more unstable since the launch of the EU-funded initiatives contributing to this paper. Many of these projects were launched in the wake of the COVID-19 crisis and Russia's invasion of Ukraine. Approximately four years later, instability has not diminished. Instead, Europe now faces additional disruptions in global energy markets, renewed supply chain risks, and intensified industrial competition.

Energy-intensive industries, such as chemicals, metallurgy, cement and fertilisers, continue to face competitive pressure from regions with lower energy costs and integrated supply chains. In various Member States, electricity and gas prices remain higher compared with trading partners. The 2024 "Study on energy prices and costs" (Directorate-General for Energy, European Commission) shows that soaring energy prices have increased total production costs across all interviewed sectors, notably for primary aluminium (38%), ferro-alloys and silicon (29%) and flat glass (25%).[2] The same study finds that energy costs in the EU are at least 20% higher than in China, the United States, Brazil, India and Türkiye. Press articles ahead of the European Council of 19 March 2026 indicate that Ursula von der Leyen, President of the European Commission, warned that Europe had already spent an additional €6 billion on fossil fuel imports since early March, calling it "the price we pay for our dependency".[3]

The transition towards renewable energy sources, one of the pillars of many EU strategic agendas (the European Green Deal, the Renewable Energy Directive, the REPowerEU plan etc.), highlights both opportunities and limitations. While renewables can reduce exposure to fossil fuels volatility, their intermittency increases the importance of storage solutions. Batteries are emerging as an essential component for addressing renewables fluctuations, stabilising grids and supporting the electrification of transport and industry.

If batteries have the potential to support the transition towards transport electrification and renewable energy, they also expose the limits of Europe's current capacity to expand key technologies and secure the raw materials they rely on. Today, EU's supply chains are vulnerable to external disruptions, while much of the global battery industry is consolidated around regions that control the full chain, from extraction to recycling. Europe does not yet operate with this level of integration. This points to the need for breakthrough R&I, as well as FOAK industrial projects to build connections across its own value chain and bring innovations quickly to the market, rather than focusing on advancing individual technologies in isolation across the value chain:

- upstream: mining, access to available raw materials, processing;
- midstream: refining and component manufacturing;
- downstream: recycling and reintegration of materials;
- cross-cutting: scale-up, industrial deployment and links between research and industry.

[2] European Commission, Directorate-General for Energy, Trinomics, Enerdata, Oeko-Institut, E3Modelling & LBST (2025) *Study on Energy Prices and Costs. Publications Office of the European Union*. Accessed 26 March 2026.

[3] The Economist, "Gas will not be killed off by renewables any time soon", article published on 19 March 2026 in the "Leaders' section of the print edition under the headline "Lingering fumes", accessed online on 23 March 2026.

An evolving context of the EU legislative initiatives related to R&I priorities in the battery sector

Over the previous decade, innovation policy has focused on addressing societal and sustainability challenges. More recently, security was brought to the centre of policy attention. As a result, innovation policy now calls for three main objectives to be addressed: **security**, **sustainability** and **competitiveness**.

The pressure to strengthen Europe's autonomy and competitiveness in the battery field is reflected in recent EU legislation, including the Critical Raw Materials Act (CRMA), the Net-Zero Industry Act and the Battery Regulation. These legal frameworks have introduced new requirements and streamlined procedures to increase domestic capacity to extract, refine, process and recycle battery materials. This section provides a brief overview of the implications of different EU initiatives for the R&I priorities and the battery sector.

The Critical Raw Materials Act

The Critical Raw Materials Act (CRMA) establishes clear benchmarks for developing domestic capacity along the strategic raw materials supply chain: 10% of the EU's annual demand should be met through domestic extraction, 40% through processing and 25% through recycling. In addition to these capacity targets, the Act emphasises the role of R&I in achieving these objectives. For the battery sector, this means advancing more mature, cost-effective and sustainable technologies for extraction, processing, separation, refining, recycling and recovery of battery-relevant materials. It also means promoting circular design, materials efficiency and substitution of critical raw materials. The CRMA also creates room for future adjustments: on the basis of better data on waste volumes and strategic raw material content, the Act may introduce additional waste-based benchmarks as part of a continued effort to improve resource efficiency. At a national level, the Act requires Member States to raise funding to increase the maturity of recycling technologies and the promotion of circular design, material efficiency and substitution.[4]

> **The CRMA establishes clear benchmarks for developing domestic capacity along the strategic raw materials supply chain. It places R&I at the centre of this effort, supporting the full value chain from extraction and processing to recycling, material efficiency and substitution.**

Despite clear targets and a defined framework, a recent report published by the European Court of Auditors (ECA) concludes that the Act has fallen behind its objectives. Achieving them, the report finds, will depend on better coordinated funding, execution and market uptake. According to Commission data cited by the ECA, more than "€1.8 billion was allocated for CRM initiatives across the 2014-2020 and 2021-2027 periods. The most significant contributions come from Horizon 2020 and Horizon Europe, followed by innovation, cohesion and development funds".[5] Although the ECA report places R&I priorities as a core element of the CRMA agenda, it also identifies the need to align them better with the implementation of the CRMA and industrial realities. The report outlines further implications for R&I priorities, particularly in critical raw materials recycling:

[4] Regulation (EU) 2024/1252 of the European Parliament and of the Council of 11 April 2024 establishing a framework for ensuring a secure and sustainable supply of critical raw materials and amending Regulations (EU) No 168/2013, (EU) 2018/858, (EU) 2018/1724 and (EU) 2019/1020.

[5] European Court of Auditors (2026) *Special Report 04/2026: Critical Raw Materials for the Energy Transition – Not a Rock-Solid Policy*. Published 2 February 2026. Accessed 27 March 2026.

- "Low collection rates: Poor separation and collection of CRM-rich waste streams, especially for electronics and batteries, due to limited local infrastructure.
- Technical challenges: CRMs are often present in very small quantities or embedded in complex products, making extraction difficult and inefficient. Lack of scalable and cost-effective recycling technologies."

> **The report of the ECA concludes that up to 2026, the CRMA has been falling behind its objectives, making recommendations for better coordination of funding, execution and market uptake for R&I priorities.**

The Net-Zero-Industry Act

The Net-Zero Industry Act (NZIA) places battery and energy storage technologies explicitly among the EU's strategic net-zero technologies and connects R&I directly to manufacturing scale-up and supply-chain resilience. According to the official document, battery manufacturing in the EU should aim to meet almost 90% of EU annual battery demand by 2030, corresponding to a manufacturing capacity of at least 550 GWh.[6]

NZIA identifies weaknesses in upstream and midstream segments of the battery value chain. More precisely, in cathodes, anodes and other key components, highlighting the need to concentrate further R&I efforts in the steps preliminary to the final assembly. The legislation emphasises the need to shape and align R&I priorities with industrial relevance, manufacturing objectives, cost competitiveness and scalability.

