Sustainable processing of Europe's low-grade sulphidic and lateritic nickel/cobalt ores and tailings into battery-grade metals

(ENICON)

D6.1

Report on identified projects for clustering activities

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

Public Deliverable

Authors:

Anna Kritikaki, Technical University of Crete (TUC)

Lefteris Doitsidis, TUC

Konstantinos Komnitsas, TUC (reviewer)

30-09-2022

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

Deliverable Number	D6.1
Deliverable Name	Report on identified projects for clustering activities
Due Date of Deliverable	30-09-2022
Actual Submission Date	30-09-2022
Deliverable Lead Partner	Technical University of Crete
Dissemination Level	Public
Public Summary enclosed	No
Work Package	WP6 - Clustering with other EU projects
No of Pages	55
Keywords	Database, clustering, Ni, Co, batteries, laterites, sulphides, ENICON
In bibliography, this report should be cited as follows:	A. Kritikaki, L. Doitsidis, K. Komnitsas, “Report on identified projects for clustering activities,” Deliverable 6.1, ENICON project (Sustainable processing of Europe's low-grade sulphidic and lateritic nickel/cobalt ores and tailings into battery-grade metals), 2022, https://enicon-horizon.eu/.

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

EXECUTIVE SUMMARY

The cobalt (Co) and nickel (Ni) demand is expected to be about 20 times higher in 2040 than in 2020. Europe plays only a minor role in the global Ni/Co supply chains, which are concentrated in the DRC, Indonesia and China. Thus, a serious problem exists in securing a reliable, affordable and sustainable supply of battery-grade Ni/Co, which is vital for Europe's aims to be climate-neutral by 2050. In view of a "domestic and foreign sourcing" procurement model, ENICON exploits the potential of (low-grade) Ni/Co resources within Europe – i.e. sulphidic Ni/Co ores and derived Ni/Co-bearing pyrite and silicate tailings, and limonitic/saprolitic laterite Ni(/Co) ores – while improving and developing the Ni/Co-refining capacity that can process imported ores, concentrates and intermediates. ENICON comprises both major improvements to existing Ni/Co metallurgical unit operations in Europe as well as the development of a new HCl-based route for both Ni/Co sulphide concentrates and laterites. ENICON's HCl-route dispenses with the old-school hydro-approach of continuously precipitating and re-dissolving metals that requires lots of chemicals and creates problematic waste streams.

The HCl-based route can be extended to the downstream processing of FeNi (Class-II Ni) obtained from laterites; mixed (Ni/Co) Sulphide/Hydroxide Precipitate (MSP/MHP) from the bioleaching of Co-rich pyrite tailings; and Ni/Co-containing silicate tailings. ENICON targets a "forensic geometallurgy" protocol, making it possible to identify and mitigate the mineralogical and textural reasons for processing losses along existing and new flowsheets. To make the transition to (near) zero-waste processing and to further reduce CO_2-footprints, ENICON develops enhanced mineral matrix valorisation processes. The outputs from ENICON's group of European Ni/Co mining, processing and refining companies will all be benchmarked in terms of positive environmental and techno-economic impacts against current methods.

WP6 "Clustering with other EU projects" aims to cluster ENICON with other on-going Horizon Europe projects of the same "HORIZON-CL5-2021-D2-01-01: Sustainable processing, refining and recycling of raw materials (Batteries Partnership)" and related calls of the Destination "Climate sciences and responses for the transformation towards climate neutrality" as well as ongoing H2020 projects on next generation batteries towards Building a Low-Carbon, Climate Resilient Future (call H2020-BAT-2019) and contributing to the objectives of The European Technology and Innovation Platform (ETIP) Batteries Europe and the European Raw Materials Alliance. ENICON will also contact Nickel and Cobalt Institutes. This should allow to maximise the generated added value at EU level by reaching a much broader group of stakeholders.

D6.1 aims to identify projects suitable for clustering activities and provide a comprehensive overview as a first step towards coordinating the efforts at European level in this highly innovative scientific field and maximizing ENICON's impact.

This deliverable will be updated every 6 months in order to include new projects, assess the results achieved so far and plan in the best possible way future activities within WP6. The outputs of this deliverable will be used during the implementation of Tasks 6.2 "Contribution to clustering workshops and activities" and 6.3 "Capacity-building seminars" as well as during disseminating and communicating ENICON's results.

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

Table of Contents

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

1 Introduction

The transition to a climate-neutral society by 2050 is both a critical challenge and an opportunity to build a better future for all. This objective is at the heart of the European Green Deal and in line with the EU's commitment to global climate action under the Paris Agreement. We are already beginning to see evidence for the global energy system's divergence from being fuel-intensive to mineral/metal-intensive. The resulting demand for nickel (Ni) and cobalt (Co), which are essential for (most) lithium-ion batteries (LIBs), is set to rise at an unprecedented rate. In its report *The Role of Critical Minerals in Clean Energy Transitions*, the International Energy Agency (IEA) predicted that the demand for Ni will increase 21 times and that for Co 19 times, within the next 20 years. New mining projects can take decades to come online, meaning that if no action is taken, we will almost certainly see demand outstripping supply. What makes matters worse for Europe is that the Ni/Co mining/processing/refining value chains are concentrated in the Democratic Republic of Congo (Co mining), Indonesia (Ni mining and refining based on High- Pressure Acid Leaching (HPAL)), and China, whose role is rapidly growing.

As Europe has little involvement in global supply chains, we face a major challenge to ensure reliable, affordable and sustainable supplies (*i.e.*, Class-I Ni: > 99.8 wt% Ni (synthesised into battery-grade $NiSO_4$) and battery-grade Co ($CoSO_4$)). In a recent Roskill/JRC report, a "domestic and foreign sourcing" procurement model is promoted. This implies that Europe mobilises its forces to (re)mine, recover and ultra-refine Ni and Co from its existing domestic primary and secondary resources, while at the same time uses its expanding refining capacity to import and process Ni/Co ores, concentrates and intermediates from outside of Europe. This is the core of the ENICON's approach.

ENICON exploits the potential of (low-grade) Ni/Co resources within Europe – i.e. sulphidic Ni/Co ores and derived Ni/Co-bearing pyrite and silicate tailings, and limonitic/saprolitic laterite Ni(/Co) ores – while improving and developing the Ni/Co-refining capacity that can process imported ores, concentrates and intermediates. ENICON comprises both major improvements to existing Ni/Co metallurgical unit operations in Europe as well as the development of a new HCl-based route for both Ni/Co sulphide concentrates and laterites. ENICON's HCl-route dispenses with the old-school hydro-approach of continuously precipitating and re-dissolving metals that requires lots of chemicals and creates problematic waste streams. The HCl-based route can be extended to the downstream processing of FeNi (Class-II Ni) obtained from laterites; Mixed (Ni/Co) Sulphide/Hydroxide Precipitate (MSP/MHP) from the bioleaching of Co-rich pyrite tailings; and Ni/Co-containing silicate tailings. ENICON targets a "forensic geometallurgy" protocol, making it possible to identify and mitigate the mineralogical and textural reasons for processing losses along existing and new flowsheets. To make the transition to (near) zero-waste processing and to further reduce CO_2-footprints, ENICON develops enhanced mineral-matrix valorisation processes. The outputs from ENICON's group of European Ni/Co mining, processing and refining companies will all be benchmarked in terms of positive environmental and techno-economic impacts against current methods. A graphical abstract of the ENICON's approach is presented in Figure 1.

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

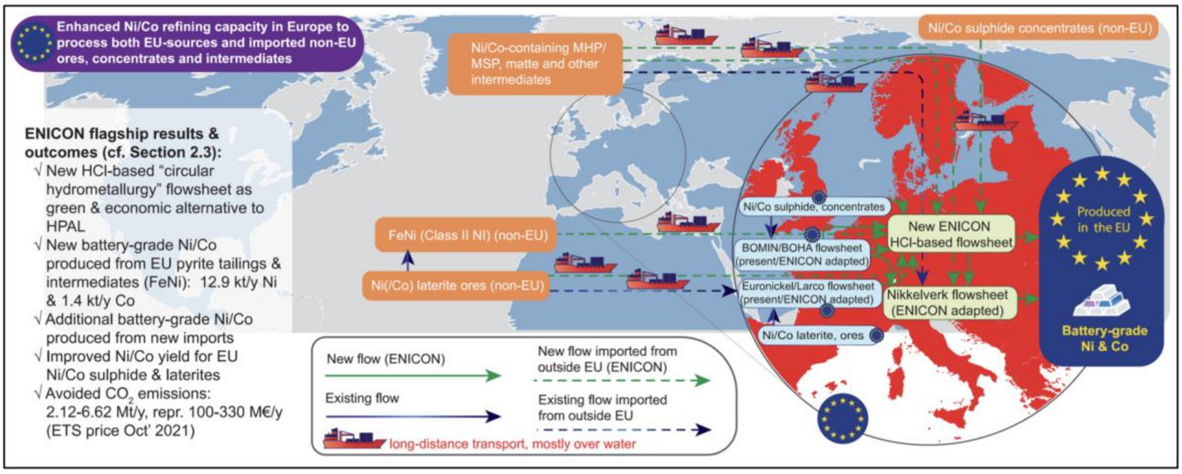

Figure 1. Graphical abstract of the ENICON's approach

A key issue is the identification of similar approaches followed by the research community and the adoption of the proposed methodologies by the industry. EU has heavily invested through different funding schemes, towards developing technologies related to batteries in general and processing ores into battery grade-metals, in particular.

This deliverable D6.1 is the first version of the report on identified projects suitable for clustering activities. Although this deliverable is due by M4, we plan on setting it up as a living document, to provide the ENICON partners a reference point in which the current research efforts will be constantly updated at European level.

The scope of this deliverable is to provide a comprehensive overview of other relevant projects, as a first step towards coordinating the efforts at EU level. The main outputs of this deliverable will be used to identify potential consortia which are suitable for clustering activities (Task 6.2). At the same time, D6.1 will be used in the context of Tasks 7.2-7.3 to enhance the efforts for disseminating and communicating ENICON's intellectual outputs and technological achievements.

2 Methodology

For the creation of the relevant projects' database an exhaustive search was performed. All the identified projects and their related data were recorded in a concise and systematic manner. In Figure 2, the structure of the table which contains the related data is presented. Every project is assigned a unique ID (P**x**, **x** corresponds to the project's ascending numbering), as an index for proper referencing. The title of the project along with the acronym and the link to the project's website are placed at the very top of the table. For each project the following information is recorded:

i) The call in which the proposal was submitted, along with the related link.
ii) The main contact person, which may be used as a reference for dissemination and clustering purposes.
iii) A short description of the project, as it is presented in its respective website.
iv) The main objectives of the project.
v) Starting and ending date.

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

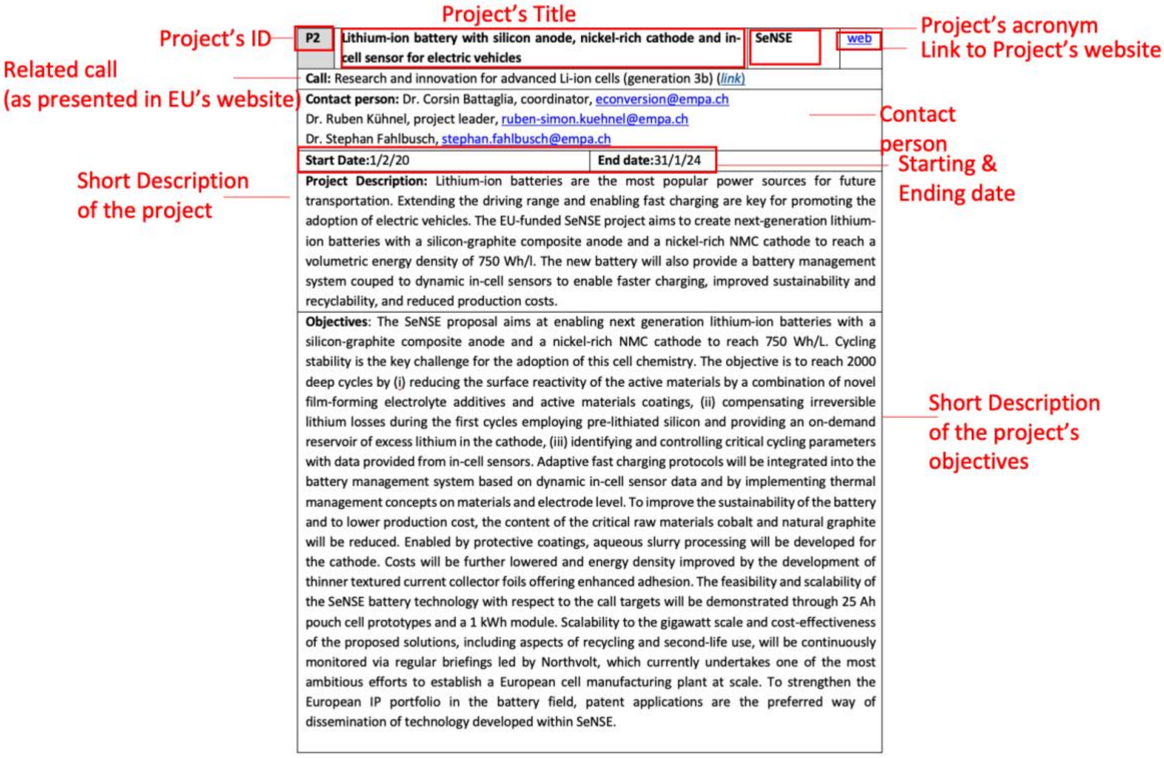

Figure 2. Sample of the projects database

3 Relevant project data

ENICON is one of the three projects, that were approved in the context of the "HORIZON-CL5-2021-D2-01-01: Sustainable processing, refining and recycling of raw materials Batteries Partnership)" call. ENICON differs significantly from the other two approved projects of the same call, namely LICORNE (P1) and RELiEF (P2), since *it exploits the potential of (low-grade) Ni/Co resources within Europe while improving and developing the Ni/Co-refining capacity that can process imported ores, concentrates and intermediates*. LiCORNE aims to increase European Li processing and refining capacity for producing battery-grade chemicals from ores, brines, tailings and off specification battery cathode materials, while 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.

Based on the intensive search carried out a total of 43 EU projects related, to a lesser or higher extent, to ENICON's activities have been identified. Most of the projects (27/43) are focusing their research activities to Li related issues, either as the main component for the proposed systems, in order produce low cost, fast charging batteries, or to investigate an appropriate manufacturing process to produce an environmentally friendly solid-state battery, with high energy capacity and high recycling efficiency.

A smaller number of projects (6/43) aimed at the selection of new prospective materials for the manufacturing process. These involve, high-capacity anodes coupled with cobalt free cathode with a polymer electrolyte separator (P14), Na-Ion cells (P16), electrolytes from lignin (P19), copper redox flow batteries (RFB) (P20), organic redox flow battery system, based on water-soluble organic electrolytes (P21), and RFB from H_2-Br_2 (P22).

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

As far as the application area is concerned (Figure 3), a large number of projects is focusing on transportation issues, mainly in electric vehicles (15/43) and aeronautical or shipping industry (5/43). Another large share of the projects (16/43) is dealing with metal processing technologies, mainly pertinent for batteries without aiming at a specific application.