> **The NZIA emphasises the need to shape and align R&I priorities with industrial relevance, manufacturing objectives, cost competitiveness and scalability.**

The Battery Regulation

The Battery Regulation, published in July 2023, has reshaped the context for battery R&I by including sustainability, safety and circularity requirements directly into product design, manufacturing and end-of-life requirements. This implies that R&I efforts are expected to support the development of alternative materials, safer chemistries and manufacturing processes that reduce environmental and health risks without compromising on performance or cost competitiveness. The regulation introduces the concepts of design-for-recycling and design-for-circularity, with a clear reinforcement of recycling-oriented innovation. Beyond the technological advancement, innovation is required to broaden its scope, covering digital tools, interoperability, traceability and secure information infrastructures.[7]

> **Beyond technological advancement, the Battery Regulation requires innovation to expand its scope covering digital solutions, interoperability, sustainability and circularity, safety and traceability.**

[6] Regulation (EU) 2024/1735 of the European Parliament and of the Council of 13 June 2024 on establishing a framework of measures for strengthening Europe's net-zero technology manufacturing ecosystem and amending Regulation (EU) 2018/1724, Official Journal of the European Union, accessed on 26 March 2026

[7] Regulation (EU) 2023/1542 of the European Parliament and of the Council of 12 July 2023 concerning batteries and waste batteries, amending Directive 2008/98/EC and Regulation (EU) 2019/1020 and repealing Directive 2006/66/EC, Official Journal of the European Union, accessed on 27 March 2026

The European Parliament Briefing on strengthening the battery industry

One of the European Parliament briefings published in December 2025 confirms that batteries are central to the EU's clean energy transition and industrial competitiveness but also questions the sector's ability to deliver on these objectives. Referring to the collapse of Northvolt, the briefing makes recommendations to anchor better R&I priorities in industrial execution while considering process stability and scale-up readiness. The briefing also points to recycling and circular value chains as a strategic area where R&I can reduce dependencies and strengthen supply security through more efficient recycling processes and better integration of secondary materials. However, it outlines that recycling alone will not deliver resilience unless supported by coherent regulation, market incentives, cost competitive technologies, as well as a stronger link with industrial policy instruments, such as Important Projects of Common European Interest (IPCEIs) and NZIA. Finally, the European Parliament enumerates the existing frameworks for the battery sector, pointing at the need to address the fragmented implementation and uneven progress across Member States.[8]

> **The European Parliament briefing from Dec 2025 recommends to better align R&I priorities with industrial execution, while simultaneously considering process stability and scale-up readiness.**

The Battery Booster Strategy

The Battery Booster Strategy, as communicated on 16 December 2025, acknowledges the progress achieved by the battery R&I sector over the past decade but also recognises that current market conditions (overcapacity concentrated in only a few regions, intense price competition and uneven state support) have created barriers to upscaling. Battery R&I is therefore expected to extend its focus beyond technological breakthrough to include production cost reductions, accelerated industrial learning curves and reliable large-scale manufacturing. At a more concrete level, the strategy calls on the battery R&I sector to close gaps in the upstream and midstream segments of the value chain and to increase support for advanced battery materials, manufacturing, recycling technologies and circular processes that enable recovery and reintegration of materials at scale. It also stresses the need for more coordinated and less fragmented R&I governance, better linking R&I priorities with the revision of the Strategic Energy Technology (SET) Plan and upcoming common investment and implementation plan.[9]

Compared with the other legislations outlined in this paper, the strategy addresses cross-cutting topics, such as skills development, workforce availability and social acceptance. This broadens its scope, treating social and environmental performance as conditions for industrial resilience and competitiveness, rather than complementary goals.

> **The Battery Booster Strategy broadens the scope of R&I beyond the technological breakthrough, expecting it to consider complementary aspects, such as production costs reductions, accelerated industrial learning curves and considerations for a reliable ramp-up to large-scale manufacturing.**

[8] Powering the EU's future: Strengthening the battery industry, briefing prepared by EPRS | European Parliamentary Research Service, Author: Guillaume Ragonnaud, January 2025, accessed on 27 March 2026.

[9] Communication from the Commission, Battery booster strategy, Strasbourg, 16 December 2025, accessed on 27 March 2026.

Beyond requirements, these recent initiatives at EU level aim to support R&I by mobilising substantial funding. During the past five years, the European Commission made €700 million available under the Horizon Europe programme to back the development of R&I projects in the CRMs value chains. The work programme will propose an additional €593 million for the interval 2026-2027, to optimise 'resource' use in a circular economy and in new production processes". [10] The European Innovation Council (EIC) will allocate a total of €100 million in blended financial support through two EIC Accelerator challenges: one for "Boosting the European Critical Raw Materials Value Chain", the other for "Advanced Materials for Renewable Energy and Energy Storage Systems".

Additional financing is expected through other EU instruments and policy frameworks (*e.g.,* European Defence Fund, Joint European Forum for IPCEIs, Advanced Materials Act). These initiatives can help shape investment priorities and support the deployment of strategic technologies in the EU. These efforts are echoed by the announcement of the European Critical Raw Materials Centre. The centre will initiate strategic efforts to increase EU's resilience in CRMs and coordinate the activities of the CRM financing hub. [11] Despite the multiple EU financing instruments aiming to jointly raise €3 billion within the next twelve months, the Battery European Partnership Association (BEPA) emphasised the need to mobilise more funding to reinforce Europe's innovation capacity. The sector faces high energy and labour costs, limited subsidies and slower electric vehicle uptake, which weaken investment prospects for domestic battery production.

After comparing EU's public funding levels with higher R&I spending in China, BEPA enumerated several recommendations aimed at addressing the challenges linked to scale, continuity and speed.[12]

Most of these recommendations were also extracted from the input provided by the beneficiaries of EU funding in the battery sector, available in Challenges and mitigation measures reported by EU-funded R&I initiatives. They refer to the need to reinforce the EU's R&I framework to achieve competitiveness at technological level through:

- diversifying battery technologies in line with future applications;
- implementing scaling approaches that reduce capital expenditure and energy use, and increase flexibility across sites and applications;
- accelerating development cycles and faster commercialisation through digitalisation;
- integrating sustainability across the battery materials value chain by combining cleaner raw materials refining with scalable recycling to secure supply for the battery production industry.

To support battery technologies moving from early research to commercialisation, the future battery partnership for 2028-2034 proposes two complementary tracks of projects:

- lower Technology Readiness Level (TRL)/early-stage concepts benefitting from more experimental freedom;
- higher TRL/industrial-scale pilots, developed in a more structured environment.