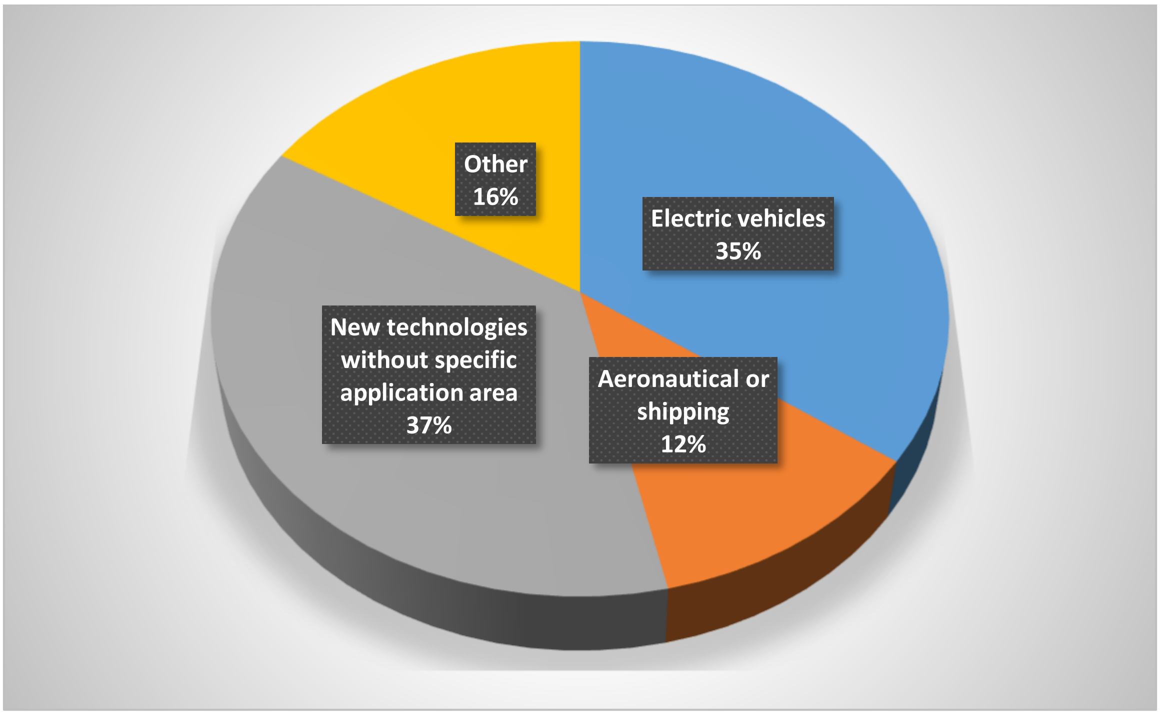

Figure 3. Projects per application area

In addition, ENICON will contact both Nickel and Cobalt Institutes.

The Nickel Institute (NI), https://nickelinstitute.org/en/, is the global association of leading primary nickel producers and its mission is to promote and support the proper use of nickel in appropriate applications.

The NI grows and supports markets for new and existing nickel applications including stainless steel, and promotes sound science, risk management, and socio-economic benefit as the basis for public policy and regulation. Through its science division NiPERA Inc., it also undertakes leading-edge scientific research relevant to human health and the environment. The NI is the centre of excellence for information on nickel and nickel-containing materials and has offices in Asia, Europe and North America.

On the other hand, the Cobalt Institute (CI), https://www.cobaltinstitute.org/, is a trade association composed of producers, users, recyclers, and traders of cobalt. It promotes the sustainable and responsible production and use of cobalt in all its forms.

Through public policy, regulatory, scientific, responsible sourcing and sustainability engagement the Institute strives to:

- Protect and grow the market for cobalt and compounds by promoting a proportionate, holistic and appropriate legislative and regulatory environment where the contribution of the entire value chain to societal goals is recognized;
- Act as the Global center of knowledge on Cobalt; and

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

- Enhance the reputation of the cobalt industry as a responsible sector with deep expertise in all relevant aspects of product stewardship.

ENICON *differs significantly from the current research efforts at European level*, since it targets a double-sided "realistic innovation" approach, while at the same time making scientific advances in Ni/Co mining, metal recovery, ultra-refining and mineral- matrix valorisation. Compared to existing EU-based flowsheets for Ni/Co mining, recovery/refining processes, ENICON will enhance the existing unit processes and will add complementary unit processes.

Overall, it aims at improving the European Ni/Co refining capacity by allowing to process Europe's low-grade Ni/Co sulphides & Ni/Co-containing tailings) & Ni(/Co) laterites. It will also develop a new HCl-based Ni/Co route which will not be a stand-alone process but it will act as a complementary process to upgrade FeNi into battery-grade Ni, while recovering Co embedded in the FeNi, or it can be connected to existing SX operations.

Finally, ENICON will have significant environmental impact by reducing the carbon footprint of the pyro-processing of Ni/Co-sulphide concentrates and the associated Ni/Co losses to the fayalitic slag during smelting & converting with the use of green hydrogen as a reductant.

4 Future activities

Within the next few months, the following activities will be discussed, agreed and planned:

- the contact persons of each identified project will be emailed; the ENICON project will be briefly presented and their interest for exchange of information will be recorded
- the projects with the highest potential for clustering will be shortlisted and the contact persons will be contacted again; if needed, e-meetings will be carried out to elucidate any pending issues
- clustering topics will be discussed and agreed with all ENICON partners
- the periods for organizing the workshops will be discussed; sufficient time will be given in order to organize them in the best possible way in order to maximize impact
- capacity building seminars will be discussed (after M9)

5 Conclusions

In the deliverable D6.1 all projects suitable for clustering activities were identified as a first step towards coordinating the efforts at European level in this highly innovative scientific field and maximizing ENICON's impact.

The identified projects derived from the same "HORIZON-CL5-2021-D2-01-01: Sustainable processing, refining and recycling of raw materials (Batteries Partnership)" and related calls of the Destination "Climate sciences and responses for the transformation towards climate neutrality"; they also included ongoing H2020 projects on next generation batteries towards Building a Low-Carbon, Climate Resilient Future (call H2020-BAT-2019) and contributing to the objectives of The European Technology and Innovation Platform (ETIP) Batteries Europe and the European Raw Materials Alliance.

The Nickel and Cobalt Institutes will be also contacted to establish common grounds for future cooperation.

This deliverable will be updated every 6 months in order to include new projects, assess the results achieved so far and plan future activities within WP6 in the best possible way. The next steps include

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

exchange of information with the contact persons of the other identified projects, shortlisting of the projects with the highest potential for clustering, establishment of the cluster, identification of clustering topics and first discussions on the workshops and capacity building seminars which will be organized at later stages.

ENICON coordinator, the partners and the project officer will be continuously informed about all activities, results and future plans of WP6.

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

Annex

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

Detailed Project List

<table>
<tr><td>P1</td><td>Lithium recovery and battery-grade materials production from European resources</td><td>LICORNE</td><td>web</td></tr>
<tr><td colspan="4">Call: Cross-sectoral solutions for the climate transition (HORIZON-CL5-2021-D2-01) (link)</td></tr>
<tr><td colspan="4">Contact person: UNDACION TECNALIA RESEARCH & INNOVATION – TECNALIA (link)</td></tr>
<tr><td colspan="2">Start Date: 1/10/22</td><td colspan="2">End date: 30/9/26</td></tr>
<tr><td colspan="4">Project Description: Europe imports more than half of the necessary battery materials, such as lithium (Li), nickel (Ni), cobalt (Co) and magnesium (Mg). Domestic production is important. In this context, the EU-funded LiCORNE project will establish the first-ever Li supply chain in Europe. It aims to increase European Li processing and refining capacity for producing battery-grade chemicals from ores, brines, tailings and off specification battery cathode materials. This supply chain encompasses five large primary resource owners having resources of lithium carbonate equivalent (LCE), of which 2.7 million tonnes are located in Europe. The value chain includes a cathode manufacturer able to reuse valuable Li, Co and Ni that will be recycled from waste cathode material. LiCORNE will investigate different ground-breaking technologies in Li processing and recovery.</td></tr>
<tr><td colspan="4">Objectives: LiCORNE aims to establish the first-ever Li supply chain in Europe. The goal is to increase the European Li processing and refining capacity for producing battery-grade chemicals from ores, brines, tailings and off-specification battery cathode materials. This supply chain encompasses five large primary resource owners (including one of the world leader in Li production) having resources of ~7.8 Mt lithium carbonate equivalent (LCE), of which 2.7 Mt are located in Europe. The European primary resources that are considered in LiCORNE would be enough to supply ~3000 GWh of batteries (i.e., ~10 years to the expected 300 GWh/year production capacity in Europe by 2030). Additionally, the value chain includes a cathode manufacturer who will be able to reuse valuable Li, Co and Ni that will be recycled from waste cathode material, and one producer and distributor of battery-grade Li-chemicals. LiCORNE will investigate 14 different ground-breaking technologies that have been selected for their potential to operate at low CAPEX and OPEX, low carbon footprint, flexibility and industrial scalability. These technologies are led by 8 top R&D centers in Europe to tackle the main bottlenecks in Li processing and recovery. During 2.5 years, R&D partners will investigate those technologies and bring their TRL from 2 to 4. After this phase, and guided by LCA and LCCA, the most promising technologies will be selected for upscaling to TRL5. During this phase a prototype system will be constructed and demonstrated to produce ~1 kg of battery-grade Li-chemicals (i.e., $LiOH{\cdot}H_2O$, Li_2CO_3 or Li-metal) from ores, brines, tailings and waste cathode material, with the recycling of Co and Ni from the latter. Results will be communicated and disseminated to a wide range of stakeholders and a first business model for a full and optimized Li supply chain in Europe will be established based on the results of the project and cost of Li produced.</td></tr>
</table>

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

<table>
<tr><td>P2</td><td>Recycling of Lithium from Secondary Raw Materials and Further</td><td>RELIEF</td><td>web</td></tr>
<tr><td colspan="4">Call: Cross-sectoral solutions for the climate transition (HORIZON-CL5-2021-D2-01) (link)</td></tr>
<tr><td colspan="4">Contact person: AVESTA BATTERY & ENERGY ENGINEERING (link)</td></tr>
<tr><td colspan="2">Start Date: Not available</td><td colspan="2">End date: Not available</td></tr>
<tr><td colspan="4">Project Description: 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 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. The expected results will contribute to decreasing the dependency of the EU on imported battery chemicals and raw materials. RELiEF will greatly strengthen the EU's competitiveness in the battery storage value chain. The RELiEF consortium consists of 12 partners, six of which are SMEs (ABEE, EXT, EURICE, IST, PEG, TC), four are non-profit RTOs (IMNR, INEGI, ZSW, NOVA) and further two are universities (LUT, ULB) and one associated industrial partner (LANX). Thus, it has strong industry involvement, entirely in the form of innovative SMEs covering the technological and also the impact maximization related aspects of the project; a perfect combination of basic research methodologies, chemical process and analysis capabilities, technology development in an industrial environment and strong ties to the recycling and battery industry and policymaking entities inside the EU.</td></tr>
<tr><td colspan="4">Objectives: New project - no information available.</td></tr>
</table>

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

P3	**First of a kind commercial Compact system for the efficient Recovery Of COblat Designed with novel Integrated LEading technologies**	**CROCODILE**	web

Call: Greening the Economy (H2020-SC5-2016-2017) (*link*)

Contact person: Dr. Amal Siriwardana (link)

Start Date: 1/6/18	**End date:** 30/11/22

Project Description: The CROCODILE project aims to drastically reduce the supply risk of cobalt for the European industries by increasing the efficiency of recovery processes for cobalt (and other relevant materials). It strives to do so with lower energy costs and environmental impacts, providing solutions with low capital investment costs. And finally, it aims to maximize the exploitation of 'local' waste. Cobalt can be leached from primary resources using bioleaching which is the extraction of metals from ores using living organisms; the process will be optimized and upscaled using a 100 L bioreactor**.** In parallel, secondary waste streams rich in cobalt will be identified and pre-concentrated by using novel advanced technologies that are capable of real-time high-speed classification. Different Co-bearing sources (like lithium batteries, electric vehicle-batteries and cobalt catalysts) are processed into a high quality cobalt concentrate by applying a **unique combination of advanced mechanical, wet mechanical and pyro-metallurgical processes**. Along with cobalt, other valuable materials like **lithium and graphite** are extracted too. Finally, the high quality cobalt concentrates (from the primary and the secondary sources) are further processed using solvent extraction and electro-winning which allows a selective extraction of cobalt. The CROCODILE project intends to optimize all the above-mentioned processes and combine them in a compact commercial mobile system with a production capacity of up to 200 kg of cobalt metal per day. Finally, CROCODILE foresees an **active stakeholder engagement** bringing together investors, industry, policy makers and civil society. Together with the CROCODILE consortium, these stakeholders scrutinize the best possible practices so that an environmental and socially-responsible business model is developed and a future replication of the project's concept can be ensured.

Objectives: The CROCODILE project will showcase innovative metallurgical systems based on advanced pyro-, hydro-, bio-, iono- and electrometallurgical technologies for the recovery of cobalt and the production of cobalt metal and upstream products from a wide variety of secondary and primary European resources. CROCODILE will demonstrate the synergetic approaches and the integration of the innovative metallurgical systems within existing recovery processes of cobalt from primary and secondary sources at different locations in Europe, to enhance their efficiency, improve their economic and environmental values, and will provide a zero-waste strategy for important waste streams rich in cobalt such as batteries. Additionally, CROCODILE will produce a first of a kind economically and environmentally viable mobile commercial metallurgical system based on advanced hydrometallurgical and electrochemical technologies able to produce cobalt metal from black mass containing cobalt from different sources of waste streams such as spent batteries and catalysts. The new established value chain in this project will bring together for the first time major players who have the potential of supplying 10,000 ton of cobalt annually in the mid-term range from European resources, corresponding to about 65% of the current overall EU industrial demand. Therefore, the project will reduce drastically the very high supply risk of cobalt for Europe, provide SMEs with novel business opportunities, and consolidate the business of large refineries with economically and environmentally friendly technologies and decouple their business from currently unstable supply of feedstocks.

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

<table>
<tr><td>P4</td><td>Near-zero-waste recycling of low-grade sulphidic mining waste for critical-metal, mineral and construction raw-material production in a circular economy</td><td>NEMO</td><td>web</td></tr>
<tr><td colspan="4">Call: Greening the Economy (H2020-SC5-2016-2017) (link)</td></tr>
<tr><td colspan="4">Contact person: Mika Paajanen Mika.Paajanen@vtt.fi</td></tr>
<tr><td colspan="2">Start Date: 1/5/18</td><td colspan="2">End date: 30/11/22</td></tr>
<tr><td colspan="4">Project Description: The NEMO project “Near-zero-waste recycling of low-grade sulphidic mining waste for critical-metal, mineral and construction raw-material production in a circular economy’” is a EU H2020 Innovation Action project (IA, call SC5-14b). Using a “4 PILOTS – 2 case-studies” concept, NEMO develops, demonstrates and exploits new ways to valorise sulphidic mining waste.</td></tr>
<tr><td colspan="4">Objectives: With an estimated volume of 600 Mtonne/y and a historic stockpile of 28,000 Mtonne, sulphidic mining waste from the production of Cu, Pb, Zn and Ni, represents the largest volume of extractive waste in Europe. When poorly managed, these “tailings” may cause major environmental problems such as acid mine drainage. In 2016 EIP Raw Materials launched a “call to arms” to transform the “extractive-waste problem” into a “resource-recovery opportunity”, as “tailings” still contain valuable & critical metals. Using a “4 PILOTS – 2 case-studies” concept NEMO develops, demonstrates and exploits, therefore, new ways to valorise sulphidic tailings. The 2 cases are the Sotkamo Ni-Cu-Zn-REE/Sc mine in Finland and the Las Cruces Cu-mine in Spain; the 4 PILOTS are located at key points in the near-zero-waste flowsheet, encompassing the recovery of valuable & critical metals, the safe concentration of hazardous elements, the removal of sulphur as sulphate salts, while using the residual mineral fraction in cement, concrete and construction products. NEMO has established an interdisciplinary consortium, including 8 industrial partners (2 mining, 4 engineering, 1 machine manufacturing & 1 construction material company), 4 research institutes, 2 universities and 1 civil society group. NEMO’s near-zero-waste technology will provide the EU with both direct and long-term, indirect advantages. The former range from new resources (e.g. base metals: Cu, Zn, Ni, Pb; critical metals: Sc, Nd, Y, Sb; SCM and aggregates etc.), CO_2 savings from metal recovery and the replacement of Ordinary Portland Cement), new job creation (> 150 FTEs), new revenues (> 200 M€/y) while the latter represent the multiplication of the former benefits (cf. 28,000 Mtonne of these tailings), while eradicating acid-mine drainage and other environmental issues, and ensuring an enhanced dialogue (framework) between industry and civil society, to obtain and maintain the License to Operate mines in EU.</td></tr>
</table>

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

P5	Delivering the 3b generation of LNMO cells for the xEV market of 2025 and beyond	3beLiEVe	web
Call: Research and innovation for advanced Li-ion cells (generation 3b) (*link*)			
Contact person: AIT Austrian Institute of Technology GmbH, Center for Low-Emission Transport, Electric Drive Technologies, **office@ait.ac.at**			
Start Date:1/1/20	**End date:**30/6/23		
Project Description: The development of better materials for use in rechargeable batteries is vital for the future of the electric vehicle market. One of these materials is lithium nickel manganese oxide (LNMO), a cobalt-free cathode material that's a cost-effective alternative to current lithium-ion (Li-ion) battery materials. **Using LNMO, the EU-funded 3beLiEVe project aims to produce the next generation of Li-ion rechargeable batteries for electric vehicles in 2025 and beyond**. Along with the next-gen battery cells, the project will also develop and integrate internal and external sensors for the cell. The data obtained from these sensors will provide a more timely and accurate view of the state of the cell and will be used to implement smart operating strategies that extend the life of the cell and improve its safety. The smart battery management system will process this data and manage an adaptive liquid cooling system. Manufacturing, second life and recycling aspects are also considered. The project's innovations will play a role in strengthening the European battery and automotive industry.			
Objectives: 3beLiEVe aims at delivering the 3b generation of LNMO cells for the electrified vehicles market of 2025 and beyond. The project addresses the full scope of the LC-BAT-5-2019 call by delivering: 3b generation batteries with LNMO cathodes, LiFSI electrolyte, and a 10-20 wt.% Si-C anode in a cell architecture capable of 750 Wh/l, 300 Wh/kg, 1.4 kW/kg, and 2,000+ deep cycles, of which 10% at 3C+; a portfolio of internal and external sensors (22 sensors per module) and an adaptive liquid cooling system managed by a smart BMS with advanced diagnostic and operational functions; cradle to cradle approach, including cell/module/pack green manufacturing processes (gigafactory level), optical equipment for inline quality inspection, 1st and 2nd life performance and recyclability demonstration, achieving 90 €/kWh life cycle cost. The project will deliver 250 cells of generation 3b in total and two demonstrator battery packs of 88 cells and 12 kWh capacity each at TRL 6 / MRL 8. These aim at demonstrating the 3beLiEVe technology performance for applications in light duty (i.e. passenger cars, freight vehicles) and commercial vehicles (i.e. city buses and trucks) in fully electric/plug-in hybrid (BEV/PHEV) configurations. 3beLiEVe technology is free of critical raw materials (cobalt and natural graphite), scalable and sustainable, aiming at 12.7 GWh production by 2025 and 33.7 GWh in 2030, for a market ranging from 1.1 to 2.5 billion €/year, i.e. 7% of the global manufacturing capacity. All the technological domains and innovations addressed in 3beLiEVe are essential for strengthening the position of the European battery and automotive industry in the future market of xEVs.			

<table>
<tr><td>P6</td><td colspan="2">Lithium-ion battery with silicon anode, nickel-rich cathode and in-cell sensor for electric vehicles</td><td>SeNSE</td><td>web</td></tr>
<tr><td colspan="5">Call: Research and innovation for advanced Li-ion cells (generation 3b) (link)</td></tr>
<tr><td colspan="5">Contact person: Dr. Corsin Battaglia, coordinator, econversion@empa.ch
Dr. Ruben Kühnel, project leader, ruben-simon.kuehnel@empa.ch
Dr. Stephan Fahlbusch, stephan.fahlbusch@empa.ch</td></tr>
<tr><td colspan="2">Start Date:1/2/20</td><td colspan="3">End date:31/1/24</td></tr>
<tr><td colspan="5">Project Description: Lithium-ion batteries are the most popular power sources for future transportation. Extending the driving range and enabling fast charging are key for promoting the adoption of electric vehicles. The EU-funded SeNSE project aims to create next-generation lithium-ion batteries with a silicon-graphite composite anode and a nickel-rich NMC cathode to reach a volumetric energy density of 750 Wh/l. The new battery will also provide a battery management system couped to dynamic in-cell sensors to enable faster charging, improved sustainability and recyclability, and reduced production costs.</td></tr>
<tr><td colspan="5">Objectives: The SeNSE proposal aims at enabling next generation lithium-ion batteries with a silicon-graphite composite anode and a nickel-rich NMC cathode to reach 750 Wh/L. Cycling stability is the key challenge for the adoption of this cell chemistry. The objective is to reach 2000 deep cycles by (i) reducing the surface reactivity of the active materials by a combination of novel film-forming electrolyte additives and active materials coatings, (ii) compensating irreversible lithium losses during the first cycles employing pre-lithiated silicon and providing an on-demand reservoir of excess lithium in the cathode, (iii) identifying and controlling critical cycling parameters with data provided from in-cell sensors. Adaptive fast charging protocols will be integrated into the battery management system based on dynamic in-cell sensor data and by implementing thermal management concepts on materials and electrode level. To improve the sustainability of the battery and to lower production cost, the content of the critical raw materials cobalt and natural graphite will be reduced. Enabled by protective coatings, aqueous slurry processing will be developed for the cathode. Costs will be further lowered and energy density improved by the development of thinner textured current collector foils offering enhanced adhesion. The feasibility and scalability of the SeNSE battery technology with respect to the call targets will be demonstrated through 25 Ah pouch cell prototypes and a 1 kWh module. Scalability to the gigawatt scale and cost-effectiveness of the proposed solutions, including aspects of recycling and second-life use, will be continuously monitored via regular briefings led by Northvolt, which currently undertakes one of the most ambitious efforts to establish a European cell manufacturing plant at scale. To strengthen the European IP portfolio in the battery field, patent applications are the preferred way of dissemination of technology developed within SeNSE.</td></tr>
</table>

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

P7	**Battery DEsign and manuFACTuring Optimization through multiphysic modelling**	**DEFACTO**	web
Call: Li-ion Cell Materials & Transport Modelling (*link*)			
Contact person: CIDETEC Energy, info@defacto-project.eu			
Start Date:1/1/20	**End date:**30/6/23		
Project Description: Rechargeable lithium-ion batteries (LIBs) power everything from portable electronics to electric cars. Since the first one was launched nearly 30 years ago, they have continued to evolve to support rapid innovation of the products that depend on them. A critical bottleneck in today's LIBs is the cathode material. Cathodes based on nickel-manganese-cobalt (NMC) are among the most promising. These materials could significantly reduce costs and enable longer driving ranges for tomorrow's electric vehicles. **The EU-funded DEFACTO project plans to turbocharge the development of next-generation LIBs for the automotive market with a comprehensive open-source modelling tool**. Using experimental data from two existing NMC cells to optimise algorithms, the platform promises to reduce development time and cost while enhancing performance and durability.			
Objectives: The DEFACTO project rationale is to develop a multiphysic and multiscale modelling integrated tool to better understand the material, cell and manufacturing process behaviour, therefore allowing to accelerate cell development and the R&I process. This approach will allow developing new high capacity and high voltage Li-ion cell generation 3b battery. This will increase the understanding of multiscale mechanisms and their interactions, reducing the R&D cell development resources, therefore unlocking an innovation-led cell manufacturing industry in Europe. The validated computational simulations will be a powerful tool to (i) tailor new optimum cell designs, (ii) optimise manufacturing steps of electrode processing and electrolyte filling, and (iii) shape new generation 3b materials. This work will be based on an iterative exchange process for model development, validation and optimisation using two cell technologies for the automotive market: a commercial NMC622/G cell taken from the product portfolio from one of the DEFACTO partners and last generation prototypes (NMC811/G-Si). Characterisation tests will provide data for model development and validation, and for gaining understanding on ageing mechanisms. Sensitivity analysis will demonstrate model robustness and reduce the number of experiments needed during cell development. The optimization algorithms will enhance cell performance and durability through optimised designs and manufacturing processes. The novel fast-track cell development procedure achieved will be further extended to LMNO/G-Si prototypes. In parallel, the set of individual multiscale and multiphysic models will be compiled in an open-source simulation tool, including mechanical and electrochemical ageing with outstanding accuracy at reasonable computational cost. The project consortium, which covers the whole cell manufacturing value chain, has the required experience to ensure a smooth and high-quality delivery of the outcomes of the project.			

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

<table>
<tr><td>P8</td><td>Sodium-Zinc molten salt batteries for low-cost stationary storage</td><td>SOLSTICE</td><td>web</td></tr>
<tr><td colspan="4">Call: Building a Low-Carbon, Climate Resilient Future: Next-Generation Batteries (H2020-LC-BAT-2019-2020) (link)</td></tr>
<tr><td colspan="4">Contact person:
Dr. Norbert Weber, Project Coordinator, E-Mail: norbert.weber@hzdr.de
Dr. Tom Weier, Communications, E-Mail: t.weier@hzdr.de
Susann Riedel, Project Manager, E-Mail: s.riedel@hzdr.de</td></tr>
<tr><td colspan="2">Start Date:1/1/21</td><td colspan="2">End date:30/6/25</td></tr>
<tr><td colspan="4">Project Description: The EU-funded SOLSTICE project plans to develop two sodium-zinc molten salt batteries operating at high temperatures that could be used for stationary energy storage. The first battery will be based on ZEBRA technology, a type of rechargeable molten salt battery based on nickel, sodium and chloride. Instead of nickel, researchers will use cheap and abundant zinc as the positive electrode. In the second all-liquid battery, researchers will apply the same chemistry but will not use a ceramic electrolyte, thereby further driving down battery costs. Both battery concepts will be brought at a technology readiness level 5.</td></tr>
<tr><td colspan="4">Objectives: SOLSTICE answers the quest for stationary energy storage with two Na-Zn molten salt batteries, which operate at elevated temperature. The first concept benefits from the existing and successful ZEBRA® technology. Replacing their Ni-electrode by cheap and abundant Zn will only minimally affect other system parts thereby ensuring fast commercialisation. The second approach, an all-liquid cell, will apply the same chemistry, but does not require a ceramic electrolyte thus reducing cost further. Both battery concepts shall be brought to TRL5, and validated by four demonstrators, operating in a realistic environment at the end of the 4-year project. The demonstrators will be equipped with a self-learning battery management system and will be accompanied by upscaling, system integration and public acceptance studies. Na-Zn technology is exceptionally performant as it promises similar efficiency and depth of discharge as Li-ion cells, but extreme current densities. Featuring molten electrodes, Na-Zn cells actually work better when being cycled, as operation keeps them warm; several cycles per day and a lifetime exceeding 10,000 cycles can be legitimately expected. Na-Zn storage is perfectly sustainable: the raw materials, table salt and Zn, are abundant in the EU, cheap and not harmful. The environmental impact of Zn-mining and battery production is expected to be minimal. Finally, recycling is greatly simplified due to the large, molten electrodes. The most valuable element, Zn, can simply be recovered as pure metal and reused after dismantling the cells. Based on the existing knowledge on ZEBRA® battery production, the storage price of Na-Zn batteries is expected to approach 1 cent/kWh/cycle by 2030 - including balance-of-plant and recycling cost. Summing up, the Na-Zn technology is the cheapest molten-salt battery, is fully sustainable, fulfils all criteria of the call - and is even realistic to be commercialized by 2030.</td></tr>
</table>

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

P9	**Long LAsting BATtery System**	**LOLABAT**	web
Call: Building a Low-Carbon, Climate Resilient Future: Next-Generation Batteries (H2020-LC-BAT-2019-2020) (*link*)			
Contact person: CY CERGY PARIS UNIVERSITE (*link*)			
Start Date:1/1/21		**End date:**31/3/24	
Project Description: Energy security, autonomy and sustainability are amongst the most pressing goals in Europe today. There is a growing need to shift away from using fossil sources for clean, renewable energy sources. Battery energy storage systems enable an increasing use of technologies supporting intermittent renewable electricity generation. They create new demands on the grid, but several advancements in sustainability and competitiveness must be made. **In this direction, the EU-funded LOLABAT project aims to develop a novel and promising battery chemistry – a rechargeable nickel-zinc battery**. This is envisioned to have very high energy and power densities and low costs. It will be environmentally friendly, using abundant, available raw materials and non-toxic elements and having high recycling potential.			
Objectives: Transition to renewable energy sources (RES) is a critical step to slow down the climate changes, to overcome the energy crisis and to ensure energy independence between different regions of the world. Battery energy storage systems (BESS) are currently seen as important technological enablers for increasing the absorption of RES into the electric grid. However, improvements in their performance, cost competitiveness and sustainability should be achieved. For EU, the complete batteries value chain and life cycle has to be considered, from access to raw material, over innovative advanced materials to modelling, production, recycling, second life, life cycle and environmental assessments. LOLABAT's 17 stakeholders aim to develop a new promising battery chemistry, RNZB (rechargeable NiZn Battery). The RNZB presented and developed during LOLABAT will have energy and power densities both the highest just after Li-ion batteries, cost the lowest just after the Lead-acid battery, while profiting from abundant and available raw materials, non-toxic elements, high safety, low risk of thermal runaway, limited environmental impact and high recycling potential. The ambitions (2024 and after) of LOLABAT are: further increase of the cycle life of NiZn (to at least 4000 cycles at 100% DoD be the end of project), development of NiZn for grid applications and its preparation for a production in Europe, by increasing its TRL via upscaling of capacity, design and integration of BMS and sensors built up in battery packs, testing and demonstration in stationary energy storage applications via six use cases in utility grid and industrial sites, its preparation for a future industrialization by realization of life cycle and life cycle cost analyses, recycling studies, assessment of norms, standards and grid compliancy, realization of business model and market studies and finally an extensive dissemination and communication of the project results and NiZn technology.			

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

P10	All Solid-sTate Reliable BATtery for 2025	ASTRABAT	web

Call: Strongly improved, highly performant and safe all solid state batteries for electric vehicles (*link*)

Contact person: Sophie Mailley
French Alternative Energies and Atomic Energy Commission (CEA) **coordinator@astrabat.eu**

Start Date:1/1/20	**End date:**30/6/23

Project Description: To avoid relying on other countries to meet its energy transition goals, Europe is faced with the challenge of developing and producing competitive lithium-ion (Li-ion) batteries. While a promising option, Li-ion technology stills needs further development in order for mass production to be economically viable and environmentally friendly. To meet this goal, **the EU-funded ASTRABAT project intends to find optimal solid-state cell materials, components and architecture that can be mass-produced to meet electric vehicle market demands**. The project will play a role in strengthening the European battery value chain as well as collaborations between research and technology organizations, SMEs and industrial partners.

Objectives: Europe is facing a major challenge to develop and produce a competitive Li-battery product in order to avoid dependency on third countries in its energy transition models. The Li-ion cell innovations should meet specific technical and economical requirements to sustain the market growth. The all-solid Li-ion technology appears to be one of the relevant options but it still has to be brought to higher TRL to be economically and environmentally friendly for a mass production compatible process. The ASTRABAT project gathers 14 partners, leaders in the different fields of research, development and production, from 8 countries. It aims to find optimal solid-state cell materials, components and architecture that are well suited to the demands of the electric vehicle market and compatible with mass production. The project will comply with improved safety demands and industrial standards. Five ambitious objectives were defined:

1. Development of materials for a solid hybrid electrolyte and electrodes enabling high energy, high voltage and reliable all-solid-state Li-ion cells
2. Gen#2D cell design: processing techniques compatible with existing routes of large scale cell manufacturing (10Ah, Energy type) and validation of a pilot prototype in a relevant industrial environment
3. Development of a 2030s eco-designed generation for Power-type and Energy type all-solid-state cells in pre-prototype (Gen#3DS and #3DC)
4. Define an efficient cell architecture to comply with improved safety demands
5. Structuration of the whole value chain of the all-solid-state battery, including eco-design, end of life and recycling

The project will reinforce the European battery value chain, strengthen collaborations between RTOs, SMEs and Industrial partners from material development to integration in vehicles. The implementation of related work packages, tasks, milestones and risk assessment is considered to achieve these objectives comprehensively.