> **For the remaining part of the working programme and in anticipation of the upcoming one, BEPA acknowledges the need for increased funding for R&I and makes recommendations to link R&I efforts with scale-up and production readiness, where innovative processes are equally cost-efficient.**

[10] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, RESourceEU Action Plan, Accelerating our critical raw materials strategy to adapt to a new reality, Brussels, 3.12.2025 COM(2025) 945 final, accessed on 26 March 2026

[11] Questions and answers on the RESourceEu Action Plan*, Dec 3, 2025, Brussels, page accessed on 27 March 2026

[12] A Battery Deal for Europe, published on 29 November 2025, accessed on 27 March 2026

The short story of the Cluster Hub "Production of raw materials for batteries from European resources"

During the previous three editions of the Raw Materials Week,[13] various speakers, mainly from the political scene and the industry sector, reinforced this sense of urgency, underlining delays in strategic projects and high dependency on external suppliers. The need for better coordination between industry, research and policy representatives emerged as a recurring theme in most debates. These concerns resonate with challenges reported by the members of the Cluster Hub "Production of raw materials for batteries from European resources".[14]

The Cluster Hub "Production of raw materials for batteries" surfaced in this legislative context as a collaborative platform for EU-funded R&I projects addressing mining, refining, processing, and recycling, as well as cross-cutting topics. Its activities reflect a growing community of actors who recognise both the urgency and the opportunities associated with the development of domestic value chains. This community counts on the participation of more than twenty EU-funded initiatives, concentrating more than 100 organisations across the battery value chain.

Despite favourable legislative developments, some adopted under accelerated procedures, evidence from EU-funded R&I projects indicates that several structural challenges persist.

Among the challenges most frequently highlighted by the cluster members in the survey, projects referred to the following barriers that limit the EU's capacity to translate research excellence into industrial resilience:

- slow permitting procedures and inconsistent application across Member States;
- insufficient scale-up infrastructure, with financial instruments not adequately supporting technologies progressing from laboratory results to a FOAK industrial deployment.

In recent years, security has become the centre of EU innovation policy, requiring active coordination and interventions at EU level. The findings collected through the survey echo challenges also raised in other policy-support documents [15] reporting on the implementation of the CRMA, hereunder:

- the slow pace of traditional policy tools is a constraint in policymaking, preventing from responding to the urgency of geopolitical risks;
- the need for a dual approach that includes both securing supply through diversified international partnerships and developing domestic alternatives;
- the importance of integrating industry at the core of policies, requiring companies to recalibrate procurement strategies through supplier diversification and the integration of geopolitical risk into corporate decision-making.

Challenges and mitigation measures reported by EU-funded R&I initiatives

The findings collected from the members of the Cluster Hub, despite not covering all the actors involved in the battery R&I ecosystem, identify a set of recurring barriers reported by ongoing and recently completed innovation projects. From the broader perspective of this paper's objective, these problems are not limited to

[13] Raw Materials Week, https://single-market-economy.ec.europa.eu/sectors/raw-materials/week_en#previous-raw-materials-weeks.

[14] The Cluster Hub "Production of raw materials for Batteries from European resources", https://www.materialsforbatterieshub.eu/.

[15] European Parliament Briefing "Implementing the EU's Critical Raw Materials Act", published in November 2024, accessed in March 2026.

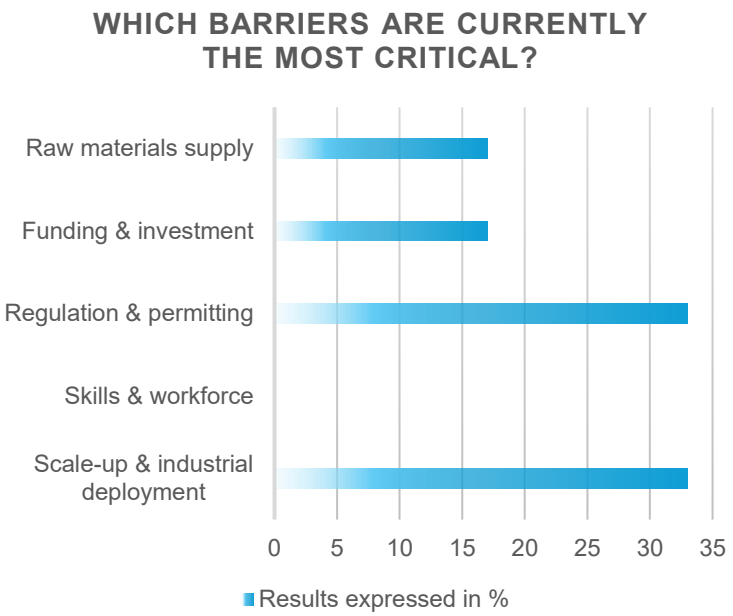
individual technologies or isolated national contexts. They are reported across the entire battery value chain, from mining and refining to processing, manufacturing and recycling projects.

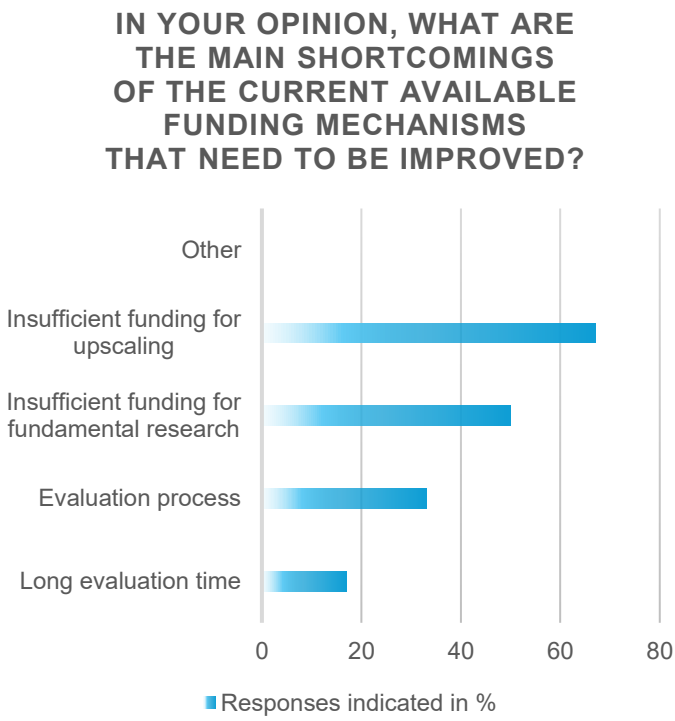
Despite recent funding initiatives and regulatory measures, Europe's battery innovation ecosystem lacks proven implementation mechanisms to transfer technologies from R&I success to industrial scale. Various EU-funded projects report promising preliminary results, some already demonstrating technical viability. When upscaling, projects face a combination of barriers:

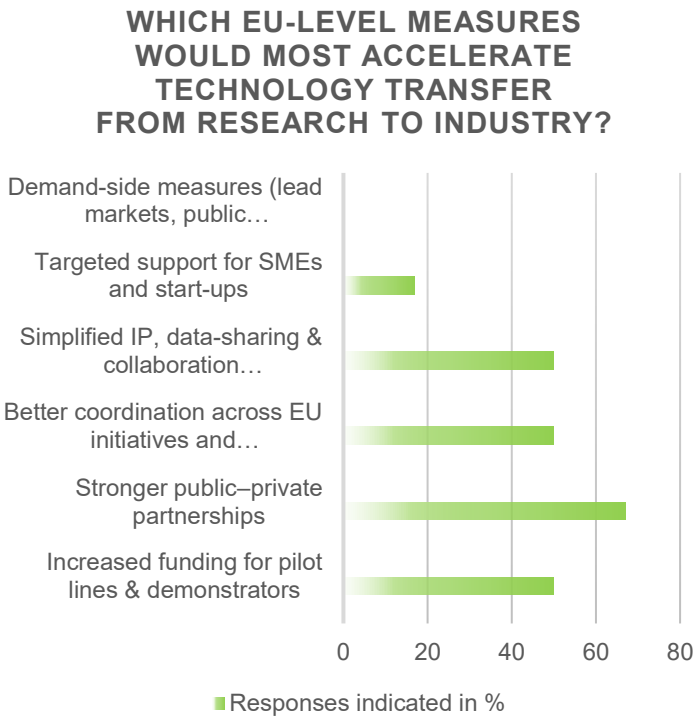
- funding gaps at higher TRLs;
- regulatory delays;
- limited pilot and demonstration infrastructure;
- insufficient access to industrial partners and manufacturing expertise;
- weak links between design, circularity, data and industrial implementation.

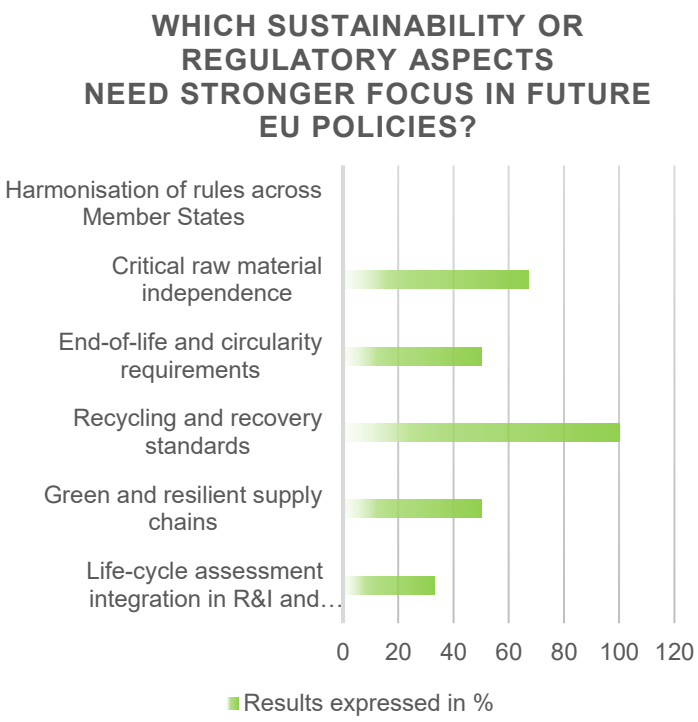
These barriers indicate that scale-up requires more than technical feasibility. It depends on cost performance, industrial readiness, validated processes and integration across the value chain. Very few projects at low and mid TRLs generate this evidence early enough to access follow-on support.

The following infographics are drawn from the survey "Cluster Hub 'Materials for batteries' - Battery R&I and Policy priorities" and they represent aggregated answers to various questions, which inform this paper. They are complemented by open-access project documents, discussions held within the cluster's workshops, as well as external stakeholder reports and position papers.









The following section presents ten barriers along with the corresponding mitigation measures suggested by survey participants and stakeholders, avoiding a separation between challenges and proposed measures. It does not propose a policy roadmap; rather, it identifies priority areas where better alignment between R&I, regulation, finance and industrial deployment could support the scale-up of European battery initiatives.

01

CHALLENGE

Raw material access and battery-grade material production

Europe remains exposed at two connected stages of the battery supply chain: access to critical raw materials and the capacity to process them into battery-grade materials. Dependence on external raw material supply and processing capacity leaves the European battery sector vulnerable to price volatility, geopolitical risk and supply disruptions.

Around 70-75% of battery cost comes from raw materials, with manufacturing accounting for another major share. China's dominant position in the sector rests on its control over both upstream (raw material supply) and midstream capacity (including refining, cathode and anode materials and manufacturing expertise).

Expected to support the supply chain, recycling activities are not yet a reliable source of battery materials for domestic battery manufacturing. Battery Innovation Days 2025 session "End of life, start of supply: Advancing battery recycling in Europe"[16] pointed out that battery recycling plants are currently delaying their ramp-up, as early fleets of electric vehicles are lasting longer than initially expected. End-of-life batteries will therefore arrive in larger volumes later than projected. In the short term, production scrap offers a more immediate opportunity to build recycling capacity, secure material flows and gain operational experience ahead of larger end-of-life streams.

[16] Review article post participation at Battery Innovation Days 2025, Session "End of life, start of supply: Advancing battery recycling in Europe" - Materials for Batteries Hub

SUGGESTED ACTIONS

The EU should give equal priority to securing access to critical raw materials and to building domestic large-scale refining and battery-grade material production capacity.

- Continue diversifying the supply sources through international partnerships that reduce Europe's delivered-material costs by securing access to competitively priced materials and minimising cost increases associated with logistics, tariffs, compliance requirements and supply chain constraints.
- Support European strategic projects for extraction, processing, recycling and battery-grade material production.
- Treat recycling as a complementary material source, not a full substitute for primary supply in the short term.
- Use production scrap as an early feedstock to build recycling capacity before end-of-life battery volumes increase.

CHALLENGE

02 Cost competitiveness remains constrained by raw materials, manufacturing experience, energy and operating costs

Final events organised by the members of the Cluster Hub "Materials for Batteries" indicate that various technologies are ready or close to technical viability. Production at scale, however, remains exposed on three fronts: raw material access, dependence on third countries and cost.

Raw materials are the largest cost component, but not the only factor behind Europe's cost gap with China and other Asian battery producers. Other factors draw European battery production more expensive:

- limited capacity in refining and battery-material production;
- higher energy and operating costs;
- less specialised equipment supplier networks;
- reduced commissioning expertise.

Materials alone explain around 40% of regional cost differences, and Europe remains exposed in Lithium Iron Phosphate (LFP) cathodes, graphite anodes, and other midstream inputs.[17] At the same time, European producers still need to build production expertise during early industrial deployment. This learning curve typically translates into yield losses, scrap rates and ramp-up delays, known as cost drivers. Despite new EU support channelled through the Battery Booster Facility,[18] ramp-up remains financially risky.

Recent sector discussions confirm that cost competitiveness is a moving target. Leading Asian producers continue to reduce costs through innovation, strong supplier ecosystems, chemistry optimisation, pack integration and accumulated industrial expertise. Europe will therefore need to support both factory ramp-up and continuous cost reduction at cell, pack and the wider value chain.