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

<table>
<tr><td>P11</td><td>advanced all Solid stAte saFE LIthium Metal technology tOwards Vehicle Electrification</td><td>SAFELiMOVE</td><td>web</td></tr>
<tr><td colspan="4">Call: Strongly improved, highly performant and safe all solid state batteries for electric vehicles (link)</td></tr>
<tr><td colspan="4">Contact person: Dr. MariaMartinez CIC energiGUNE mmartinez@cicenergigune.com
Ms.Leire Olaeta , CIC energiGUNE, lolaeta@cicenergigune.com</td></tr>
<tr><td colspan="2">Start Date:1/1/20</td><td colspan="2">End date:31/12/23</td></tr>
<tr><td colspan="4">Project Description: Electric vehicles (EVs) play an important role in the bid to meet global goals on climate change. Although the market for EV batteries has seen consistently high growth rates over the past few years, currently the battery technology is dominated by players from Asian countries. The EU-funded SAFELiMOVE project intends to increase Europe's representation in this market by gathering key European actors in the battery sector, including industrial materials producers, battery manucfacturer, R&D centres and the automotive industry. The project aims to develop a new lithium-metal battery cell technology based on a safe, reliable and high-performance solid-state electrolyte. Its high specific energy (450 Wh/kg), fast charging and long cycle life is expected to extend EV range, helping the transport sector to reduce greenhouse gas emissions.</td></tr>
<tr><td colspan="4">Objectives: Transport is responsible for around a quarter of EU greenhouse gas (GHG) emissions, and more than two thirds of transport-related GHG emissions are from road transport. Countries around the world are betting on EVs to meet sustainability targets. Battery cells are considered as the heart of EVs, and currently EU OEMs import around 90% of the battery cells from Asian companies. New materials and processes are needed if the EU wants to catch up with Asian battery manufacturers. SAFELiMOVE will gather key European actors in the battery sector, from industrial materials producers, to R&D centers and automotive industry, covering the complete knowledge and value chain. SAFELiMOVE will not only strengthen the R&D in the energy and automotive sectors but especially the European industry in these fields. SAFELiMOVE project aims to support a market-driven disruptive technology change towards high energy density batteries (450 Wh/kg or 1200 Wh/L) and improved safety in a cost-effective manner. SAFELiMOVE delivers innovations in five main technology areas: development of nickel-rich layered oxide cathode materials; high specific capacity, lithium metal anode materials; advanced hybrid ceramic-electrolyte with improved ion conductivity at room temperature; interface adoption for effective Li transport by surface modification and/or over-coatings, and knowhow creation for the development of scale up production of all-solid-state batteries. By higher energy density batteries towards 450 Wh/kg, faster charging and longer cycle life, SAFELiMOVE aims to meet future battery requirements for EVs. Thus, the range of EVs will be extended and the electro-mobility and decarbonization will be further pushed forward with impact in climate change scenarios.</td></tr>
</table>

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

<table>
<tr><td>P12</td><td>Liquid-Processed Solid-State Li-metal Battery: development of upscale materials, processes and architectures</td><td>SOLiDIFY</td><td>web</td></tr>
<tr><td colspan="4">Call: Strongly improved, highly performant and safe all solid state batteries for electric vehicles (link)</td></tr>
<tr><td colspan="4">Contact person: INTERUNIVERSITAIR MICRO-ELECTRONICA CENTRUM (link)</td></tr>
<tr><td colspan="2">Start Date:1/1/20</td><td colspan="2">End date:31/12/23</td></tr>
<tr><td colspan="4">Project Description: Sustainable batteries with ultra-high performance and smart functionalities will play a critical role in powering Europe's transition from fossil fuels to renewable energies. Conventional lithium-ion batteries utilise a liquid electrolyte. Solid-state lithium-ion batteries, or lithium-metal solid-state batteries, use a solid electrolyte and lithium metal as the battery anode. These are garnering increasing attention for their promise of low cost, high performance and enhanced safety, yet they are far from achieving commercial viability. The EU-funded SOLiDIFY project is developing materials and manufacturing processes to bring their novel liquid-processed solid-state fabrication technology to fruition. It will enable successful integration of their solid nanocomposite electrolyte and fabrication of a new generation of lithium-metal solid-state batteries with Europe leading the charge.</td></tr>
<tr><td colspan="4">Objectives: The SOLiDIFY project proposes a unique manufacturing process and solid-electrolyte material to fabricate Lithium-metal solid-state batteries – known as Gen. 4b on the EU battery roadmap. The concept is based on a solid nanocomposite electrolyte or nano-SCE. It is made by a sol-gel reaction which is used advantageously for a liquid-to-solid approach in the fabrication of the composite cathode and the solid-electrolyte separator. The general strategy to reach the target energy density of 1200Wh/L (400Wh/kg) in 20 minutes charging time is: (1) enabling the integration of high-energy NMC active materials and (2) development of new electrode architectures for high mass loading and enabled by the liquid-to-solid approach. An added imposed challenge is a water-based cell assembly process. To this end, suitable protection of the high-energy NMC powder with ALD thin-film coatings is pursued. Finally, thin lithium foils with protective artificial interphase coatings will be developed for lamination on the nano-SCE separator.
The main goal of SOLiDIFY is to bring the liquid-processed solid-state cell fabrication concept from demonstration in the lab (TRL3) to demonstration of prototypes in pilot line (TRL6), with upscaling of the concept both towards (1) the development of manufacturable materials and processes and (2) the discovery of full cell assembly schemes with ultimate demonstration of 1Ah pouch cells. The material research will focus on (1) solutions enabling the upscaling process and manufacturability and (2) further improvement of cell integration steps to enhance performance. Manufacturable parameters such cost, environmental impact and recycling will also be handled. The larger scope of the SOLiDIFY project entails the development of a novel and potentially European-lead solid-state battery technology with fully covered EU value chain.</td></tr>
</table>

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

<table>
<tr><td>P13</td><td>Solid state sUlfide Based LI-MEtal batteries for EV applications</td><td>SUBLIME</td><td>web</td></tr>
<tr><td colspan="4">Call: Strongly improved, highly performant and safe all solid state batteries for electric vehicles (link)</td></tr>
<tr><td colspan="4">Contact person: Dr. Jens Ewald, FEV EUROPE GMBH, coordination@sublime-project.eu</td></tr>
<tr><td colspan="2">Start Date:1/5/20</td><td colspan="2">End date:30/4/24</td></tr>
<tr><td colspan="4">Project Description: With transport responsible for about a quarter of the world's greenhouse emissions, the development of electric vehicles (EVs) is deemed crucial. The EU-funded SUBLIME project aims to significantly increase the use of EVs by taking on the technical challenges presented by the consumer needs. These are mainly associated with reducing EV costs while increasing their ability to travel greater distances and allowing for fast charging. The SUBLIME project will help develop a complete value chain for new sulfide electrolyte-based solid-state battery cells with high capacity and high voltage stability.</td></tr>
<tr><td colspan="4">Objectives: Wide global deployment of electric vehicles (EVs) is necessary to reduce transport related emissions, as transport is responsible for around a quarter of EU greenhouse gas (GHG) emissions, and more than two thirds of transport-related GHG emissions are from road transport. SUBLIME's overall aim is to significantly increase EV adoption by taking on the technical challenges that are presented by the consumer needs - especially the reduction in costs of EVs, increasing their capabilities regarding long distance traveling and fast charging. SUBLIME concept entails development of a complete value chain, from requirements to testing, for new sulfide electrolyte based solid-state battery cells with high capacity and high voltage stability (scalable to mass production) to reach gravimetric energy density of >450 Wh/kg and volumetric Energy density of >1200 Wh/l. SUBLIME proposes the usage of high capacity and high voltage electrode materials. Li metal as anode (LiM), Ni rich NMC material e.g. or NMC90505 as cathode are foreseen to be used to achieve the targeted energy density. The battery will be inherently safe and will be able to operate at room temperature or lower; thus facilitating the start of the vehicle in broad operating conditions. Interfaces showing a fast Li-ion transport will be developed in the project and partners will focus on developing intimate and (electro)-chemically stable interfaces with strong mechanical properties. The interfaces will be specifically designed to increase stability of the component and the malleable nature of the sulfide enables good interfacial contact. SUBLIME will bring the sulfide electrolyte solid-state battery technology to TRL 6. The scale-up to pre-industrial volume will ensure that results are, indeed, scalable to large-volume commercial manufacturing. SUBLIME will deliver a roadmap to 2030, enabling eventual market entry by a very strong constellation of European partners, to bring about the transition towards electric.</td></tr>
</table>

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

<table>
<tr><td>P14</td><td>Advanced material solutions for safer and long-lasting high capacity Cobalt Free Batteries for stationary storage applications</td><td>CoFBAT</td><td>web</td></tr>
<tr><td colspan="4">Call: Strengthening EU materials technologies for non-automotive battery storage (link)</td></tr>
<tr><td colspan="4">Contact person: https://www.cofbat.eu</td></tr>
<tr><td colspan="2">Start Date:1/11/19</td><td colspan="2">End date:31/10/23</td></tr>
<tr><td colspan="4">Project Description: For decades, scientists have been exploring materials to produce a new generation of long-lasting batteries. The EU-funded CoFBAT project aims to develop novel batteries for energy storage that are cobalt free and in a modular format, rendering it suitable for different wide-ranging applications, be it domestic or industrial. New materials and components will be developed and optimised to achieve novel battery cells with longer lifetime, improved ciclability, lower costs, improved safety, lower environmental impact and more efficient recycling. The proposed solutions will allow Europe to become less dependent on raw materials for securing the supply chain, since CoFBAT gathers the whole value chain in battery production from materials to battery manufacturing, including electrochemical characterization and life cycle assessment. The feasibility, of a metal recovery process will also be deeply investigated and recommendations for future application made.</td></tr>
<tr><td colspan="4">Objectives: The project main goal is to develop new generation batteries for battery storage with a modular technology, suitable for different applications and fulfilling the increasing need of decentralised energy production and supply for private households and industrial robotised devices. New materials and components will be developed and optimised to achieve longer lifetime (up to 10,000 cycles depending on the material selected), lower costs (down to 0.03 €/kWh/cycle), improved safety and more efficient recycling (>50%). The expected results will strengthen EU competitiveness in advanced materials and nanotechnologies and the related battery storage value chain, preparing European industry to be competitive in these new markets. This will be achieved by using high capacity anodes coupled with cobalt free cathode and with a very safe gel polymer electrolyte separator, leveraging partners' knowledge in advanced materials. This new technology will be developed up to a TRL 6 (large prismatic cell ESP-Cell 30Ah) at the end of the project, producing these novel high voltage high capacity batteries close to practical applications. Further, the proposed solution will allow Europe to become more independent from raw material and the feasibility of a metal recovery process will be deeply investigated and recommendations for future application will be made. To achieve the ambitious targets, the CoFBAT project covers the entire value chain, bringing together industrial experts in material development and battery science together with engineering companies and institutes and battery producers and integrators.</td></tr>
</table>

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

<table>
<tr><td>P15</td><td colspan="2">Ecologically and Economically viable Production and Recycling of Lithium-Ion Batteries</td><td>ECO2LIB</td><td>web</td></tr>
<tr><td colspan="5">Call: Strengthening EU materials technologies for non-automotive battery storage (link)</td></tr>
<tr><td colspan="5">Contact person: Stefan Durm, stefan.durm@eura-ag.de</td></tr>
<tr><td colspan="2">Start Date:1/1/20</td><td colspan="3">End date:30/6/24</td></tr>
<tr><td colspan="5">Project Description: The Sintbat project, http://www.sintbat.eu/home.html, managed to develop a cheap and energy efficient, maintenance free, lithium-ion based energy storage system offering an in-service time of 20 to 25 years. The EU-funded project ECO2LIB adds to the successes of that project, shifting focus to a new key performance improvement (KPI), the cycle related costs per energy. An extended LCA, cradle-to-grave will also be setup to judge the environmental impact of the different options and to choose the best. In fact, the ECO2LIB acronym was created to underscore the ecological and economical importance of the project.</td></tr>
<tr><td colspan="5">Objectives: After the successful project Sintbat, this project aims to continue the effort with the modified objectives of LC-BAT-2-2019. This new call moves the focus to a new KPI, the cycle related costs per energy: €/kWh/cycle. It very well reflects the real need of the customers if a minimum volumetric energy density is added. An extended LCA, cradle-to-grave will be setup to judge the environmental impact of the different options and to choose the best. To show the both ECO-aspects (ECOlogical and ECOnomical) of our project the acronym ECO²LIB was created. Especially for the deployment of advanced battery systems, time to market is an important factor. This criterion is helpful to select between the different electrochemical systems:
- Lithium-Sulphur: is heavily investigated, but up to now doesn’t show a break-through to reach acceptable cycle life
- Lithium-Air: For this system, many major problems are known to be solved, like Li metal protection, dendrite growth, cleaned air inlet, oxygen-stability of the catholyte
- Zinc-Air: is better, but this system, as all Metal-Air systems, will never lead to a maintenance-free battery
- All-Solid-State: has a chance in the polymer version, but rather not in oxidic or sulfidic version
- Sodium-Ion: can be potentially interesting for large-scale storage due to cost advantages (replacing Cu with Al), but is still held back due to the lack of a useful and stable anode material and a complex surface chemistry
- Organic-based systems: can be potentially interesting for large-scale storage due to potential sustainability impacts, but have problems regarding energy density (especially volumetric), cycling stability, and materials degradation
Consequently, the consortium decided to continue the improvement of the well-established Lithium-Ion system with advanced materials, methods and corresponding recycling-concept. So it will be possible to directly exploit the results of ECO²LIB in an IPCEI project, which is under preparation.</td></tr>
</table>

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

P16	NA ION materials as essential components to manufacture robust battery cells for non-automotive applications	NAIMA	web
Call: Strengthening EU materials technologies for non-automotive battery storage (*link*)			
Contact person: **https://naimaproject.eu/contact/**			
Start Date:1/12/19	**End date:**31/5/23		
Project Description: The share of renewable energy sources in the EU energy market is constantly growing, demanding highly consolidated technologies such as wind energy and solar photovoltaics to face global competitiveness. The market requires higher flexibility that can be achieved with the growth of decentralised installations and lower costs. However, advanced and cost-effective alternatives to existing technologies are developed in Asia. **The EU-funded NAIMA project intends to develop and test new-generation sodium-ion cells and prove that they are highly competitive, safe, solid and the most cost-effective solution to replace lithium-based technologies**. The new technology relies on a robust European battery value chain that is committed to significantly invest in the sector, making EU manufacture highly competitive worldwide.			
Objectives: The EU is transitioning to The EU is transitioning to a secure, sustainable and competitive energy system as laid out in the EC's Energy Union strategy. The growing penetration of renewable energy sources in the EU energy market, go hand in hand with a high-competitiveness of the most consolidated technologies: Wind Energy and Solar Photovoltaics. The non-dispatchable renewable generation requires a higher flexibility in the energy system, where the weight of much more decentralised installations grow day-to-day. In fact, the flourishing of a wide portfolio of renewable energy installations is allowing the deployment of large to small scale industrial electricity grids, and in an increased share of electricity produced in private households. The NAIMA project will demonstrate that the new generation of high-competitive and safety Na-Ion cells developed and tested during the project, is one of the most robust and cost-effective alternatives to unseat the current and future Li-based technologies, nowadays controlled by Asian industry. The EU cannot jeopardize the future of its stronger industry to a technology already in the hands of non-European countries. Just the availability of the raw materials of Li-ion cells is almost a "miracle". Under this scenario, the most robust non-Lithium alternative is the technology based on Sodium-ion (Na-ion). This disruptive technology is already supported by a solid European Battery value chain (industry partners of the consortium) through their solid commitment of substantial investments in the manufacturing of all components of a battery, preserving the ownership and industry strength around European countries. Within the framework of the project, 3 SIB prototypes will be tested in 3 multi-scale Business Scenarios to provide solid evidences about the competitiveness of the technology in 3 real ESS environments (renewable generation, industry and private household) through the application of an assessment and monitoring protocol.			

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

P17	**Computer aided design for next generation flow batteries**	**CompBat**	[web]
Call: Modelling and simulation for Redox Flow Battery development (*link*)			
Contact person: info@compbat.com			
Start Date:1/2/20	**End date:**31/1/23		
Project Description: CompBat aims to take flow batteries to the next level, identifying new prospective molecules for their chemical composition. Tools will be developed to this end, using machine learning paired with a high-throughput screening method to enable large-scale automated testing. Targeted molecules are bio-inspired organic compounds, as well as derivatives of a specialty bulk-manufactured chemical. Sophisticated calculations will be deployed to obtain data on molecules and their properties. Based on the results, **The EU-funded CompBat project will perform modelling of flow battery systems to allow for predictions on performance, and a cost estimation approach will be applied**. Furthermore, the team will examine the possibility of using solid boosters to enhance battery capacity.			
Objectives: CompBat will focus on developing tools for discovery of new prospective candidates for next generation flow batteries, based on machine learning assisted high-throughput screening. Density functional theory calculations will be used to obtain data on solubilities and redox potentials of different molecules, and machine learning methods are used to develop high-throughput screening tools based on the obtained data. The results of the high-throughput screening are validated with experimental results. Target molecules will be bio-inspired organic compounds, as well as derivatives of the redox active specialty chemical already manufactured in bulk quantities. Stability and reversibility of the molecules will also be investigated by DFT calculation, experimental investigations and machine learning methods, for a selected group of interesting molecules. Numerical modelling of flow battery systems will be performed with finite element method, and with more general zero-dimensional models based on mass-transfer coefficients. The models will be verified experimentally, and the modelling will generate a data-set to allow prediction of the flow battery cell performance based on properties of the prospective candidates obtained from high-throughput screening. This data is used then to predict the flow battery system performance from the stack level modelling. Freely available cost estimation tools are then adapted to estimate the system performance also in terms of cost. This approach will allow prediction of the battery performance from molecular structure to cost. Furthermore, the concept of using solid boosters to enhance the battery capacity will be investigated by developing models to simulate the performance of such a systems, and validating the models experimentally with the candidates already reported in the literature.			

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

P18	Modelling for the search for new active materials for redox flow batteries	SONAR	web
Call: Modelling and simulation for Redox Flow Battery development (*link*)			
Contact person: Dr.-Ing. Jens Noack, Adj. Assoc. Prof. (UNSW) Fraunhofer Institute for Chemical Technology ICT jens.noack@ict.fraunhofer.de			
Start Date:1/1/20	**End date:**31/12/23		
Project Description: SONAR will develop a framework for the simulation-based screening of electroactive materials for aqueous and nonaqueous organic redox flow batteries (RFBs). It will adopt a multiscale modelling paradigm, in which simulation methods at different physical scales will be further advanced and linked by combining physics- and data-based modelling. SONAR will develop a screening framework to determine levelized cost of storage, starting from the automatic generation of candidate structures for the electroactive material, then iterating through molecular-, electrochemical interface-, porous electrodes-, cell-, stack-, system- and techno-economic-level models. To increase the throughput of the screening, SONAR will exploit advanced data integration, analysis and machine-learning techniques, drawing on the growing amount of data produced during the project. Project results are expected to reduce the cost and time-to-market of redox flow batteries, thus strengthening the competitiveness of the EU battery industry.			
Objectives: SONAR will develop a framework for the simulation-based screening of electroactive materials for aqueous and nonaqueous organic redox flow batteries (RFBs). It will adopt a multiscale modelling paradigm, in which simulation methods at different physical scales will be further advanced and linked by combining physics- and data-based modelling. Competing energy storage technologies are only comparable when using the levelized-cost-of-storage (LCOS) as a global metric, accounting for the complex interrelations between factors like CAPEX, lifetime and performance. SONAR will thus develop a screening framework to determine LCOS, starting from the automatic generation of candidate structures for the electroactive material, then iterating through molecular-, electrochemical interface-, porous electrodes-, cell-, stack-, system- and techno-economic-level models. For the iterative traversal of the different scales, exclusion criteria like solubility, standard potentials and kinetics will be defined, and the results for individual candidates will be stored in a database for further processing. To increase the throughput of the screening, SONAR will exploit advanced data integration, analysis and machine-learning techniques, drawing on the growing amount of data produced during the project. The models will be validated e.g. by comparison with measurements of redox potentials for known chemistries, or measurement data of RFB half-cells and lab-sized test cells. SONAR will work closely with industrial partners (incl. JenaBatteries, Volterion) to ensure the commercial viability of the results. The models will be exploited individually and in a comprehensive screening service offered by Fraunhofer SCAI, facilitating the rapid assessment of the technical and economic potential of a new technology in its earliest development stages. This will reduce the cost and time-to-market, thus strengthening the competitiveness of the EU's battery industry in the emerging field of organic RFBs.			

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

P19	**Development of full lignin based organic redox flow battery suitable to work in warm environments and heavy multicycle uses.**	**BALIHT**	web

Call: Advanced Redox Flow Batteries for stationary energy storage (*link*)

Contact person: Javier Peña, AIMPLAS, **dgpro@aimplas.es**
Elise Regairaz , AliénorEU, **elise.regairaz@alienoreu.com**

Start Date:1/12/19	**End date:**31/5/23

Project Description: The EU-funded BALIHT project is designing new redox organic flow batteries that can work at temperatures of up to 80 °C. Researchers claim that the batteries will offer longer duration, higher power and a 20 % higher energy efficiency compared to other organic battery types. The new battery will be based on low-cost, abundant organic molecules that are easily dissolved in water, electrolytes comprising lignin, thin non-fluorinated membranes and carbon electrodes. Redox organic flow batteries are one of the most promising approaches to sustaining a grid powered by the sun and wind, improving grid flexibility and stability and providing high-performance charge points for electric cars.

Objectives: Redox flow batteries (RFBs) are designed to work up temperature of 40ºC, however, discharging the battery generates heat. A cooling system is required to avoid electrolyte degradation or battery malfunction. Cooling requires energy and reduces the battery global efficiency. Moreover, higher temperatures have advantages: low electrolyte viscosity (less pump energy), better electrolyte diffusion in electrode & increase battery power due to increase electron mobility.

BALIHT project aims to develop a new organic redox flow battery suitable to work up to temperatures of 80ºC, with a self-life similar than current organic ones, but with an energy efficiency 20% higher than current RFB since cooling system is not required, less pump energy & high power.

Redox-active organic molecules with promising prospect in the application of RFBs, benefited from their low cost, vast abundance, and high tunability of both potential and solubility. These organic molecules are more soluble in water, which allows more concentrated electrolyte and increased battery capacity.CMBlu has developed an organic redox flow battery technology that use electrolytes from lignin, thin non-fluorinated membrane, carbon-based electrodes and plastic frames. Lignin is a renewable resource and the largest natural source of aromatic compounds from which efficient electrolytes can be produced.

BALITH concept of organic RFB makes this technology suitable for many applications where the requirements for batteries are more challenging like:

- Smoothing of non-dispatchable renewable power plants (like solar or wind)
- Support for Ancillary services
- High performance electric car recharge points
- Improvement of grid flexibility and stability (at both transmission and distribution level).
- Avoid cooling needs in RFB placed in warm countries (between 40º Latitude North & 40º Latitude South).

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

P20	Copper-Based Flow Batteries for energy storage renewables integration	CUBER	web
Call: Advanced Redox Flow Batteries for stationary energy storage (*link*)			
Contact person: Corneliu Barbu, Aarhus University, coba@ece.au.dk			
Start Date:1/1/20	**End date:**31/12/23		
Project Description: The search for competitive energy storage is linked to the transition towards renewable energy solutions. The all-copper redox flow battery (CuRFB), based on RFB technology, is designed in a simple, modular and scalable way and offers security and sustainability. **The EU-funded CUBER project will prove that RFB technology can be integrated into Smart Cities and residential self-consumption market segments**. Its development could allow wider applications such as back-up power system in isolated areas, for energy management and grid balancing in renewable energy plants. The project coordinates a wide range of European actors in aiming to develop operating pilots that will confirm and introduce innovative methods to produce and consume renewable energy in urban, rural and industrial sites.			
Objectives: The CuBER project proposes the validation of a promising RFB technology, the all-copper redox flow battery (CuRFB), able to cover a wide range of the aforementioned market applications due to its simple, modular and scalable design, security and sustainability. Firstly, a 5kWDC CuRFB pilot will be designed for its integration in Smart Cities and residential self-consumption market segments within the CuBER action. Subsequently, the planning of further developments will allow its application at larger scales, both as back-up power system in isolated areas (i.e. copper mining) and for energy management and grid balancing in renewable power production. CuBER thus focuses first on improving the infrastructures for renewables self-consumption and grid integration within the Smart Cities and Net Zero Buildings concepts. It seeks to unify the expertise of different European actors in the field of Electrochemistry, Electrochemical Energy Storage, Electronics, Process Engineering, Smart Sensors, IoT´s and Solar Power Industries with the objective of deploying functional pilots capable of validating an holistic and innovative way of producing and consuming renewable energy in urban, rural and industrial areas all around the EU, that will change the actual O&M paradigm, increasing significantly the competitiveness of RFB energy storage solutions in the global energy sector and creating new business opportunities for the companies involved.			

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

P21	Affordable High-Performance Green Redox Flow Batteries	HIGREEW	web
Call: Advanced Redox Flow Batteries for stationary energy storage (*link*)			
Contact person: Dr Eduardo Sanchez, CIC energiGUNE, esanchez@cicenergigune.com Ms Estibaliz Crespo, CIC energiGUNE, ecrespo@cicenergigune.com			
Start Date:1/11/19	**End date:**31/5/23		
Project Description: The EU-funded HIGREEW project, composed of nine partners plus the coordinator CIC energiGUNE, aims to design an efficient low-cost organic redox flow battery system. The new battery will be based on water-soluble organic electrolytes, which will be low-cost and compatible with optimised low-resistance membranes and fast electrode kinetics. The new technology will allow researchers to develop more environmentally sustainable redox flow batteries with higher power and energy densities while also offering longer duration. The consortium is aiming for a levelised cost of storage below EUR 0.1/kWh/cycle by the end of the project and EUR 0.05/kWh/cycle by 2030.			
Objectives: The objective of HIGREEW (Affordable High-performance Green REdox floW batteries) is to design, develop and validate and an advanced redox flow battery, based on new water-soluble low-cost organic electrolyte compatible with optimized low resistance membrane and fast electrodes kinetics for a high energy density and long-life service. The battery prototype engineering design will be twofold: affordable balance of plant to optimize performance through advanced control strategy to achieve an LCOS of < 0.10€/kWh/cycle at the end of the project and 0.05€/kWh/cycle by 2030 and designed for recycling, to maximize the recycling of the components. The consortium is formed by 9 partners coordinated by CIC Energigune, Spanish research centre, that will be the focus on electrolyte and algorithm development to maximise the batteries life span and minimise its LCOS. The development of advanced materials will be complemented with the University Autonomous of Madrid to improve membranes performance and the French CNRS research centre to optimize the electrode. The 3 key components will be tested and validated at lab scale and cell level with the collaboration of the University of West Bohemia (CZ). The stack engineering will be developed by C-TECH, UK's SME specialised in electrochemical and electro-heating process equipment, that will work together with Pinflow to optimize active components at laboratory scale and battery stack design. The system design and scale up to manufacture a battery prototype of 5Kw will be done in collaboration between Heights, UK's engineering, and Gamesa Electric, Spanish large industry leader in renewables. The battery prototype will be tested and validated in the pilot plant of Siemens Gamesa -third party linked to Gamesa- located in Spain. The testing and validation will be the focus on safety-hazards, LCA and LCOS. The exploitation strategy will be led by Uniresearch, who are highly experienced in EU projects. The project will last 40M with a cost of 3,7M€.			

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

P22	Membrane-free Low cost high Density RFB	MELODY	web
Call: Advanced Redox Flow Batteries for stationary energy storage (*link*)			
Contact person: The MELODY Project, Renewable Energy Department, University of Exeter, Penryn Campus, **info@melodyproject.eu**			
Start Date:1/1/20	**End date:**31/3/24		
Project Description: Redox flow batteries (RFBs) are a promising technology for renewable energy storage. However, obstacles such as costly and scarce materials, the short lifetime of catalysts, and the system's complexity and safety problems have prevented introduction to the mass market. **The EU-funded MELODY project aims to develop a sustainable RFB technology that will significantly reduce electricity storage costs by 2030.** To achieve this, the project will apply a unique triple cost reduction strategy to the standard RFB concept, while also tackling the current technology's technical problems in an integrated manner. This work will pave the way for a more extensive integration of renewables in the European energy mix.			
Objectives: Redox Flow Batteries (RFB) are a key enabling technology for the energy transition. Mass market introduction of RFB's has been hampered by various factors – material scarcity and cost (e.g. vanadium-based RBF), limited catalyst lifetime, membrane costs, system complexity and safety issues. The development of an economically viable, environmentally benign and sustainable redox-flow battery (RFB) storage systems is therefore eagerly awaited. The MEmbraneless LOw cost high DensitY RFB (MELODY) project will develop a sustainable RFB technology that is able to reduce the costs of electricity storage to an absolute minimum, even below the 0.05 €/kWh/cycle by 2030 as set out in the SET plan. MELODY employs a unique triple cost reduction strategy on the conventional RFB concept while tackling all major technical issues in an integrated manner. The three key elements are 1) A membraneless flow battery concept 2) the choice for hydrogen and bromine 3) Simplified system design. This approach will results in the realization and operation technology for a practical membraneless H2-Br2 redox flow battery at industrially relevant scale (based on dedicated Cell, Stack and Balance of Plant development and piloting). Hereby MELODY will improve all elements that will be limiting after successfully eliminating the membrane (Electrode and electrolyte development, sustainability and techno-economic assessments). With an unrivalled low Levelized Cost of Storage MELODY's solution is best positioned to change storage from a pure cost factor into a valuable business cases and will enable a wider integration of renewables in the European energy mix. To successfully complete all objectives as set out in the call, MELODY brings together a world-class consortium of SME's (Elestor, PV3 Technologies, Vertech), industry (Shell) and academic leaders (TU Delft, Technion, University of Exeter, ETH Zurich) that has all required know-how and capabilities to complete the project.			

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

P23	**CObalt-free Batteries for FutuRe Automotive Applications**	**COBRA**	web
Call: Research and innovation for advanced Li-ion cells (generation 3b) (*link*)			
Contact person: cobra@baxcompany.com			
Start Date:1/1/20	**End date:**31/12/23		
Project Description: Cobalt is necessary for the production of the most common types of lithium-ion batteries (Li-ion), like the rechargeable ones used to power our portable electronic devices and electric vehicles. The transition to electric mobility is widening the gap between supply and demand and increasing the price of cobalt. However, substitution of cobalt in Li-ion batteries, although possible, has not taken place. **The EU-funded COBRA project aims to reverse this situation. It is developing a cobalt-free cathode with the participation of three universities and seven research and technology organisations as well as four SMEs and five enterprises, covering the entire value chain of the EU battery industry**.			
Objectives: COBRA aims to develop a novel Co-free Li-ion battery technology that overcomes many of the current shortcomings faced by Electrical Vehicle (EV) batteries via the enhancement of each component in the battery system in a holistic manner. The project will result in a unique battery system that merges several sought after features, including superior energy density, low cost, increased cycles and reduced critical materials. To achieve these ambitious targets we will: upgrade the electrochemical performance by focusing on Co-free cathode, advanced Si composite as anode and electrolyte/separator; cell manufacturing and testing for electrical and electrochemical performance; leverage the use of smart sensors and advanced communication to optimise the system control; battery-pack manufacturing that deliver cost-effective and environmentally sustainable battery over its lifetime. The proposed Li-ion battery technology will be demonstrated at TRL6 (battery pack) and validated it on an automotive EV testbed. The involvement of several leading organisation for battery manufacturing ensure easy adaptation to production lines and scale up to contribute to a higher market adoption while helping to strengthen Europe's position in the field. Overall, the project includes the participation of 3 universities, 7 RTOs, 4 SMEs and 5 enterprises covering the entire value chain and strongly engaging EU battery industry.			