[17] "Batteries: Scaling the engine of electrification", McKinsey Global Institute article, Martin Linder, Jakob Fleischmann, Anna Kortis, Olivier Bus, June 2026

[18] The Battery Booster Facility, https://climate.ec.europa.eu/eu-action/eu-funding-climate-action/innovation-fund/battery-booster-facility_en

SUGGESTED ACTIONS

The EU should also support the expertise build-up in battery manufacturing at scale. Learning and process optimisation are key elements to accelerate adoption. Ramp-up expertise can reduce discards/scrap faster.

- Support innovations and measures that can reduce Europe's production cost gap by funding not only low TRL innovations, but also industrial scale-up and manufacturing readiness capabilities. These could include process optimisation, quality control, failure analysis, energy use reduction, predictive maintenance, as well as digital twins for gigafactory ramp-up.
- Align funding with industrialisation timeframes.
  - Maintain R&I priorities on continuous improvement of the battery chemistries (especially for LFP, sodium-ion), where improvements in energy density, material efficiency and manufacturing can reduce cost per kWh.
  - Continue investments in next-generation technologies with credible cost, integration and scale-up potential (*e.g.* solid-state batteries, dry manufacturing processes).[19]

CHALLENGE

03 European production needs demand-side support, but must still become cost-competitive

European battery production will not scale without credible demand. In addition to slow technology maturation, high operating costs and scarce access to battery raw materials, uncertain demand in end-use markets remains an additional pressure point for European producers.

Demand-side support can help create early markets for European-made batteries and components, but it cannot replace the need for cost competitiveness. Customers are unlikely to pay a premium simply because a battery is 'Made in Europe'. Cost parity remains necessary for mass adoption, especially in price-sensitive markets such as electric vehicles and stationary storage.

Without predictable demand, companies have fewer reasons to invest in upstream, processing and manufacturing capacity in Europe. Without scale, however, European producers struggle to reduce costs, improve yields and build the industrial learning needed to compete with established Asian suppliers.

SUGGESTED ACTIONS

The EU should create early demand for European-made batteries and components while keeping support linked to performance, sustainability, resilience and cost competitiveness.

- Propose demand-side instruments for *European-made* batteries and components.
- Link demand support to performance, sustainability, resilience and cost competitiveness. Avoid support mechanisms that protect European production without a credible pathway towards cost parity, quality improvement and industrial scale.
- Encourage long-term agreements between material producers, cell manufacturers, recyclers and end users to reduce demand uncertainty and support investment decisions.

[19] McKinsey, "Scaling the energy of electrification", p.12

CHALLENGE

04 Weak business case for secondary battery materials

Demand for secondary materials is growing, but not always at the pace required by investment plans. Despite recycled material gaining traction on the political agenda, it is not always commercially interesting. The current lack of viable business cases, stable regulation and safe cross-border battery movement risks keeping new capacity idle.

Feedstock uncertainty is also important. Large volumes of end-of-life batteries are expected to arrive later than initially projected, while production scrap is a more immediate but limited source of recyclable material.

The challenge is even greater for chemistries such as LFP, Lithium Manganese Iron Phosphate (LMFP), Sodium-ion and other emerging battery types, where the lower share of high-value metals weakens the economics of recycling. Without targeted support, recycling capacity may focus only on material streams with the strongest short-term commercial value rather than on the wider circularity and supply-security needs of the European battery sector.

SUGGESTED ACTIONS

Recycling should be perceived as a source to supplement primary battery materials.

- Ensure safe cross-border movement of batteries, production scrap and black mass. Digital procedures could provide a solution to relieve the administrative burden and accelerate procedures.
- Strengthen the market conditions for secondary battery materials and support their integration back into new cells manufacturing. This can be achieved by reducing uncertainty around quality and facilitating long-term offtake agreements between recyclers, refiners and cell manufacturers. Targeted incentives that recognise the lower environmental and strategic value of secondary materials can address the price competitiveness barrier.
- Support recycling infrastructure able to process both production scrap and end-of-life battery waste.
- Continue funding demonstration projects that test recovered materials in new cells and components.
- Prioritise R&I and industrial support for direct recycling (where feasible), hydrometallurgical and other processing routes that are capable of recovering metals, graphite and other components at battery-grade quality. Additional attention should be placed on process integration in existing recycling facilities, reagent recovery, electrification and valorisation of side streams.
- Place specific attention to recycling routes for LFP and LMFP and other emerging chemistries, where the lower share of high-value metals makes the business case more difficult. EU support should therefore focus on processes that recover a broader range of materials and upgrade these outputs into battery-grade materials.

CHALLENGE

05 Battery design and data gaps make recycling difficult

Batteries are still designed mainly for performance, cost and weight reduction, often featuring compact architectures, welded structures and adhesives that are difficult to disassemble. This design complexity makes end-of-life treatment not only more difficult, but also more expensive.

The Battery Passport has been proposed to facilitate recycling operations, providing data on chemistry, state-of-health (SoH) and battery architecture. However, stakeholders raised concerns about data ownership, confidentiality, intellectual property (IP) and the cost of collecting and maintaining data.[20]

SUGGESTED ACTIONS

The EU should integrate design-for-circularity and workable data requirements from the concept phase, while preserving design flexibility for different battery applications.

- Develop Battery Passport frameworks based on tiered, need-to-know data access (chemistry, SoH, architecture). The passport should avoid exposing IP-sensitive data or turning the passport into a compliance burden.
- Support selective standardisation of data, interfaces and information needed to handle, dismantle, repair, reuse, transport and/or recycle batteries.
- Preserve design flexibility for battery storage solutions tailored for specific applications.
- Involve recyclers, second-life and repair operators in the design phases of battery projects.

CHALLENGE

06 Unaligned regulatory and permitting procedures across Member States

Whether for extractive, refining or recycling facilities, permitting remains slow, inconsistent and often unpredictable, creating uncertainty for project timelines and discouraging private investment.

The challenge is not only the length of procedures, but also their inconsistent and often unaligned application across Member States. In practice, project developers may face simultaneous obligations under the Water Framework Directive (WFD), Natura 2000 and the Industrial Emissions Directive (IED), which can lead to cumulative, and sometimes conflicting requirements. For instance, a mining or refining project may be required to avoid any deterioration of water bodies under the WFD, demonstrate no adverse effect on protected habitats under Natura 2000, and comply with Best Available Techniques under the IED. These requirements are often assessed by different authorities and based on separate methodologies, with limited scope for balancing trade-offs or recognising mitigation measures collectively. In Europe, permitting procedures for mining projects can extend for up to 15 years, whereas countries like Canada and Australia operate shorter timelines.[21] This creates uncertainty for project timelines and discourages private investments in pilot, demonstration and first-of-a-kind facilities.

SUGGESTED ACTIONS

- Simplify and accelerate permitting for extraction, refining, manufacturing and recycling facilities. Reduce unnecessary administrative complexity without compromising on the environmental and safety standards.