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

P24	Hybrid power-energy electrodes for next generation lithium-ion batteries	Hydra	web
Call: Research and innovation for advanced Li-ion cells (generation 3b) (*link*)			
Contact person: **https://h2020hydra.eu/contact**			
Start Date:1/5/20	**End date:**31/8/24		
Project Description: Lithium-ion (Li-ion) batteries are an advanced battery technology that are used in a wide range of products including personal electronics and electric vehicles. They are also a key enabling technology in emerging markets like grid-scale renewable energy integration and aerospace. To ensure the continued success of these markets, new innovations in Li-ion battery technology are needed to improve performance and reduce the reliance on critical raw materials. **The EU-funded Hydra project aims to develop a new generation of Li-ion technology that uses sustainable materials to improve the energy, power, and cost of the battery**. The project will combine novel materials and environmentally friendly manufacturing techniques with pilot-scale cell manufacturing to develop high-energy batteries with long lifetime. Moreover, it will build a synergy with strong investments by the project's industrial partners, aiming to retain a significant market share for Europe.			
Objectives: The core technological approach of the HYDRA project consists of using hybrid electrode technology to overcome the fundamental limits of current Li-ion battery technology in terms of energy, power, safety and cost to enter the age of generation 3b of Li ion batteries. HYDRA, taking its name from the mythological beast, will use a multi-headed integrative approach: In addition to novel material development and scale-up of components and battery cells manufacturing, assisted by modelling, HYDRA will build a synergy with strong investments by the project's industrial partners and foster reaching and keeping a significant market share for Europe. The necessary competitiveness will be obtained by hybridizing high energy with high power materials. These materials will be implemented at the cell/electrode level, via sustainable, eco-designed scaled-up manufacture and safe electrolyte systems, demonstrated in pilot scale to TRL6, and will be ready for commercialisation 3 years after the project end. To reach this target, HYDRA mobilizes a strong industry commitment: the partners include a strong value-chain of suppliers with global competitiveness for xEV batteries and a direct liaison to the market in sectors such as automotive and maritime transport, ensuring a fast-uptake of results, with an added value of 1BN € in the next decade. Ecological and economical sustainability also keep a strong importance, as HYDRA will be performing life cycle assessments and value-chain analyses on local and global scales. All aspects from raw materials via battery cell production and end-use/market to recycling and 2nd life usage will be evaluated. The HYDRA concept uses abundant electrode materials like iron, manganese and silicon, and eliminates the use of the CRMs cobalt and natural graphite, with a net CRM reduction of >85%. The new materials will be produced in an environmentally friendly, energy-efficient manner, and using water in place of organic solvents.			

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

P25	MODelling of Advanced LI Storage Systems	MODALIS2	web
Call: Li-ion Cell Materials & Transport Modelling (*link*)			
Contact person: Martin Petit, IFP Energies Nouvelles, info@modalis2-project.eu			
Start Date:1/1/20	**End date:**31/12/22		
Project Description: The EU battery sector faces significant challenges in a global, highly competitive environment. As the market of electric vehicles (EVs) and electronic instruments is growing, a new approach is needed that makes the development processes of next-generation battery systems cost-efficient. **The EU-funded MODALIS2 project proposes an all-integrated development process that increases capacity and considerably reduces costs of EV battery cells**. The goal of the project is to develop and validate modelling and simulation instruments for expediting the development of batteries with higher capacity and materials with improved performance. It aims to increase battery safety during transport and functioning, optimise cyclability and decrease production costs. The project will test and prepare the new cell generation with a high capacity of storage for mass production.			
Objectives: For a competitive EU battery sector, the development of next-generation battery systems needs cost-efficient processes. MODALIS² will make a significant contribution to a cost-down for EV battery cells through an all-integrated development process based on numerical tools relying on extensive measurement data and material characterization all the way down to micro-structures. With the integrated modelling and simulation, MODALIS² will provide degrees of freedom for the cell and battery development processes that allows to address the following design challenges: i) faster development of batteries with higher energy density with new materials; ii) faster development of materials with higher optimized performances for higher-energy battery applications; iii) improved battery safety during transport and operation; iv) optimization of cyclability; v) lower development costs; and vi) better understanding of material interactions within the cell. The main achievement of MODALIS² is to develop and validate modelling & simulation tools for Gen 3b cells by aiming for higher capacities for the positive & negative electrodes; and for Gen 4b cells by enabling the use of solid electrolytes for improved safety and to facilitate the use of Li-M for the negative electrode. These new technologies are submitted to new specific mechanisms and phenomena (mechanical stresses on negative electrodes, volumetric expansion, solid electrolytic conduction) that are not considered by current modelling and simulation tools. MODALIS² will address the material characterization of next-generation (3b and 4b) Li-Ion cells in different physical domains, then expanding a carefully chosen set of models towards integrating new cell generations and implementing the models into a numerical simulations toolchain scalable to mass production. The modelling & simulation toolchain will allow faster time-to-market for next-gen cells.			

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

P26	MODelling of Advanced LI Storage Systems	LiPLANET	web

Call: Network of Li-ion cell pilot lines (*link*)

Contact person: https://www.liplanet.eu/join

Start Date:1/1/20	**End date:**31/3/22

Project Description: The development of e-mobility and electric power sectors are strategic goals of the European Union. However, Europe still needs more efficient, high-performance Li-ion batteries as there is Asian dominance in this field. The EU must develop a competitive Li-on battery production value chain**. The EU funded LiPLANET project aims to create an ecosystem for viable industrial scale manufacture of high-performance Li-ion cells**. This will be achieved with a network of significant European Li-ion cell pilot lines and most important related entities. Their tasks will be to identify needs and assets, organise cooperation of scientists and industry, trainings and legal framework enabling pilot lines, as well as testing methods to form the production roadmap.

Objectives: The development of cost-effective, reliable, and high-performance battery cells will be essential to strategic sectors in Europe such as the automotive industry (electro-mobility) and the electric power sector. However, the world production of battery cells is largely dominated by Asian companies. To reduce the gap with the battery cell production in Asia and become a world leader, the EU must have independent capacity to develop, upscale and produce battery cells.

LiPLANET aims to build a more competitive Li-ion battery cell manufacturing ecosystem and increase the production of Li-ion cells towards industrial scale, by bringing together the most relevant European Li-ion cell pilot lines and the main stakeholders of the battery sector. The creation of a network of Li-ion cell pilot lines will allow to exploit synergies between pilot line operators, identify knowledge and equipment gaps, organise joint trainings as well as, favour collaboration with industry and academia, and facilitate the access to market.

For this purpose, different activities have been designed:

-the mapping of the European Li-ion cell pilot lines and the implementation of a network,

-the creation of a standardised legal framework and a data exchange platform for the cooperation between industry, academia and pilot lines,

-a round-robin test to compare qualification methods,

-the development of a roadmap to reach industrial scale production.

LiPLANET's consortium is formed by recognised entities in this field. In that sense, they will be in a good position to create awareness of the network. The grounds of the project and sustainability of the network (based on a series of services provided to the battery industry) were first discussed during the European Battery Cells R&I workshop in January 2018 in Brussels, and during a dedicated workshop in September 2018 in Frankfurt.

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

P27	**MODelling of Advanced LI StoHigh-Voltage Spinel LNMO Silicon-Graphite Cells and Modules for Automotive and Aeronautic Transport Applications rage Systems**	**HighSpin**	Web

Call: Cross-sectoral solutions for the climate transition (HORIZON-CL5-2021-D2-01) (*link*)	
Contact person: AIT AUSTRIAN INSTITUTE OF TECHNOLOGY GMBH , (*link*)	
Start Date: 1/9/22	**End date:** 31/8/26
Project Description: The EU-funded HighSpin project aims to strengthen the position of the European battery industry by delivering the next generation of battery cells for automotive and aviation applications. In particular, it aims to develop a cell with a silicon/graphite anode and lithium nickel manganese oxide cathode. The HighSpin cell will be designed for 2 000 deep cycles and will deliver an energy density of 390 Wh/kg. Project activities will include microstructure optimisation of the active materials, development of high-voltage electrolyte formulations, high-speed laser structuring of the electrodes, and the inclusion of cell-level sensors. Researchers aim to bring the technology to TRL 6.	
Objectives: HighSpin aims to develop high-performing, safe and sustainable generation 3b high-voltage spinel LNMO||Si/C material, cells and modules with a short industrialization pathway and demonstrate their application for automotive and aeronautic transport applications. The project addresses in full the scope of the HORIZON-CL5-2021-D2-01-02 topic, setting its activities in the “high-voltage” line. The project objectives are: Further develop the LNMO||Si/C cell chemistry compared to the reference 3beLiEVe baseline, extracting its maximum performance. Develop and manufacture LNMO||Si/C cells fit for automotive and aeronautic applications. Design and demonstrate battery modules for automotive and aeronautic applications. Thoroughly assess the LMNO||Si/C HighSpin technology vs. performance, recyclability, cost and TRL. The HighSpin cell delivers 390 Wh/kg and 925 Wh/l target energy density, 790 W/kg and 1,850 W/l target power density (at 2C), 2,000 deep cycles, and 90 €/kWh target cost (pack-level). The project activities encompass stabilization of the active materials via microstructure optimization, the development of high-voltage electrolyte formulations containing LiPF6 and LIFSI, high-speed laser-structuring of the electrodes, and the inclusion of operando sensors in the form of a chip-based Cell Management Unit (CMU). HighSpin will demonstrate TRL 6 at the battery module level, with a module-to-cell gravimetric energy density ratio of 85-to-90% (depending on the application). Recyclability is demonstrated, targeting 90% recycling efficiency at 99.9% purity. HighSpin aims at approaching the market as a second-step generation 3b LNMO||Si/C in the year 2028 (automotive) and 2030 (aeronautics), delivering above 40 GWh/year and 4 billion/year sales volume in the reference year 2030.	

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

P28	**Innovative and Sustainable High Voltage Li-ion Cells for Next Generation (EV) Batteries**	**IntelLiGent**	web
Call: Cross-sectoral solutions for the climate transition (HORIZON-CL5-2021-D2-01) (*link*)			
Contact person: SINTEF AS **(link)**			
Start Date: 1/9/22		**End date: 31/8/25**	
Project Description: Focusing on electromobility applications, especially electric cars, buses and trucks, the EU-funded IntelLiGent project will develop and demonstrate European generation 3b high voltage lithium-ion batteries with increased energy density, faster charging and longer cycle life. IntelLiGent will combine Co-free high voltage cathodes with high-capacity silicon-graphite anodes to increase energy- and power- densities. As an evolution of existing chemistries, the manufacturing processes are compatible with those currently used commercially, and so the project goal is to provide a direct boost to the European battery value chain by enabling world-leading battery technologies using already optimised manufacturing methods. Further, the project will focus on materials production and processing routes which substantially reduce the manufacturing cost and environmental footprint.			
Objectives: The IntelLiGent project answers to the need for general public acceptance of EVs, by facilitating the industrial deployment of next-generation batteries allowing for an increased driving range, fast charging capabilities, low cost and increased safety. **IntelLiGent will develop European generation 3b high voltage (>4.7 V) LIBs with increased energy density (>350-400 Wh/kg, 750-1000 Wh/l), charge acceptance (>2C) and cycle-life (>2000 deep cycles) compared to the state-of-the-art, while reducing cost (<100 €/kWh on pack level) and carbon footprint of the produced ce**lls. The ambitious goals will be realized through optimized cells produced with; - High-voltage spinel LNMO cathode materials engineered to enhance stability and enable aqueous processing whilst exploring strategies to increase specific capacity beyond the theoretical maximum of standard LNMO - Energy efficient high-capacity stable Si-Gr anodes delivering 850 mAh/g - High-voltage electrolytes with innovative additives that form protective layers on the anode and the cathode - Self-mitigating and healing binders and separators minimize parasitic reactions and degradation - Novel open-source modelling tools and high-throughput screening will be employed to accelerate the development of environmentally benign materials with minimized use of critical raw materials -Optimized electrode design (≥4.5 mAh/cm2) and cell design-based commercial-scale automotive cells (20 Ah) as well as battery modules (1 kWh) at TRL 6 From an industrial viewpoint, a prerequisite for succeeding is continuity in battery R&D&I projects and training/education of required staff, which IntelLiGent will foster by broad dissemination and exploitation of the project results across the battery value chain. The project will result in strengthening of the European battery value chain by developing European industries with leading-edge technologies on battery materials, and allowing for accelerated roll-out of electrification for mobility.			

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

<table>
<tr><td>P29</td><td>Composite Silicon/Graphite Anodes with Ni-Rich Cathodes and Safe Ether based Electrolytes for High Capacity Li-ion Batteries</td><td>SiGNE</td><td>web</td></tr>
<tr><td colspan="4">Call: Cross-sectoral solutions for the climate transition (HORIZON-CL5-2021-D2-01) (link)</td></tr>
<tr><td colspan="4">Contact person: UNIVERSITY OF LIMERICK (link)</td></tr>
<tr><td colspan="2">Start Date: 1/9/22</td><td colspan="2">End date: 31/8/25</td></tr>
<tr><td colspan="4">Project Description: The EU-funded SiGNE project aims to develop advanced lithium-ion battery technology with higher energy density, optimised chemistry and faster charging time compared to state of the art. To achieve their goals, researchers will use a certain amount of silicon in the anode and electrically connect it to the graphite material. Nanowires will improve silicon's beneficial properties by increasing the amount of available surface area in contact with the electrolyte. A sustainable fibre-based separator will be developed, acting as an isolation layer between the anode and cathode. Researchers will demonstrate the innovative battery at scale to enable its adoption in electric vehicles. Furthermore, they will consider circular economy principles to address second-life applications once the lifespan of the battery comes to an end.</td></tr>
<tr><td colspan="4">Objectives: SiGNE will deliver an advanced lithium-ion battery (LIB) aimed at the High Capacity Approach targeted in this work programme. Specific objectives are to (1) Develop high energy density, safe and manufacturable Lithium ion battery (2) optimise the full-cell chemistry to achieve beyond state of art performance (3) Demonstrate full-cell fast charging capability (4) Show high full-cell cycling efficiency with >80% retentive capacity (5) Demonstrate high sustainability of this new battery technology and the related cost effectiveness through circular economy considerations and 2nd life battery applications built upon demonstrator and (6) Demonstrate high cost-competitiveness, large-scale manufacturability and EV uptake readiness. SiGNE will achieve these objectives by incorporation of 30% Si as a composite where it is electrically connected to the Graphite in nanowire form. This will realise a volumetric ED of >1000 Wh/L when pre-lithiated and paired with a Ni-rich NCM cathode optimised to deliver 220 mAh/g. This will be further enabled by a specifically designed electrolyte to maximise the voltage window and enable stable SEI formation. A sustainable fibre based separator with superior safety features s in terms of thermal and mechanical stability will be developed. SiGNE will establish the viability of volume manufacturing with production quantities of battery components manufactured by project end. The battery design and production process will be optimised in a continuous improvement process through full cell testing supported by modelling to optimise electrode and cell designs through manufacture as a prismatic cell and prototype testing at by OEMs. (SOH) monitoring across the entire battery lifecycle will optimise safety 2nd use viability. SIGNE will go significantly beyond SoA with recovery of anode, cathode and electrolyte components. In this circular economy approach recovered materials will be returned to the relevant work package to produce new electrodes.</td></tr>
</table>

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

P30	**Gen. 4b Solid State Li-ion battery by additive manufacturing**	**AM4BAT**	web
Call: Cross-sectoral solutions for the climate transition (HORIZON-CL5-2021-D2-01) (*link*)			
Contact person: ACONDICIONAMIENTO TARRASENSE ASSOCIACION (link)			
Start Date: 1/7/22	**End date:** 30/6/26		
Project Description: Next-generation lithium-ion batteries will need to offer higher energy and power densities at a lower cost. Current battery manufacturing is struggling to further improve these key metrics. **The EU-funded AM4BAT project will leverage additive manufacturing technologies for fabricating 3D lithium-ion batteries. Using vat photopolymerisation 3D printing, the aim is to develop a high-performance battery with energy density of 400 Wh/kg for electric vehicles.** AM4BAT outcomes will contribute to the creation of a sustainable European battery manufacturing value chain, helping the EU to succeed in the electric mobility rollout.			
Objectives: AM4BAT will develop innovative component materials and assemble an anode-free all-solid-state battery (ASSB) manufactured by a cost-competitive and sustainable vat photopolymerization 3D printing. The objective is to reach a high-performance battery the energy density of 400 Wh/kg and 1000 Wh/L for electric vehicles applications. This will be achieved by developing materials including i) single crystal NMC811 with superior energy, ii) LNMO Co-free and higher voltage for power AM4BAT variant, iii) dopped LLZO with different size from 0.5 to 5µm and 50-100 nm for higher loading in the HSE, and iv) novel acrylic, nanocellulose, sustainable photocurable polymer. The materials will be optimized for their processing by additive manufacturing. AM4BAT will then validate the technology via 3-Ah pouch cells reaching TRL5, and will carry out an evaluation of manufacturability, a full sustainability assessment and a recycling study to support customers' uptake. Identified stakeholder groups as well as other research initiatives will be actively involved to ensure dissemination of AM4BAT results and broader users' acceptance. With its ambitious concept based on cutting-edge 3D printed ASSB and a strong consortium involving the whole value chain from material providers to an OEM, AM4BAT aims to overcome the remaining technological obstacles of the Gen 4b technology as specified in the work programme and accomplish the urgent shorter-term needs of the battery industry: to make Gen 4b batteries a viable technology beyond 2025. On longer term, the AM4BAT outcomes will contribute to the creation of a sustainable European battery manufacturing value chain helping the EU to succeed in the electric mobility roll-out and accelerate the energy transition.			