[20] Review article post final event of EU-funded projects RESPECT and FREE4LIB, Europe's next battery challenge moves beyond recycling - Materials for Batteries Hub

[21] Position Paper Euromines-Omnibus-on-Enabling-Effective-Procedures.pdf, published in June 2025, accessed in April 2026.

- Provide regulatory guidance on legal obligations for project developers, and acceptable trade-offs in common interests (for developers, authorities and local communities). This can reduce litigation risks and approval timelines.
- Streamline requirements across legislation by clarifying how different frameworks interact and where well-founded trade-offs can be applied. Avoid duplication, conflicting assessments and cumulative obligations that prevent permitting.
- Support permitting authorities by addressing resource constraints, improving technical capacity and ensuring consistent interpretation of rules across departments and Member States.
- Align EU objectives with their implementation in Member States to ensure consistent and predictable permitting practices across jurisdictions.

CHALLENGE

07 Difficulties bridging laboratory-scale processes and industrial-scale production

Despite reporting promising results at smaller scale, projects face practical barriers to reach commercialisation:

- engineering and equipment limitations;
- feedstock access;
- permitting;
- high capital and operational costs to cover longer validation cycles;
- relatively limited access to industrial partners;
- lack of clear demand.

Funding mechanisms are well-developed for low TRL but less available for higher TRL (*e.g.*, 7-9), where projects need to demonstrate industrial feasibility. Recent EU communications have announced new support for the ramp-up of EV battery-cell manufacturing, including the Battery Booster Facility[22] and Innovation Fund support. This is an important step, but similar de-risking mechanisms may also be needed in other strategic parts of the battery ecosystem where Europe still lacks sufficient industrial capacity.

In addition, projects report a lack of access to facilities capable of testing processes at higher technology readiness level (TRL 6-8). This hinders validation of industrial feasibility, slows certification and delays commercial uptake. Unsustained links between R&I and scale-up risk repeating the pattern in which research is developed in Europe, but production takes place elsewhere.

SUGGESTED ACTIONS

- Increase funding for pilot lines, demonstrators and FOAK facilities across the entire battery value chain.
- Ensure that successfully implemented R&I projects will have available funds for scaling their technologies to high TRL levels, few years after their launch. R&I projects typically run for three to four years, with tangible results often becoming available only towards the final months.

[22] Battery Booster Facility - Climate Action - European Commission

Funding programmes and calls should be aligned and coordinated with clear perspective over longer times to exploit and support the scale-up of these final results and project outcomes.

- Improve access to facilities capable of testing processes at TRL 6-8.
- Design project timelines so recovered materials are available early enough for cell testing and performance validation.
- Require industrial validation plans, cost targets and scale-up pathways in EU-funded projects.
- Involve industrial partners earlier in R&I projects to ensure that technical results are aligned with manufacturing, certification and market requirements.

CHALLENGE

08 Unsupported technology transfer mechanisms between R&I and industry

Collaboration between research and technology organisations (RTOs) and industry is often hampered by unclear IP frameworks, limited incentives for industry participation and insufficient support for small and medium enterprises (SMEs).

Cluster members' inputs call for a more integrated framework that links research, scale-up and deployment more coherently. They emphasise the need to involve industrial expertise earlier in battery R&I projects. This could ensure that promising technologies are developed with manufacturing constraints, market requirements and cost targets.

SUGGESTED ACTIONS

- Improve IP frameworks and data-sharing frameworks for collaboration between RTOs, universities and industry.
- Support joint ventures and strategic partnerships that enable technology localisation, skills transfer and access to existing industrial manufacturing expertise.
- Allocate targeted support for SMEs participating in high-TRL battery projects.
- Allocate prices for joined patented foregrounds or for foregrounds that are officially transferred or adopted by industry.

CHALLENGE

09 Fragmented and unaligned funding programmes

Current support for R&I is distributed across several instruments. Horizon Europe, including the BATT4EU Partnership, remains the main vehicle for collaborative research and innovation, while Battery 2030+ sets out a longer-term research agenda for next-generation battery technologies. Support for higher-TRL demonstration and industrial deployment is provided through instruments such as the Innovation Fund, including the recently announced Battery Booster Facility, EIC instruments, IPCEI Batteries, InvestEU/EIB financing, and, where relevant, LIFE and European Regional Development Fund (ERDF). Digital Europe can also contribute to battery-related data (e.g., CIRPASS – standards-based Digital Product Passport), digitalisation and skills.

This funding landscape creates important opportunities, but it can equally create confusion for further research, industrial validation and deployment. EU-funded projects may generate promising results at lower or intermediate TRLs but then struggle to identify the next suitable funding route, meet different eligibility requirements or bridge the period between project completion and commercial investment.

SUGGESTED ACTIONS

- Propose an integrated European initiative dedicated to accelerating industrialisation across the battery value chain.
- Establish pathways between low-TRL research, demonstration, industrial validation and deployment funding.
- Ensure that future designed calls are linked to market needs, industrial timelines and scale-up requirements.
- Reduce gaps between funding stages by aligning call timing, proposal evaluation timelines, reporting requirements and evaluation criteria.
- Encourage low- and mid-TRL projects to anticipate future cost, scale-up and industrial validation requirements.
- Ensure that promising project results receive support for follow-on testing, certification, industrial validation and investment readiness.
- Initiate new high-TRL funding programmes alongside the Innovation Fund with battery materials production capacity at competitive cost being the priority evaluation criteria. This would shift the focus on the project's contribution to competitive and resilient battery materials manufacturing, rather than solely on CO_2 avoidance. The latter should be treated as a secondary evaluation criterion or addressed through separate mandatory activities to capture, store and/or use emissions.

CHALLENGE

10 Need for application-specific and next-generation battery technologies

Demand is expanding beyond electric vehicles (EVs) and different applications need different battery types and digital capabilities. Europe should continue supporting current industrial deployment while investing in application-specific and next-generation battery technologies.

SUGGESTED ACTIONS – including several recommendations from the report 'Scaling the energy of electrification'[23]

- Support R&I tailored to different battery applications: EVs, stationary storage, industrial batteries, defence, aviation, robotics and data centres

[23] McKinsey, "Scaling the energy of electrification", p.12

- Continue supporting mature lithium-ion technologies as they scale in Europe. At the same time, funding should also be allocated to next- generation batteries, such as sodium-ion, solid-state, post-lithium, silicon-blend anodes and circular solutions.
- Assign dedicated support for stationary storage, in view of the wide adoption of renewables. Europe's BESS installed capacity is expected to reach 60 GWh by 2030.
- Prioritise technological solutions and system designs that reduce reliance on scarce materials, improve safety, reduce costs, extend battery lifetime and simplify reuse and/or recycling.
- Build capabilities beyond cell R&I focus, also covering battery management systems, electronics, sensors, cloud-based monitoring, predictive maintenance and lifecycle data.
- Connect future technologies to European manufacturing and deployment capacity. Projects developing next-generation batteries should show how results could be tested, manufactured, certified, integrated into applications and eventually scaled in Europe.