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

<table>
<tr><td>P31</td><td>Halide solid state batteries for ELectric vEhicles aNd Aircrafts</td><td>HELENA</td><td>web</td></tr>
<tr><td colspan="4">Call: Cross-sectoral solutions for the climate transition (HORIZON-CL5-2021-D2-01) (link)</td></tr>
<tr><td colspan="4">Contact person: CENTRO DE INVESTIGACION COOPERATIVA DE ENERGIAS ALTERNATIVAS FUNDACION, CIC ENERGIGUNE FUNDAZIOA (link)</td></tr>
<tr><td colspan="2">Start Date: 1/6/22</td><td colspan="2">End date: 31/5/26</td></tr>
<tr><td colspan="4">Project Description: The next generation in electric vehicle batteries will probably see the replacement of lithium-ion batteries with higher-performing alternatives. It is therefore crucial to develop different types of solid-state batteries to fulfil the growing energy density requirements. Generation 4b batteries have higher energy densities and longer ranges. The EU-funded HELENA project will respond to the need for a safe, high energy efficiency solid-state battery cell. Researchers are looking to produce a Generation 4b battery with a high-energy density lithium metal anode, a nickel-rich nickel–manganese–cobalt cathode and a superionic halide solid electrolyte. Project activities should enable low-cost, scalable and safe cell manufacturing and fast battery charging, thereby boosting the electric vehicles’ driving range.</td></tr>
<tr><td colspan="4">Objectives: To support the upcoming short-term needs of the battery industry, it is imperative to have new differentiating European battery technology for 4b generation batteries on the market from 2025. Halide solid state batteries for ELectric vEhicles aNd Aircrafts (HELENA) responds to the need of the development of a safe, novel high energy efficiency and power density solid state battery (4b generation batteries) cells, based on high capacity Ni-rich cathode (NMC), high-energy Li metal (LiM) anode and Li-ion superionic halide solid electrolyte for application in electric vehicles and, especially in aircrafts. HELENA will support Europe, in this sense, on its transition towards a climate-neutral continent since electric aviation is poised to take off within the next five to 10 years, with innovations already being pursued for electric vehicle batteries. Moreover, HELENA will avoid dependence on Asia for battery production. HELENA is built by a multidisciplinary and highly research experienced consortium that covers the whole battery value chain and proposes a disruptive halide-based solid-state cell technology with the overall aim to significantly increase the adoption of these batteries on aircrafts and EVs The technical challenges that are presented by current conventional battery technology and the consumer needs will be overcome - especially the reduction in costs of battery devices, enable scalable and safe cell manufacturing, increasing their capabilities for long distance traveling and fast charging, ensuring a high safety of the battery.</td></tr>
</table>

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

P32	SOLID-STATE LITHIUM METAL BATTERY WITH IN SITU HYBRID ELECTROLYTE	SEATBELT	web
Call: Cross-sectoral solutions for the climate transition (HORIZON-CL5-2021-D2-01) (*link*)			
Contact person: CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS **(link)**			
Start Date: 1/7/22	**End date:** 30/6/26		
Project Description: Electric vehicles are powered by batteries, which are the most important part. But the demand for electric vehicles is increasing so fast that it will soon outpace battery cell production. **The EU-funded SEATBELT project will help to pave the road towards a cost-effective, robust all-solid-state lithium battery comprising sustainable materials by 2026. Specifically, it will achieve the first technological milestone of developing a battery cell that meets the needs of the electric vehicle industry.** The low cost cell will be safe by design with sustainable and recyclable materials, reaching high energy densities and long cyclability in line with the 2030 EU targets. The project will be the start point of the first EU all solid-state battery value chain.			
Objectives: As of 2025, new generations of Li batteries based on silicon/carbon (Gen. 4a) and Li metal (Gen. 4b) anode, where flammable liquid electrolyte is replaced by a non-flammable solid-one, will take over the current Li-ion device. However, only all-solid-state Gen. 4b Li batteries are expected to fulfil the needed cell gravimetric energy density specifications demanded by electromobility and stationary applications. Therefore, SEATBELT ambition is to generate a local EU industry that revolves around a cost-effective, robust all-solid-state Li battery comprising sustainable materials by 2026. SEATBELT intends to achieve the first technological milestone of developing a battery cell (TRL5) meeting the needs of Electric Vehicle (EV) and stationary industry. The low-cost SEATBELT cell is safe-by-design with sustainable and recyclable materials, reaching high energy densities (>380 Wh/kg) and long cyclability (>500 cycles) by 2026 in line with the 2030 EU targets. The cells are produced by low-cost solvent-free extrusion process comprising a combination of innovative materials: thin Li metal, hybrid electrolyte, a safe cathode active material without critical materials and thin Al current collector. The cell design being optimized by interface (operando and atomistic modelling) and process (machine learning) methodologies. In addition, new in situ imaging instrumentation will be developed to investigate safety properties and mechanical deformation to assess cell safety in real conditions. An innovative recycling cycle from materials to cell level will be also established. Thus, SEATBELT will be the start point of a first EU all-solid-state battery value chain, whose main players in RTD and Industry sectors are within the consortium. So, cells and modules will cycle using industrially relevant protocols dedicated to EV and stationary applications. SEATBELT consortium is composed of 14 beneficiary partners and 3 affiliated entities, and one associated partner, from 7 European countries with an overall budget of 7851448.50€.			

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

P33	**Development of ADVAnced next GENeration Solid-State batteries for Electromobility Applications**	**ADVAGEN**	web
Call: Cross-sectoral solutions for the climate transition (HORIZON-CL5-2021-D2-01) (*link*)			
Contact person: AVESTA BATTERY & ENERGY ENGINEERING (link)			
Start Date: 1/8/22		**End date:** 31/7/26	
Project Description: To date, the battery market is dominated by lithium-ion (Li-ion) chemistries, as the energy density has more than doubled and their costs have dropped by a factor of at least 10. However, conventional Li-ion batteries (LIB) are reaching their performance limits in terms of energy density and facing safety issues, is required the development and production of new battery generations, such as Solid-State Batteries (SSBs), to create a new industry value chain in Europe towards their commercialization. Consequently, high-energy-density EU-made SSBs will ensure the supply of, among others, the automotive sector. To do so, the development and deployment of new manufacturing technologies, enabling the large-scale production of SSBs, is crucial. Indeed, among the overarching themes to develop and produce sustainable batteries in the future, the BATTERY 2030+ roadmap4 considers manufacturability as a cross-cutting key area. Innovative and scalable manufacturing techniques to produce SSBs will accelerate cost reduction, energy savings, and enhanced safety. **ADVAGEN will develop a new lithium metal (LiM) battery cell technology based on a safe, reliable, and high performing hybrid solid-state electrolyte (LLZO-LPS based), gaining a competitive advantage over the worldwide (mainly Asian) competition**. This will sustainably strengthen the EU as a technological and manufacturing leader in batteries as specified in the ERTRAC electrification roadmap and SET-Plan Action Point-7. ADVAGEN consortium contains key EU actors in the battery sector, from industrial materials producers (SCHT, CPT, ABEE), battery manufacturer (ABEE) to R&D centers (IKE, CEA, IREC, TUB, CICe, POLITO, INEGI, UL, FEV) and the automotive industry (TME), covering the complete knowledge and value chain. By developing high-performance, affordable and safe batteries, ADVAGEN aims to re-establish European competitiveness in battery cell production.			
Objectives: New project - no information available.			

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

P34	**PUlsed Laser depoSition tEchnology for soLid State battery manufacturIng supported by digitalizatiON**	**PULSELiON**	web
Call: Cross-sectoral solutions for the climate transition (HORIZON-CL5-2021-D2-01) (*link*)			
Contact person: RISE RESEARCH INSTITUTES OF SWEDEN AB (***link***)			
Start Date: 1/9/22	**End date:** 31/8/2026		
Project Description: The EU aims to have at least 30 million zero-emission vehicles on the roads by 2030. In-house production of high-performance battery technology is key to the wider adoption of electric vehicles. **The EU-funded PULSELiON project aims to develop the manufacturing technology for Generation 4b solid-state batteries.** These batteries will comprise a lithium-metal anode, sulfide solid electrolytes and a nickel-rich nickel–manganese–cobalt cathode. A novel pulsed laser deposition technique will be adapted and modified into a single-step vacuum process for safe and efficient manufacturing of the batteries' anode components. The cathode layer will be produced using conventional wet processing techniques.			
Objectives: Europe's objective to have 30 million electric vehicles (EVs) by 2030 can only be achieved by large scale, in-house production of highly effective and performant batteries. Development of solid-state battery technologies could improve the energy density and safety of lithium metal solid state batteries. PULSELiON project aims to develop the manufacturing process of Gen 4b solid-state batteries (SSBs) based on lithium-metal anode, sulfide solid electrolytes, and Nickel-rich NMC cathode. Novel pulsed laser deposition technique developed by PULSEDEON will be adapted and modified into a single-step vacuum process for safe and efficient manufacturing of anode components composed of lithium metal, protective layers, and sulfide based solid electrolytes. The cathode layer will be made based on conventional wet processing techniques. Initially, the anode and cathode layers will be developed in small scale for making coin cells and monolayer cells for optimising the materials and process. SSB cells will be developed with optimised process routes and will be upscaled to a pilot line proof-of-concept (TRL 6) by manufacturing large scale solid-state batteries (10 Ah). Digitalisation will be incorporated in the process modelling task with the inputs obtained from process upscaling and cell testing tasks, which will enable efficient process optimisation.			

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

P35	Sustainable manufacturing and optimized materials and interfaces for lithium metal batteries with digital quality control	SOLID	web
Call: Cross-sectoral solutions for the climate transition (HORIZON-CL5-2021-D2-01) (*link*)			
Contact person: TEKNOLOGIAN TUTKIMUSKESKUS VTT OY – VTT (link)			
Start Date: 1/9/22	**End date:** 1/9/26		
Project Description: The SOLiD project will create a sustainable and cost-efficient pilot scale manufacturing process for a high energy density, safe and easily recyclable solid-state Li-metal battery. We will use roll-to-roll (R2R) dry extrusion coating for the blend of cathode active material, solid polymer electrolyte, and conducting additives. R2R slot die coated primers on the cathode current collector will enhance adhesion, performance and corrosion resistance of the cell. The polymer electrolyte layer will be R2R coated, using an optimal design for the slot die head. For the Li metal anode, we will utilize cost-efficient R2R pulsed laser deposition, which enables minimizing the Li thickness down to 5 µm. The Li metal production will be combined with an inline process for interfacial engineering to ensure compatibility with the other layers and stability. The process development will be supported by digitalization methods to go towards zero-defect and cost-efficient manufacturing. The proposed methods enable sustainable manufacturing of Gen. 4b solid state batteries with minimised amount of critical raw materials (Co and Li), and with superior performance and safety: The protective layers enable the use of NMC811, which reduces the amount of Co into minimum without compromising the lifetime, and PLD process helps to minimize the Li thickness. Dry coating eliminates the use of toxic solvents and energy-consuming drying steps, and the digital quality control will reduce the amount of waste. The thickness of each layer will be minimized to reach energy density above 900 Wh/l. Cost will be reduced by cost-effective production methods and by maximizing the yield. Safety and long cycle life are guaranteed by the solid electrolyte and the protective interlayers. Supported by the life-cycle thinking and stakeholder engagement, the SOLiD project will enable the design for a sustainable solid state battery factory of the future.			
Objectives: New project - no information available.			

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

<table>
<tr><td>P36</td><td>Scalable and sustainable pilot line based on innovative manufacturing technologies towards the industrialization of solid-state for the automotive sector</td><td>SPINMATE</td><td>web</td></tr>
<tr><td colspan="4">Call: Cross-sectoral solutions for the climate transition (HORIZON-CL5-2021-D2-01) (link)</td></tr>
<tr><td colspan="4">Contact person: AVESTA BATTERY & ENERGY (link)</td></tr>
<tr><td colspan="2">Start Date: 1/8/22</td><td colspan="2">End date: 31/7/26</td></tr>
<tr><td colspan="4">Project Description: EU-funded SPINMATE aims to demonstrate a scalable, sustainable, safe and cost-effective digital-driven proof-of-concept pilot line, at a TRL6 level, as a first step towards the large-scale manufacturing of generation 4b (Gen 4b) SSB cells and module to support the electrification of the automotive sector. To do so, SPINMATE proposes the development and implementation of innovative and scalable manufacturing and processing solutions. SPINMATE's Gen 4b SSB cells will create a new industry value chain in Europe towards their commercialisation. This new generation technology will ensure enhanced energy densities, overcoming current LIB limitations; improved safety; increased sustainable mass production; and decreased carbon footprint and cost.</td></tr>
<tr><td colspan="4">Objectives: SPINMATE aims to demonstrate a scalable, sustainable, safe and cost-effective digital-driven proof-of-concept pilot line, at a TRL6 level, as a first step towards the large-scale manufacturing of generation 4b (Gen 4b) SSB cells and module, in order to support the electrification of the automotive sector. To do so, SPINMATE proposes the development and implementation of innovative and scalable manufacturing and processing solutions (notching/cutting, stacking and sealing/packaging steps, among others). Furthermore, new industry 4.0 and 5.0 concepts (Industrial Internet of Things – IIoT and Machine Learning – ML algorithms, Digital Twins, giga-factory line simulation,…) are proposed to be applied for the digitalisation of the proof-of-concept pilot line, as well as the assembly and manufacturing processes. Thus, SPINMATE will manufacture small 1 Ah and large 10 Ah SSB cells, after the development and optimisation of (i) advanced solid polymer electrolyte with high ionic conductivity and wide electrochemical stability, (ii) Li metal foil with surface treatment enabling a more stable interface as anode and (iii) Ni-rich layered oxide cathode with improved cycling stability. Regarding electrodes (i.e. anode and cathode) and electrolyte processing, innovative solvent-free extrusion routes, roll-to-roll approach and optimised solvent casting methods are suggested. SPINMATE's Gen 4b SSB cells will create a new industry value chain in Europe towards their commercialisation. This new generation technology will ensure (i) enhanced energy densities, overcoming current LIB limitations, (ii) improved safety in both solutions and workers; (iii) increased sustainable mass production; and (iv) decreased carbon footprint and cost</td></tr>
</table>

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

<table>
<tr><td>P37</td><td>Carbon Neutral European Battery Cell Production with Sustainable, Innovative Processes and 3D Electrode Design to Manufacture</td><td>BatWoMan</td><td>web</td></tr>
<tr><td colspan="4">Call: Cross-sectoral solutions for the climate transition (HORIZON-CL5-2021-D2-01) (link)</td></tr>
<tr><td colspan="4">Contact person: AIT AUSTRIAN INSTITUTE OF TECHNOLOGY GMBH (link)</td></tr>
<tr><td colspan="2">Start Date: 1/9/22</td><td colspan="2">End date: 31/8/25</td></tr>
<tr><td colspan="4">Project Description: Europe's leadership position in sustainable battery production will be secured via new sustainable and cost-efficient lithium-ion battery cell production. This is the goal of the EU-funded BatWoMan project, paving the way towards carbon-neutral cell production. The project's efforts will focus on energy efficient and no volatile organic compounds processed electrodes, with slurries of high dry mass content. It will also establish an innovative dry room reducing concept with improved electrolyte filling. Low-cost and energy-efficient cell conditioning, namely wetting, formation and ageing, is also on the project's agenda. An innovative platform based on AI will support these technological improvements. The overall goal of the project is to reduce by more than half the cell production cost and energy consumption.</td></tr>
<tr><td colspan="4">Objectives: BatWoMan develops new sustainable and cost-efficient Li-ion battery cell production concepts, paving the way towards carbon neutral cell production within the European Union. This is realized via the following technological efforts: 1) energy-efficient, no volatile organic compounds (VOCs) processed electrodes, with slurries of high dry mass content; 2) innovative dry room reducing concept with improved electrolyte filling; 3) low-cost and energy-efficient cell conditioning, namely wetting, formation and ageing. The above stated technological improvements will be supported digitally via creating an AI-driven, innovative platform for smart re-tooling, constantly monitoring the sustainability and efficiency of the proposed individual production steps and developing a battery data space providing relevant cell background data. This way, BatWoMan will lead to estimated cell production cost reduction of 63.5% and cell production energy consumption reduction by 52.6% and therefore enable a European leadership position in sustainable battery production.</td></tr>
</table>

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

<table>
<tr><td>P38</td><td>Towards the sustainable giga-factory: developing green cell manufacturing processes</td><td>GIGAGREEN</td><td>web</td></tr>
<tr><td colspan="4">Call: Cross-sectoral solutions for the climate transition (HORIZON-CL5-2021-D2-01) (link)</td></tr>
<tr><td colspan="4">Contact person: VIRTUAL VEHICLE RESEARCH GMBH (link)</td></tr>
<tr><td colspan="2">Start Date: Not available</td><td colspan="2">End date: Not available</td></tr>
<tr><td colspan="4">Project Description: The EU has established an ambitious industrial goal to make Europe a strategic global leader in the Li-ion battery value chain, deploying a sustainable and innovative industry. This urges the sector to make sure that the industrial production is inherently sustainable, safe, flexible and cost-effective while delivering cutting edge cells. The main objective of GIGAGREEN is to boost the next wave of electrode and cell component processing techniques, enabling breakthrough innovations to improve the environmental, economic and social performance of generation 3b Li-ion cells manufacturing industry, thus positioning Europe at the forefront of the global market. GIGAGREEN proposes a structured research plan to develop and scale up (TRL 3-4 to 5-6) novel electrode and cell component manufacturing processes that follow a Design to Manufacture (DtM) approach. This is, seeking for the minimum environmental impact and energy consumption, cell designs which facilitate the re-use and disassembly, increasement of the cost-efficiency and safety of processes and products, and high-throughput technologies able to be easily scaled up and automated in the context of industry 4.0/5.0 giga-factories. Supported by a vibrant and experienced consortium of academic and industrial partners, GIGAGREEN will follow two alternative R&I trajectories. The first one, based on N-Methyl-2-pyrrolidone (NMP)-free wet processing, is designed for a quick scale up and market uptake of optimised wet coating systems in current industrial setups (final TRL6, 30 cells of 10 Ah prototyped as demonstration). The second one, based on dry processing, will explore breakthrough technologies, achieving a smaller TRL by the end of the project (final TRL5, 30-40 mAh monolayer pouch cells prototypes as proof of concept), paving the path for upcoming R&I experiences to continue scaling up the most promising dry processing techniques.</td></tr>
<tr><td colspan="4">Objectives: New project - no information available.</td></tr>
</table>

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

<table>
<tr><td>P39</td><td>Green and Sustainable Processes for Electrode Production</td><td>greenSPEED</td><td>web</td></tr>
<tr><td colspan="4">Call: Cross-sectoral solutions for the climate transition (HORIZON-CL5-2021-D2-01) (link)</td></tr>
<tr><td colspan="4">Contact person: VIRTUAL VEHICLE RESEARCH GMBH (link)</td></tr>
<tr><td colspan="2">Start Date: 1/7/22</td><td colspan="2">End date: 31/12/25</td></tr>
<tr><td colspan="4">Project Description: Lithium-ion technology is the means to greener and more sustainable mobility and other mobile applications, but the process of cell manufacturing is still energy consuming and using environmentally harmful substances. The greenSPEED project offers solutions for new sustainable electrode and cell manufacturing processes with reduced energy consumption, lower carbon footprint and ZERO Volatile Organic Compounds (VOCs) emissions. To that aim, the project main target is developing a battery cell comprised of electrodes manufactured by innovative dry processes. Our composite cathode, based on Ni-rich NMC, is to be manufactured by scalable roll-to-roll dry electrode coating process, that fully removes the use of casting-solvents and eliminates the need of energy-intense drying-, condensate and transportation process required in state-of-the-art electrode fabrication. The greenSPEED high-capacity pure-silicon anode is to be manufactured taking full advantage of our innovative process based on Microwave-Assisted Plasma Enhanced Chemical Vapor Deposition (MW-PECVD), which deposits porous silicon directly on the copper current-collector starting from locally produced silane gas (SiH_4). Moreover, the use of advanced modelling and simulation techniques including digital twins, artificial intelligence, and machine learning are to be employed to predict and optimise cell performance in early development stages, support the cell production process by virtually assessing the influence and importance of production parameters and thus minimising the number of experiments and to accelerate electrode production optimisation steps. The greenSPEED cell aims at increasing energy density (+69%) while reducing energy consumption (-32%) and costs (-21%) of production as compared to state-of-the-art Li-ion cells. The concepts here proposed have been already demonstrated at TRL 2/3 with the aim of reaching TRL 5/6 by the end of the project.</td></tr>
<tr><td colspan="4">Objectives: New project - no information available.</td></tr>
</table>

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

<table>
<tr><td>P40</td><td colspan="2">Eliminating VOC from Battery manufacturing through dry or wet processing</td><td>NoVOC</td><td>web</td></tr>
<tr><td colspan="5">Call: Cross-sectoral solutions for the climate transition (HORIZON-CL5-2021-D2-01) (link)</td></tr>
<tr><td colspan="5">Contact person: RISE RESEARCH INSTITUTES OF SWEDEN AB (link)</td></tr>
<tr><td colspan="2">Start Date: 1/9/22</td><td colspan="3">End date: 31/8/26</td></tr>
<tr><td colspan="5">Project Description: Improvements in battery technology are necessary to drive forward the electric vehicle (EV) industry in Europe. The EU-funded NoVOC project plans to design two competitive cell-manufacturing technologies for automotive batteries: dry and wet cell. Researchers will manufacture automotive cells in two formats – pouch and cylindrical – at a fraction of the current costs of cell manufacturing. Importantly, the cells will contain no toxic organic solvents.</td></tr>
<tr><td colspan="5">Objectives: The project NoVOC addresses the topic Environmentally sustainable processing techniques applied to large scale electrode and cell component manufacturing for Li ion batteries. The activities of NoVOC are tailored to the challenges addressed by the call topic: 1. Lower carbon footprint cell manufacturing in Europe. 2. New sustainable electrode and cell manufacturing techniques with low energy consumption, and no Volatile Organic Compounds (VOCs) emissions. 3. Electrode coating production techniques eliminate organic solvents reduce the capital costs associated to the solvent recovery system. 4. Dry manufacturing techniques with next generation materials. 5. Industrializing closed loops and process design to return low-value chemicals from manufacturing processes to high-value products. In NoVOC we aim to design and demonstrate two competitive cell manufacturing technologies aqueous and dry cell manufacturing technologies for automotive batteries intended for production in Europe. The innovations proposed in NoVOC centre on improvements of cell manufacturing process by integrating two novel electrode manufacturing processes into the currently available cell assembly process and demonstrate manufacturability of automotive cells in two formats (pouch and cylindrical) with no toxic organic solvent at the fraction of the cell manufacturing cost that is currently available today. Next generation cell manufacturing processes developed in Europe for electric vehicles batteries.</td></tr>
</table>

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

<table>
<tr><td>P41</td><td>Sodium-Ion and sodium Metal BAtteries for efficient and sustainable next-generation energy storage</td><td>SIMBA</td><td>web</td></tr>
<tr><td colspan="4">Call: Building a Low-Carbon, Climate Resilient Future: Next-Generation Batteries (H2020-LC-BAT-2019-2020) (link)</td></tr>
<tr><td colspan="4">Contact person: TECHNISCHE UNIVERSITAT DARMSTADT Dr. Magdalena Graczyk-Zajac</td></tr>
<tr><td colspan="2">Start Date:1/1/21</td><td colspan="2">End date:30/6/24</td></tr>
<tr><td colspan="4">Project Description: The transition to green energy requires innovative energy storage solutions that combine improved performance, recyclability and sustainability. The battery of the future has to be safe, energy-dense, low-cost and highly efficient. Electrochemical energy storage systems offer the most promising solution, and sodium ions could meet these standards. To address this challenge, the EU-funded SIMBA project aims at developing a cost-effective, safe, all-solid-state battery with sodium as the mobile ionic charge carrier for stationary energy storage applications. Breaking new ground in sustainable energy storage, SIMBA could help solve a major problem of the energy revolution.</td></tr>
<tr><td colspan="4">Objectives: The project main goal is the development of a highly cost-effective, safe, all-solid-state-battery with sodium as mobile ionic charge carrier for stationary energy storage applications. To achieve this goal, several aspects need to be considered including material innovations, sustainable electrode and cell manufacturing, improved characterisation and understanding of the electrochemical processes. SIMBA has the ambitious and realistic goal to tackle these challenges and has formulated the following objectives: (1) Safer batteries with a novel Solid-State Electrolyte (SSE) (TRL3-5), by developing a new class of single-ion conducting polymers (SIPEs) and its production method. (2) Higher energy density and more durable anodes by developing materials up to TRL5 using sustainable manufacturing methods. (3) Low-cost and higher energy cathode materials, by developing ultra-low-cost Prussian White (PW) and high energy density layered oxides (P2/O3) up to TRL5. (4) Obtaining deep understanding of fundamental mechanisms incl. degradation phenomena, taking place at the Solid-Electrolyte-Interface (SEI) and within the battery components. (5) Demonstration of a scaled-up highly efficient 12V, 1Ah battery module incl. BMS to validate the re-use of materials, recyclability, performance, LCA, and potential for further development. Jointly this will result in a sodium-based battery demonstrating the improved performance, recyclability and sustainability, for a stationary energy storage use-case, including a detailed Total Cost of Ownership analysis.</td></tr>
</table>

<table>
<tr><td>P42</td><td>CURRENT DIRECT – Swappable Container Waterborne Transport Battery</td><td colspan="2">CURRENT DIRECT</td><td>web</td></tr>
<tr><td colspan="5">Call: Building a Low-Carbon, Climate Resilient Future: Next-Generation Batteries (H2020-LC-BAT-2019-2020) (link)</td></tr>
<tr><td colspan="5">Contact person: link</td></tr>
<tr><td colspan="2">Start Date: 1/1/21</td><td colspan="3">End date: 31/12/23</td></tr>
<tr><td colspan="5">Project Description: A shift towards clean energy is a difficult but necessary task for the transport sector, which is responsible for a quarter of Europe's greenhouse gas emissions. This creates a specific challenge for the waterborne transport field, where, according to prognosis, emissions will increase rapidly, thus hindering the goals of the Paris Agreement. The use of batteries can reverse this trend, but current technology makes them much too expensive. To solve the problem, the EU-funded Current Direct project proposes to develop and demonstrate an innovative lithium-ion cell engineered for waterborne transport. It is based on novel manufacturing techniques that will enable significant cost reduction and fast adoption of methods supporting reduced greenhouse gas emissions.</td></tr>
<tr><td colspan="5">Objectives: The transport sector contributes to almost a quarter of Europe's greenhouse gas (GHG) emissions. Compared to other sectors, such as agriculture or energy industries, it is the only sector with emissions higher than that of 1990. Waterborne transport emissions represent around 13% of the overall EU greenhouse gas emissions from the transport sector. Moreover, waterborne transport emissions could increase between 50% and 250% by 2050 under a business-as-usual scenario, undermining the objectives of the Paris agreement. The challenge for a large-scale adoption and implementation of batteries for waterborne transport is mainly related to the high costs of the battery systems and cells.
The Current Direct project addresses these challenges by proposing an innovative lithium-ion cell optimized for waterborne transport, using novel manufacturing techniques allowing for a consistent cost reduction compared to the current market prices. Additionally, a swappable containerized energy storage system optimized for cost and operation in the waterborne transport industry will be developed.
The overarching aim of the Current Direct project is to develop and demonstrate an innovative interchangeable waterborne transport battery system and EaaS Platform in an operational environment at the Port of Rotterdam at TRL7 that facilitates fast charging of vessels, fleet optimization and novel business models. The Current Direct project is dedicated to (i) significantly reduce the total cost of waterborne transport batteries, (ii) cut GHG emissions of the marine transport sector through electrification of vessel fleets, (iii) increase the energy density of waterborne battery cells and (iv) trigger investments for innovation, job and knowledge creation in the European marine transport and battery sector.</td></tr>
</table>

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/

P43	Solutions for largE bAtteries for waterBorne trAnsporT	SEABAT	web
Call: Building a Low-Carbon, Climate Resilient Future: Next-Generation Batteries (H2020-LC-BAT-2019-2020) (*link*)			
Contact person: Dr.ir Jeroen Stuyts, Email: **Jeroen.Stuyts@flandersmake.be**			
Start Date:1/1/21	**End date:**31/12/24		
Project Description: The waterborne transport sector is very active, playing a central role in the globalised market. It is also an energy intensive sector that is looking for ways to reduce its carbon footprint. **The EU-funded SEABAT project will provide an alternative to previous energy storage solutions for waterborne transport by developing a full-electric maritime hybrid battery concept**. This concept combines two different battery types in a standardised and modular package that may allow it to be produced in larger quantities and profit from economies of scale.			
Objectives: The overall objective of SEABAT is to develop a full-electric maritime hybrid concept based on (1) combining modular high-energy batteries and high-power batteries, (2) novel converter concepts and (3) production technology solutions derived from the automotive sector. A modular approach will reduce component costs (battery, convertor) so that unique ship designs can profit from economies of scale by using standardised low-cost modular components. The concept is suitable for future battery generations and high-power components that may have higher power densities or are based on different chemistries. Expected results: optimal full-electric hybrid modular solution, minimising the battery footprint and reducing the oversizing (from up to 10 times down to max. 2 times). Validating as a 300 kWh system (full battery system test) at TRL 5, and virtually validating the solution for batteries of 1 MWh and above, using 300 kWh system P-HiL tests. The result will be a validated hybrid battery solution for capacities of 1 MWh and beyond, a roadmap for type approval and a strategy towards standardisation for (among others) ferries and short sea shipping. The solution will deliver a 35-50% lower total cost of ownership (TCO) of maritime battery systems, including 15-30% lower CAPEX investment, 50% lower costs of integration at the shipyard and a 5% investment cost recuperation after the useful life in the vessel. The SEABAT consortium unites all the necessary expertise for developing the hybrid topology and implementing it in the industry. The market pick-up of the SEABAT solution is maximised by having 20 shipbuilders and integrators in the consortium; they are represented by the SOERMAR association. The stakeholder group, in which end users and port authorities are represented, supports the wide adoption of the SEABAT solution in the European maritime market, and the increase in European skills base in large battery technology and manufacturing processes.			

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101058124
https://enicon-horizon.eu/