CLUSTER HUB
PRODUCTION OF RAW MATERIALS FOR BATTERIES FROM EUROPEAN RESOURCES

BATRAW

Recycling of end-of-life battery packs for domestic raw material supply chains and enhanced circular economy

Factsheet	
Duration	**May 2022 - Apr 2026**
EU contribution	**€9 786 739**
Type of action	**Innovation Action**
Coordinating org.	**Technological Centre LEITAT**
Consortium size	**17 partners**
Grant Agreement	**101058359**
Official website	**https://batraw.eu/**

Main objective of the project

BATRAW's main objective is to develop and demonstrate two innovative pilot systems for sustainable recycling and end-of-life [EoL] management of EV batteries, domestic batteries, and battery scraps, contributing to the generation of secondary streams of strategically important CRMs and battery raw materials.

Pilot 1 will deliver innovative technologies and processes for dismantling of battery packs achieving recovery of 95% of battery pack components and separating waste streams, including cells and modules, by semi-automated processes for recycling.

Pilot 2 will scale and demonstrate efficient pre-treatment and continuous hydrometallurgical recycling of battery cells and modules, including innovative steps for C-graphite, Al and Cu separation from black mass and Mn extraction, achieving a recovery of the full range of battery raw materials (Co, Ni, Mn, Li, C-graphite, Al and Cu) at 90-98% selectivity.

Innovations will be scaled and demonstrated in a pilot system with recycling capacity of 1 tonne of lithium-ion battery (LIB) packs dismantled per shift (8 hours) and treat 300 kg of black mass per day.

Impact

BATRAW's outcomes are of strategic importance within the prospects of the exponentially growing EU battery market and reducing EU import dependency of CRMs. The project will further promote the overall sustainability and circularity of battery products and raw materials by developing new procedures for battery repair and reuse, enabling faster diagnostics and conversion of EV packs into second life batteries, delivering eco-design guidelines for battery manufacturing, demonstrating blockchain platform for raw material tracking and supply chain transparency (Battery Passport) and delivering guidelines for safe transports and handling of battery waste.

Primary activities

- Battery recycling/waste management
- Cross-cutting: contribution policies, methodologies, sustainability, digitalisation tools

Representatives of BATRAW project outline the need for closer cooperation between research, industry and policymakers as one of the key improvement aspects in upscaling battery recycling and raw materials recovery in Europe.

Challenges

The project identifies the following barriers currently slowing down the transition from pilot results to industrial deployment:

- regulatory uncertainty
- unaligned funding pathways
- limited technology-transfer condition

Recommendations

Proposed recommendations with potential to support Europe's recycling capacity, improve collaboration mechanisms and reinforce sustainability requirements across the battery value chain:

- Enhance public–private partnerships for scaling up and deploying recycling technologies.
- Improve IP and data-sharing to accelerate technology transfer and cooperation across research, industry and SMEs.
- Increase support for SMEs and start-ups, which face difficulties entering joint development projects.
- Reinforce regulatory attention to sustainability and circularity through early LCA integration in R&I and industrial processes, clearer recycling and recovery standards, and more consistent end-of-life requirements for batteries and related components.

LiCORNE

Building a sustainable and autonomous lithium supply chain for Europe

LiCORNE

Factsheet	
Duration	**Oct 2022 - Sep 2026**
EU contribution	**€ 6 766 313**
Type of action	**Research & Innovation Action**
Coordinating org.	**Fundación Tecnalia Research & Innovation**
Consortium size	**14 partners**
Grant Agreement	**101069644**
Official website	**https://www.licorne-project.eu/**

Main objective of the project

The LiCORNE project is designed to set up the first European Lithium (Li) complete supply chain by targeting three groups of resources: (i) ores and tailings, (ii) continental and geothermal brines, and (iii) off specification cathode materials.

The primary goal of LiCORNE is to investigate 18 different lithium recovery processes designed to operate at lower temperatures and avoid the use of strong acidic agents, addressing the main drawbacks of current state-of-the-art ore and brine processing. Additionally, the project intends to improve social trust and change the perception of mining activities through workshops with local communities to discuss concerns around mining and show how lithium extraction can be done in ways that are both practical and acceptable to those living close to future sites.

Impact

The LiCORNE project is expected to have an impact on Europe's processing and refining capacity to produce battery-grade chemicals such as lithium carbonate, lithium hydroxide and lithium metal.

Primary activities

- Battery raw material extraction (mining)
- Materials processing and refining
- Battery recycling/waste management

Challenges

Although respondents from the LiCORNE project, representatives of research and industry, recognise the value of EU instruments, they raise concerns about:

- fragmentation, scale-up finance and coordination across R&I funding and long-term planning
- market uptake to develop outcomes to higher TRLs
- missing connection between research and industrial reality
- access to raw materials

Recommendations

With concerns about the shy presence of a strategic framework able to coordinate stakeholders and reduce fragmentation, LiCORNE suggests the following mitigation measures:

- increase support for pilot lines, demonstrators and high-TRL activities (*e.g.* FOAK industrial facilities)
- strengthen public-private partnerships to:
  - bring industrial expertise into R&I processes
  - ensure better alignment between research outputs and market requirements
  - reduce risks associated with scale-up
- shift focus of future R&I programmes towards **next-generation battery technologies** with longer-term industrial potential.

The LiCORNE contributions include a broader strategic recommendation related to Europe's industrial positioning, calling for **stronger support for battery production within Europe**, regardless of the origin of the companies involved, ensuring:

- industrial activity is maintained in Europe
- innovation ecosystem linked to battery manufacturing is preserved
- dependency on external production capacity is reduced

GR4FITE3

Graphite Resilience For lithium-Ion Battery Anodes Through a Sustainable European End-to-End Supply Chain

Factsheet	
Duration	**May 2023 - Apr 2027**
EU contribution	**€ 4 798 586,25**
Type of action	**Innovation Action**
Coordinating org.	**RINA Consulting SPA**
Consortium size	**10 partners**
Grant Agreement	**101103752**
Official website	**https://gr4fite3.eu**

Main objective of the project

The project GR4FITE3 aims to reach Graphite Resilience for lithium-ion battery anodes through a sustainable European end-to-end supply chain. This supply chain includes environmentally responsible European mining of natural crystalline flake graphite from Europe's largest natural graphite resource; highly innovative, continuous and low energy input upgrading of the mined ore, adding recycled and fully repaired for reuse synthetic graphite and optionally silicon nanoparticles to compose a unique anode active material's particle architecture, making the high-density anodes, creating the cells, developing battery modules, certifying the lithium-ion batteries for safety and viability, and ultimately using these products by the OEMs including an established European electric bus manufacturer and a utility grid developer, among others.

The purpose of the GR4FITE3 project is to demonstrate the creation of a sustainable supply chain for European industrial graphite and carbon products for specific use as anode active materials in Lithium-Ion batteries designed for applications in electric vehicles and power sources for utilities, such as solar and wind farms.

Primary activities

- Battery raw material extraction (mining)
- Battery recycling/waste management
- Cross-cutting (policy, methods, tools)

Challenges

GR4FITE3 respondents point at limited pilot, demonstration and scale-up infrastructure, as well as insufficient financing for both fundamental research and FOAK plants:

"Academic research delivers high-energy-density results at coin-cell level but scaling to gigafactory production often fails".

However, one of the most critical barriers identified is access to raw materials and raw material processing.

Recommendations

- Increase support and financing for scale-up and demonstration activities/facilities to transfer R&I advancements to production.
- Devote more focus to reducing Europe's dependence on critical raw materials through an integrated strategy applied across Member States that combines:
  - diversification of import sources
  - development of domestic extraction and processing capacities
  - intensified recycling and recovery of strategic materials
  - material substitution whenever technically feasible
  - support for next-generation battery chemistries that reduce reliance on constrained elements

GR4FITE3 partners foresee Europe's resilience in critical raw materials depending on a mix of industrial policy, technological developments, social acceptance of new projects, complemented by the stockpiling for strategic materials.

RELiEF

Recycling of Lithium from Secondary Raw Materials and Further

Factsheet	
Duration	**July 2022 - Dec 2025**
EU contribution	**€ 6 003 240**
Type of action	**Research & Innovation Action**
Coordinating org.	**Avesta Holding**
Consortium size	**12 partners**
Grant Agreement	**101069789**
Official website	**https://lithium-relief.eu/**

Main objective of the project

Current recycling technology is focused on recovering Li from battery scrap, while hardly much focus and technological development is going towards other Li sources. Hence, the aim is to recover Li from potential secondary sources in order to reduce unrecovered Li from its waste generation, which is estimated to be approx. 27.33% of the current global Li production. RELiEF proposes an integrated recycling facility for Li from secondary raw material sources with continuous processing to produce battery materials. Li wastes will be reduced by more than 70%, which will instead be recycled into high-value battery-grade material. The results of the integrated and continuous process up to battery precursor recovery will be demonstrated at TRL 5 and the battery active material closed-loop process will be demonstrated at TRL4 with a 1.5 – 2.5 kg/week output of battery active materials and a new business model will be developed for the materials, acquisition and processing, taking into account environmental and social sustainability.

Multiple segments of the battery value chain:

- Both mining and recycling
- Materials processing/refining
- Battery materials manufacturing
- Manufacturing & industrial scale-up
- Cross-cutting (policy, digitalisation, tools)

Challenges

RELiEF responses highlighted regulatory and permitting uncertainty, as well as the lack of implementation pathways for new technologies. They also underlined “the need for policy frameworks backed by robust and reliable compliance measures to intensify support for innovation”.

Moreover, at project completion, RELiEF partners published a cross-regulation policy brief revisiting the Critical Raw Materials Act, the Batteries Regulation, the Circular Economy Act and the Chips Act. The brief highlights the need for consistent definitions, especially on secondary CRMs, and proposes a reassessment of the EU’s circular model currently primarily focused on the recycling of EoL products.

Recommendations

- Align EU calls and market and industry realities
- Improve coordination across EU initiatives and programmes to reduce fragmentation and improve efficiency.
- Develop consolidated collaboration frameworks, simplified IP and data-sharing protocols to facilitate cross-sector collaboration.
- Accelerate evaluation time and rethink assessment process for new initiative proposals applying for EU funding.
- Prioritise the following dimensions for improved sustainability and regulatory alignment:
  - Life-cycle assessment (LCA) integration
  - green and resilient supply chains
  - recycling and recovery standards
  - critical raw material independence

Other recommendations from RELiEF’s final policy brief, looking at policy harmonisation, coordinated circularity and social acceptance, include:

- standardisation of secondary CRM definitions
- mandatory sustainability verification
- green premiums for circular materials
- adaptive governance and community engagement
- industrial symbiosis pathways
- integration of secondary CRM rules into the Chips Act and Circular Economy Act.

MaaSiveTwin

MAnufacturing as a service And Supply chain predictIVE Twin for critical raw materials

Factsheet	
Duration	**April 2024 - June 2028**
EU contribution	**€ 5 253 290,00**
Type of action	**Research & Innovation Action**
Coordinating org.	**Firma Battronics**
Consortium size	**8 partners**
Grant Agreement	**101138334**
Official website	**https://maasivetwinproject.eu/**

Main objective of the project

MaaSiveTwin aims to develop a digital twin and Manufacturing-as-a-Service platform for critical raw materials value chains. The project tracks and models mining, processing, transport, production capacity, sustainability and supply-chain conditions affecting critical raw materials used in clean energy technologies, including lithium, cobalt and nickel for batteries.

The digital twin is designed to improve supply-chain efficiency, reduce uncertainty and support informed decision-making. It provides real-time data analysis and scenario prediction to help industrial actors anticipate supply disruptions, demand-supply mismatches, price fluctuations and logistics risks. The solution will be tested in industrial contexts including lithium refining and large-scale LiFePO4 battery manufacturing.

By combining data collection, modelling, simulation, machine learning and optimisation tools, MaaSiveTwin aims to support more resilient and digitalised CRM value chains and enable alternative sourcing or processing routes when disruptions occur.

Multiple segments of the battery value chain:

- cross-cutting (policy and decision-support tools, digital support for Li refining and $LiFePO_4$ battery manufacturing contexts
- supply chain modelling and monitoring for CRMs
- Manufacturing-as-a-Service tools for CRM processing value chains

Challenges

MaaSiveTwin response identifies scale-up and industrial deployment as the most critical constraint in the battery ecosystem. Their contribution to the survey points at a persistent gap between research outcomes and industrial requirements, which threatens to maintain R&I at small or pilot scale, while industrial production requires a significantly higher level of technical complexity and risk.

The project lists the following challenges as particularly severe:

- difficulties in progressing from laboratory and pilot stages to industrial application
- fragmentation of R&I efforts across Europe
- constraints related to access to raw materials
- limited availability of finance for scale-up and FOAK
- new R&I proposal evaluation process

Additional constraints include limited pilot, demonstration or scale-up infrastructure, skills and workforce shortages, regulatory and permitting uncertainty, and weak technology transfer from research to industry.

Recommendations

MaaSiveTwin project proposes a short list of recommendations with potential to improve the conditions for industrial scale-up and, at a broader level, the coordination across innovation ecosystems:

- increased support and funding for pilot lines and demonstration facilities to address the gaps between R&I and industrial deployment
- targeted support for SMEs and start-ups
- coordinated policy action that aligns R&I priorities with industrial deployment needs
- stronger focus on green and resilient supply chains
- frameworks that prioritise production and value creation within Europe (*e.g.* “Made in EU”)

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